Republic of Iraq
Ministry of Higher Education & Scientific Research
University of Baghdad
College of Dentistry

The Efficacy of Hydraulic Pressure Sinus Lift Versus Osteotome Lift Via Crestal Approach Utilizing Sinus Endoscopy (A Randomized Clinical Study)

A thesis
Submitted to the council of the College of Dentistry at the University of Baghdad, in partial fulfillment of requirements for the Degree of Master of Science in
Oral and Maxillofacial Surgery

Submitted by
Aseel Hamid Madab
B.D.S.

Supervised by
Prof. Dr. Thair A. Lateef
B.D.S., H.D.D., F.I.B.M.S.

2019 A.D. 1440 A.H.

Certification of the Supervisor

I certify that this thesis entitled "**The Efficacy of Hydraulic Pressure Sinus Lift Versus Osteotome Lift Via Crestal Approach Utilizing Sinus Endoscopy (A Randomized Clinical Study)**" was prepared by **Aseel Hamid Madab** under my supervision at the College of Dentistry/ University of Baghdad in partial fulfilment of the requirements for the degree of Master of Science in Oral and Maxillofacial Surgery.

Signature

Professor

Dr. Thair A. Lateef

B.D.S., H.D.D., F.I.B.M.S.

(The supervisor)

Linguistic certification

This is to certify that the thesis entitled **" The Efficacy of Hydraulic Pressure Sinus Lift Versus Osteotome Lift Via Crestal Approach Utilizing Sinus Endoscopy (A Randomized Clinical Study)"** was prepared under my linguistic supervision. Its language was amended to meet the style of the English language.

Signature:

Prof. Dr. Abdulkarim Fadhil Jameel

Linguistic Reviewer / / 2019

Certification of the examination committee and the dean

We, the members of the examining committee, certify that after reading the thesis and examining the student **"Aseel Hamid Madab"** in its contents, it is adequate for the award of the Degree of Master of Science in Oral and Maxillofacial Surgery.

Signature
Assistant Professor
Dr. Sahar Shakir Al-Adili
B.D.S, M.Sc. (Oral and Maxillofacial Surgery)
(Chairman of Examination Committee)

Signature
Assistant Professor
Dr. Hassanien A. Al-Jumaily
B.D.S, CABMS
(Oral and Maxillofacial Surgery)
(Member)

Signature
Consultant
Dr. Waleed Khaleel Ismael
B.D.S, F.I.B.M.S.
(Oral and Maxillofacial Surgery)
(Member)

Approved by the council of the College of Dentistry/University of Baghdad.

Signature
Professor
Dr. Hussain F. Al-Huwaizi
B.D.S, M.Sc., Ph.D.
Dean of the College of Dentistry
University of Baghdad

Dedication

To a piece of Aden my home land and culture that is watered with science, blood and sun ray, to Mesopotamia, the cradle of civilizations and sciences and will always be.

My father, the pacemaker of my life. My mother, god's second paradise on earth, my beloved sisters and loved ones, I dedicate my humble effort to you.

Acknowledgement

First and above all, I praise **Allah**, the almighty for providing me this opportunity and granting me the capability to proceed successfully.

This thesis appears in its current form due to the assistance of several people and guidance of my supervisor. I would therefore like to offer my sincere thanks to all of them.

I'm profoundly grateful to the Dean of Dentistry College, University of Baghdad **Prof. Dr. Hussein F. Al-Huwaizi** for his assistance and kind attitude with all master students.

It's a pleasure to thank Assistant Dean for Scientific Affairs and students **Prof. Dr. Nidhal H. Ghaib** in facilitating routine procedures.

I must also acknowledge **Assist Prof. Dr. Sahar Shakir Al-Adili**, Chairman of Oral and Maxillofacial Surgery Department.

Prof. Dr. Thair A. Lateef, my esteemed supervisor, my cordial thanks for accepting me as M.Sc. student, suggesting the topic of this essay, his warm encouragement, expertise, thoughtful guidance, critical comments and correction of thesis. I doubt that I will ever be able to convey my appreciation fully but I owe him my eternal gratitude.

I would like to express my extreme sincere gratitude and appreciation to **Assist Prof. Dr. Salwan Y. Bede.**, member of the teaching faculty in Oral and Maxillofacial Surgery Department for his endless help and generous advices in writing and pedagogy.

With boundless love and appreciation, I would like to thank members of teaching of Oral and Maxillofacial Surgery Department**, Dr. Auday M. Al-Ani, Dr. Hassanein A. Hadi.**

I'm highly indebted to **Dr. Huda M. Ismael** member of teaching of Oral and Maxillofacial Surgery department for her guidance and advices throughout the study and assistance in publishing my article.

I would like also to thank my colleagues from my internship at Oral and Maxillofacial Surgery department **Dr. Ali Ghaith Ahmed, Dr. Athra'a A. Ahmed, Dr. Mustafa Al Najjar, Dr. Ahmed Makky Abbas.,** and **Dr. Shahad A. Ameer.,** for their wonderful collaboration, you supported me greatly and were always willing to help me.

I'm thankful to my statistician **Dr. Monaf Faiq Ahmed** for his knowledge in analyzing thesis data.

Abstract

Background: Rehabilitation of posterior maxilla is compromised by deficient residual bone height that inversely affects the primary dental implant stability. Sinus lift procedure, which was developed and has been applied widely in clinics, for maxillary sinus membrane elevation either the lateral or the crestal approach is used depending on the bone height of the residual ridge. Crestal approach had the limelight among clinicians due to it’s many advantages in comparison with the lateral approach. Nonetheless, the crestal approach has several drawbacks in that the osteotome technique depends heavily on the skill of the clinician and give rise to complications such as headache and vertigo after sinus lift procedure. Various surgical procedures and devices have been developed to overcome the shortcomings of the osteotome technique. Among these devices using hydraulic pressure for sinus membrane elevation have demonstrated a low risk of sinus membrane perforation as well as ease of application. Since in general crestal approach defined to be a blind approach in which sinus membrane perforation cannot be recognized clearly, thus endoscopic surgery has change the philosophy and practice of modern implant surgery in all aspects. It give rise to minimally invasive surgery procedures based on the ability to visualize and to operate via small channels.

Aims:

1. To evaluate the efficacy of hydraulic sinus lift with the use of osung sinus lift kit.

2. To assess for the presence of sinus membrane perforation with endoscopy.

Materials and methods: This clinical prospective randomized study was organized from December 2017 to December 2018. Simultaneous 52 implants placement with sinus augmentation (one-stage surgery) were done for 30 patients (5 males and 25 females) with a mean age of 46.86 years (range: 19-72) divided into 2 groups: group A (Osung) the hydraulic pressure technique and group B (Osteotome) the conventional osteotome technique, were enrolled in this study. For each patient, a presurgical examination with orthopantomography and cone beam computed tomography for initial assessment of the residual bone height, endoscope used intraoperatively in each case to asses the presence of *shniedrian membrane* perforation, followed by augmentation of the sinus with osteon III plus collagen membrane.

Results: Twenty seven cases (51.9%) were managed by osung procedure for sinus lift, while twenty five cases (48.1%) were performed by osteotome sinus lift. The mean of subantral bone height for patients managed by osung procedure was 4.77 ± 1.17 mm, while those with osteotome procedures was 4.89 ± 1.32 mm. There was no statistical significant difference between them. Also there was no significant difference regarding the thickness of *shniedrian membrane* between perforated cases (0.97 ± 0.74 mm) and nonperforated ones (0.69 ± 0.71 mm), the P value was (0.516). Perforation of sinus membrane observed in 12% of cases managed by osteotome procedure and in 3.7% of cases treated by osung kit.

Conclusion: The use of endoscope is simple, easy, and quick for direct visualization of the Schneider membrane. Results from this study exhibited that maxillary sinus floor elevation using Osung water lift system via crestal approach is a predictable procedure with a low perforation rate as compared with Osteotome technique.

List of contents

Subject	Page No.
Acknowledgment	I
Abstract	III
List of contents	V
List of tables	VIII
List of figures	IX
List of abbreviation	XIII
Introduction	1
Aims of the study	4
Chapter One: Review of literature	
1.1 Historical background	5
1.2 Embryology	5
1.3 Surgical anatomy	5
1.3.1 The maxillary sinus and ostiomeatal complex	5
1.3.2 Sinus septa	7
1.3.3 Blood supply	8
1.3.4 Venous drainage	9
1.3.5 Innervation	9
1.4 Antral mucous membrane (*Schneidrian membrane*)	10
1.5 Maxillary sinus bacterial flora	11
1.6 Maxillary sinus functions	11
1.7 Sinus compliance	11
1.8 Sinus pnuematization (SP)	12
1.9 Cone beam computed tomography (CBCT)	14
1.9.1 CBCT applications	15
1.9.2 Features specific to MS observed in CBCT	16
1.10 Indications for sinus lift procedure	17
1.11 Classification of alveolar bone availability	17
1.12 Sinus lift approaches	19
1.12.1 Lateral approach	19
1.12.1.2 Disadvantages of lateral window technique	20
1.12.2. Crestal (Transalveolar or Transcrestal) approach	20
1.12.2.1 Advantages of crestal approach	24
1.12.2.2 Disadvantages	25
1.13 Endoscopic sinus lift surgery	25
1.14 Sinus augmentation	28

1.14.1 Biomaterials in sinus augmentation procedures	29
1.15 Complications associated with crestal approach	31
Chapter Two: Materials and Methods	
2.1 Study sample	38
2.1.1 Eligibility criteria	39
2.1.2 Exclusion criteria	39
2.2 Armamentariums & medications	40
2.3 Methodology	47
2.3.1 Study design	47
2.3.2 Preoperative assessment	48
2.3.2.1 History	48
2.3.2.2 Clinical examination	48
2.3.2.3 Radiological examination	48
2.4 Patient's preparation	51
2.5 Surgical procedure	51
2.6 Instructions & postoperative care	63
Chapter Three: Results	
3.1. Sinus lift procedure	65
3.2. Age and gender	66
3.3. Preoperative CBCT examination	67
3.3.1. SP degree	67
3.3.2. Subantral bone height	68
3.4. Tooth site No.	69
3.5. Dental implant dimensions	70
3.6. Perforation of sinus membrane	71
Chapter Four: Discussion	
4.1. Sinus lift procedure	76
4.2. Age and gender	79
4.3. Preoperative CBCT examination	80
4.3.1. SP degree	80
4.3.2. Subantral bone height	80
4.4. Dental implant dimensions	81
4.5. Perforation of sinus membrane	82
4.6. The role of endoscopy	83
4.7. Sinus membrane thickness	89
Conclusions	**92**
Suggestions	**93**
References	**94**

List of tables

Table No.	Table title	Page No.
Chapter two: Materials & Methods		
2.1	Study sample.	39
Chapter three: Results		
3.1	The distribution of study patients by type of sinus lift procedure.	65
3.2	The distribution of study patients by age and gender.	66
3.3	The distribution of study patients by SP degree.	67
3.4	The comparison in the mean of subantral bone height between group A & B.	68
3.5	The distribution of study patients by tooth site No.	69
3.6	The distribution of cases by dental implant dimensions.	70
3.7	The comparison between SL procedures by perforation of sinus membrane.	71
3.8	The association between perforation of sinus membrane and general characteristics.	72
3.9	The association between perforation of sinus membrane and SP degree.	73
3.10	The association between perforation of sinus membrane and tooth site No.	73
3.11	The association between perforation of sinus membrane and dental implant dimensions.	74
3.12	The comparison in mean of subantral bone height between cases with perforated sinus membrane and those with intact one.	74
3.13	The comparison in mean of membrane thickness between cases with perforated sinus membrane and those with intact membrane.	75

List of figures

Figure No.	Figure title	Page No.
Chapter one: Review of literature		
1.1	Schematic representation of the alveolar antral artery as anastomosis of the posterior superior alveolar artery with the infraorbital artery	9
1.2	Frontal section of the maxillary sinuses. Hyperpneumatization of the left sinus and atrophy of the alveolar ridge subsequent to tooth loss is evident	13
1.3	The high pressure pushes the *Schneiderian membrane* away from the drill.	24
1.4	Demonstration of varying distances at which the PSAA is located.	34
Chapter two: Materials & Methods		
2.1	The surgical set.	40
2.2	Dental implant engine (Dentium Co., Korea) illustrating settings of the device.	40
2.3	(A, B, C) OCA-KIT (Osung Co., Germany).	41
2.4	(A) Implant surgical kit (NucleOss T6 Co., Turkey). (B) DI with S.L.A surface inside its package (NucleOss T6 Co., Turkey).	42
2.5	(A) Sinus osteotomes kit type A (Dentium Co., Korea), (B) Surgical mallet used with osteotomes to create a greenstick fracture of the antral floor (Leeds Co., England).	42
2.6	(A, B) SY-P029-1 medical video endoscope (Sunny Medical Equipment Ltd. Co., China).	43
2.7	(A, B) Collagen membrane (Genoss Co., Korea).	44
2.8	Osteon III lifting in its package (Genoss Co., Korea).	44
2.9	(A) Vernier (Medident Co., Australia). (B) Vernier (Hardened Co., China).	45
2.10	(A) & (B) Kodak 9500 Cone Beam 3D System with effective dose 92 µSv & Orhtopantogram system with effective dose 11.9 (Carestream CS 8100 3D Health Inc., France).	45
2.11	Sequential flow chart.	47
2.12	Preoperative panoramic view demonstrating a general preliminary outline of the MS for initial	49

	assessment of both sides and interpretation for the anatomical limitations (MS, nasal cavity, mandibular canal & mental foramen).	
2.13	Preoperative panoramic view showing the distance from the midline of maxilla to the anterior sinus border. SP3 degree of sinus pneumatization in the left side (23 mm).	49
2.14	Preoperative CBCT scan: (A) Panoramic view illustrating general sinus view, any sinus abnormality, subantral distance & membrane thickness. (B) Illustrating axial, coronal, 3D views presenting jaw orientation determining width and bone height of implant recipient site.	50
2.15	Preoperative CBCT scan (panoramic view) revealing the subantral distance (SAD) at different points to determine the lowest height and where SL should be performed.	50
2.16	(A) Three sided flap (limited flap design commences from tooth #12, to tooth #14. (B) Reflection of full mucoperiosteal flap noticing the bulge of the lateral wall of the sinus which clarify the it's extension.	52
2.17	OCA-KIT with drills & stoppers.	52
2.18	(A) OKA-KIT pilot and cannon drills. (B): Pilot drilling initiated at osteotomy site verifying the proposed implant site. (C): Cannon drill ⦰ 3.2 mm and stopper at the site of tooth #3.	53
2.19	Portraying the use of sensor gauge to ensure sinus floor opening.	54
2.20	Cannon drill A.I (⦰ 3.2 mm) with its edge cutting features and non-traumatic apical end.	54
2.21	OKA-KIT aqua tap with their diameters.	55
2.22	Aqua tap connected to the tube that already connected to a plastic syringe loaded on aqua syringe so as to get rid of air bubbles.	55
2.23	(A) & (B) Insertion of final aqua tap assembled with the specific stopper and adaptor in order to perform the aqua lift of sinus membrane.	56
2.24	Aqua syringe connected to the aqua tap boosting normal saline solution gradually to accomplish membrane lifting at tooth site # 3.	56

2.25	Aqua syringe locking device.	57
2.26	(A) & (B) Parallel pins in initial osteotomy sites verifying the proposed implants position and angulation.	58
2.27	Gentle and controlled firm tapping of the sinus floor utilizing 3.4 mm osteotome & mallet with the assistant supporting patient's head.	58
2.28	(A) Endoscopic parts assembled together, (B) Drying the socket by cotton swabs to prevent lens beclouding.	59
2.29	(A) Introducing the endoscopic camera into the socket, (B) Endoscopic monitor turned on displaying implant bed and membrane with clarity.	59
2.30	(A) Intact Schneider membrane with grayish-bluish hue (B) Piece of sinus floor following fracture with part of Schneider membrane that is intact (this picture mostly seen when SL is performed by the OCA-KIT). (C) & (D) Displaying obvious sinus membrane perforation during osteotome and Osung techniques respectively.	60
2.31	(A) Resorbable collagen membrane soaked in normal saline solution. (B) The membrane is folded and hosted into SMS in tooth site # 3. (C) Osteon III sinus bone graft installed through implant bed into the SMS in tooth site # 14. (D) Successive insertion of the bone graft with the aid of OKA-KIT bone condenser in tooth site # 3.	61
2.32	(A) Motorized installation of DI at tooth site # 3. (B) Connecting the cover screws to the DI.	62
2.33	Wound closure.	62
	Chapter three: Results	
3.1	Distribution of study patients by type of sinus lift procedure.	65
3.2	Distribution of study patients by age.	66
3.3	Distribution of study patients by gender.	67
3.4	Distribution of study patients by SP degree.	68
3.5	Difference in mean the of subantral bone height between patients in group A and B.	69
3.6	Distribution of study patients by tooth site No.	70
3.7	Distribution of cases by dental implant dimensions.	71

3.8	The difference between SL procedures by perforation of sinus membrane.	72
Chapter four: Discussion		
4.1	Endoscopy illustrating the microstructure of the sinus membrane.	85
4.2	Perforated sinus membrane clearly visualized with the aid of endoscope.	85
4.3	No evidence of sinus membrane perforation at rest position.	87
4.4	(A) A proper application of collagen barrier membrane beneath the sinus membrane (B) The non-autogenous bone graft material can be clearly illustrated with the use of endoscope.	88

List of abbreviations

Abbreviation	Complete word
3D	3-Dimensional
AAA	Alveolar antral artery
&	And
A.I	Artificial intelligence
BPPV	Benign paroxysmal positional vertigo
β-TCP	Beta-tricalcium phosphate
BCP	Biphasic calcium phosphate
BMD	Bone mineral density
BMP	Bone morphogenetic protein
Ca-p	Calicium phosphate
°C	Celsius degree
CEJ	Cemento enamel junction
Co.	Company
CT	Computed tomography
CBCT	Cone beam computed tomography
cc	Cubic centimeter
DI	Dental implant or implants
Ø	Diameter
Fig.	figure
1^{st}	First
GBR	Guided bone regeneration
HU	Hounsfield unit
HA	Hydroxy apatite
kHz	Kilohertz
kV	Kilovolt
IP/MM	Lines per millimeter (camera resolution units)
LCD	Liquid crystal display
MS	Maxillary sinus or maxillary sinuses
Max	Maximum
μm	Micrometer
μSV	MicroSievert
mSV	MiliSievert
mA	Mill amperage
mg	Milligram

mL	Milliliter
mm	Millimeter
Min	Minimum
N/cm	Newton/centimeter
N.S	Non-significant
#, No.	Number
OPG	Orthopantomogram
OMSFE	Osteotome maxillary sinus floor elevation
OCA	Osung crestal approach
ORC	Oxidized regenerated cellulose
%	Percentage
PSME	Piezoelectric sinus membrane elevation
PDGF	Platelet derived growth factors
PRF	Platelet rich fibrin
PSSA	Posterior superior alveolar artery
P	Probability
QR	Quick response
RBH	Residual bone height
rpm	Revolutions per minute
S.L.A	Sand blasted. Large grit. Acid etched.
2^{nd}	Second
Sig	Significant
SA	Sinus augmentation
SCS	Sinus cavity space
SFE	Sinus floor elevation
SL	Sinus lift
SMS	Sinus membrane space
SP	Sinus pneumatization
S	Small
S.D	Standard deviation
SBH	Subantral bone height
SAD	Subantral distance
Tab	Tablet
3^{rd}	Third
TGF-β	Transforming growth factors

Introduction

Introduction

The maxillary sinuses were first discovered by ***Leonardo da Vinci*** in **1489**. It governs approximately 12 to 15 mL of air **(Chanavaz, 1990)**, and opens into the inferior aspect of the ethmoidal infundibulum through an ostium; of particular importance is the integrity of the ostiomeatal complex which is the morphfunctional unit responsible for drainage and aeration of the anterior ethmoidal, maxillary, and frontal sinuses **(Testori *et al*., 2010)**.

Pneumatization could happen in all paranasal sinuses during growth period causing them to enlarge in volume but when affects maxillary sinuses particularly after tooth extraction this leads to insufficient alveolar ridge height for dental implant installation necessitating atraumatic sinus membrane elevation and surgical void augmentation with different grafting materials **(Sharan & Madjar, 2008)** to enable placement of implants other than short one because the minimum length for predictable dental implant success is 10 mm or what is called the standard length implant **(Griffin & Cheung, 2004)**.

Implant placement has become a widespread dental procedure to restore the edentulous jaw with functional defects. However, in many cases, insufficient vertical bone height of the residual ridge and poor bone quality give rise to difficulties in implant placement in the maxillary posterior area. This is partially due to the rapid progression of alveolar bone resorption and pneumatization of the maxillary sinus after tooth extraction. To overcome such anatomical and physiological problems, a sinus lift procedure, which was composed of a maxillary sinus membrane elevation step and bone graft step, was developed and has been applied widely in clinics.

The crestal approach, which is known as the osteotome technique, was introduced first in **1977** by ***Tatum*** and published in **1986**.

Summers In **1994** modified this technique suggesting the use of a specific set of osteotomes for preparing the implant site and elevating the sinus floor. The crestal approach had the limelight among clinicians due to its many advantages in comparison with the lateral approach.

Kim *et al.* in **2013** reported devices using hydraulic pressure for sinus membrane elevation have demonstrated a low risk of sinus membrane perforation as well as ease of application. Recently, companies have developed devices for the sinus lift procedure by the crestal approach using a special drilling system and hydraulic pressure.

Kim *et al.* in **2008** stated that the most common intraoperative complication seems to be *Schneiderian membrane* perforation. Large tears can cause sinusitis, graft infection, or graft displacement into the sinus which could compromise new bone formation and implant survival **(Reiser *et al.*, 2001)**.

Endoscopy has changed the philosophy and practice of modern surgery, all types of maxillofacial surgery are now commonly done endoscopically **(Pedroletti *et al.*, 2010).** The introduction of the endoscope into dental implant procedures, particularly transalveolar sinus lifts, has made advances in implantation techniques possible **(Zheng *et al.*, 2014)**. A technique to raise the sinus membrane during the operation under endoscopic control was introduced in the late 1990s **(Engelke & Deckwer, 1997)**.

Nahlieli *et al.* in **2011** described the **Modular Implant Endoscope**, in working options, endoscopic observations, and highlighted its potential for the development of innovative endoscopic techniques for dental implant procedures. The advantages of using it in dental implant procedures were described, and examples of how miniature visualization and surgical endoscopic techniques can be applied to increase the success of implantation are outlined. The new **modular implant endoscope** accurately identified all microanatomical and pathological structures, and simplified dental implant procedures.

This randomized clinical study is accomplished to evaluate the efficiency of hydraulic sinus lift technique using Osung kit versus the conventional osteotome technique with the aid of sinus endoscopy. The current research is the first of it’s kind to be transpired in Iraq.

Aims of study

The study is aimed to:

1. Evaluate the efficacy of hydraulic sinus lift with the use of osung sinus lift kit.
2. Assess the presence of maxillary sinus membrane perforation with the use of sinus endoscopy.

Chapter One
Review of literature

Review of Literature

1.1 Historical background

The maxillary sinuses (MS) were first discovered and demonstrated by ***Leonardo da Vinci*** in **1489** but the earliest attribution of importance was given to ***Nathaniel Highmore,*** the British surgeon and anatomist who designated it in detail in **1651**. However, it was only in the late **19th** century that the first comprehensive, organized anatomical and pathological descriptions of the paranasal sinuses were issued by ***Zuckerkandl*** **(Sargi & Casiano, 2007)**.

1.2 Embryology

The MS is the first sinus to develop in utero. After birth, it undergoes two periods of rapid growth, between birth and 3 years of life, then between ages 7 and 18 years **(Sargi & Casiano, 2007)**.

It is not seen on imaging at birth and presents as a shallow rounded sac. Rapid pneumatization is noticed between 1 and 4 years. The floor of the sinus reaches level of the inferior meatus by 7 years of age and the adult appearance is attained by 12 and 14 years when the floor of the sinus reaches level of the nasal cavity floor **(Vaid & Vaid, 2015)**.

1.3 Surgical anatomy

1.3.1 The maxillary sinus and ostiomeatal complex

Since the maxillary sinus lift procedure has become routine in oral rehabilitation, detailed knowledge related to maxillary sinus anatomy and its variations is indispensable **(Malec *et al.*, 2015)**.

The MS is the largest of the paranasal sinuses. It has an estimated volume of approximately 12 to 15 cm **(Chanavaz, 1990; Cordioli *et al.*, 2001)**.

The average dimensions of the adult sinus are 2.5 to 3.5 cm wide, 3.6 to 4.5 cm tall, and 3.8 to 4.5 cm deep **(Van Den Bergh *et al*., 2000)**.

The MS has a pyramidal shape with an anterior wall corresponding to the facial surface of the maxilla. Its posterior bony wall separates it from the pterygomaxillary fossa medially and from the infratemporal fossa laterally. Its medial wall does not contain any bone; it is formed by the middle meatus mucosa, a layer of connective tissue and the sinus mucosa. The floor of the MS is formed by the alveolar process of the maxillary bone and the hard palate. It lies at the same level of the floor of the nose in children, and 5-10 mm under the floor of the nose in adults and in an edentulous patient, it is 1 cm below the nasal floor **(Van Cauwenberge *et al*., 2006)**.

The sinus floor extends anteriorly to the premolar or canine region and posteriorly to the maxillary tuberosity with in many cases its lowest part close to the area of the first molar. It is the thickest wall in dentate adults **(Woo & Le, 2004)**.

The roof of the MS corresponds to the floor of the orbit, and frequently shows a posteroanterior bony canal for the distal part of the second branch of the trigeminal nerve **(Kubal, 1998)**.

The components of the ostiomeatal complex comprise the maxillary ostium, middle meatus, ethmoidal infundibulum, bulla ethmoidalis, uncinate process, and hiatus semilunaris **(Vaid *et al*., 2011)**.

The maxillary ostium is located along the superior aspect of the medial sinus wall drains into the base of the ethmoidal infundibulum **(Kubal, 1998)**.The size of the ostium varies between (3-10) mm and it can exhibit variable shapes and positions **(May *et al*., 1990)**. The fact that the ostium is high in the medial wall reduces the likelihood of a blockage during sinus augmentation **(Van Den Bergh *et al*., 2000)**.

1.3.2 Sinus septa

One of the most common morphological variations was described by ***Underwood*** in **1909** as sinus septa **(Underwood, 1910)**. They are walls of cortical bone present within the maxillary sinus; their shape has been described as an inverted bow arch arising from the inferior or lateral walls of the sinus, and may even divide the sinus in two or more cavities **(Farmand, 1986; Kannaperuman *et al*., 2015)**. Even though ***Underwood*** **(Underwood, 1910)**, published a detailed description of MS anatomy in **1910**. For decades these septa were considered clinically insignificant anatomical variations until the advent of sinus augmentation **(Kannaperuman *et al*., 2015)**.

Septa prevalence should be considered on each occasion prior to sinus lift surgery, as its presence may lead to perforation or tearing of the *Schneiderian membrane* or a reduction in the capability of augmentation steps in treatment success rate **(Malec *et al*., 2015)**.

It is important for septa to be accurately diagnosed on preoperative imaging. The occurrence and location of MS septa have been evaluated using panoramic radiography and computed tomography (CT). The prevalence of sinus septa varies from 16% to 58% according to **Kannaperuman *et al*., 2015** and around 24.6% with no relation of patient's age or gender in contribution to **Raghunathan *et al.***, **2016**.

Ulm *et al.* in **1995** considered the incidence of septa if they measured more than 2.5 mm**,** while **Diserens *et al*.** in **2005** considered only bony septa more than 4 mm in height or width because they can cause problems during sinus lift.

Ella *et al*. in **2008**, defined septa as one or more cortical bony ridges of at least 4 mm.

1.3.3 Blood supply

The posterior superior alveolar artery, inferior orbital artery, greater palatine artery, and sphenopalatine artery are the main branches of the maxillary artery that provide blood supply to the bony walls and membrane of the antrum. The sites of the inferior orbital and the posterior superior alveolar arteries are important in surgical planning as damage to these arteries could cause bleeding **(Hur *et al*., 2009; Rosano *et al*., 2011)**.

The two arteries reconnect with each other and form a double arterial arcade which encompasses the MS **(Kqiku *et al*., 2013)**.

This anastomosis is either extraosseous 23-26 mm away from alveolar ridge or endosseous 16.4 -19.6 mm from the alveolar margin **(Rosano *et al*., 2011)**.

The dental branch of the posterior superior alveolar artery has an endosseous anastomosis with the inferior orbital artery in all dissected anatomical cases, but this anastomosis is found radiographically in only 50% of cases **(Solar *et al*., 1999; Kqiku *et al*., 2013)**. Of particular importance is the intraosseous anastomosis which is also called **alveolar antral artery (AAA)**. It was first described in **1934** and it passes through the area where the bony window (in lateral approach) is most frequently opened during sinus elevation **(Strong, 1934)**, as illustrated in figure (Fig.) (1.1):

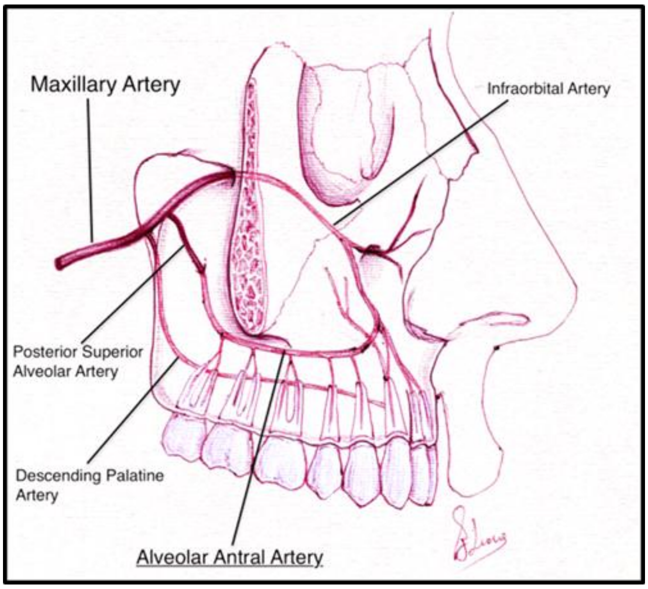

Figure (1.1): Schematic representation of the alveolar antral artery as anastomosis of the posterior superior alveolar artery with the infraorbital artery (Valente, 2016).

1.3.4 Venous drainage

Take place through the facial, sphenopalatine veins and pterygoid venous plexus. The importance of the vascular drainage of antrum lies in the fact that apart from joining typical ways in the maxilla to the jugular veins, it can as well drain ascending into the ethmoid and frontal sinuses and ultimately reach the cavernous sinus in the brain. Extension of infection through this course is a grave complication of MS infections **(Hauman *et al*., 2002)**.

1.3.5 Innervation

Is by the maxillary nerve. The posterior and middle superior alveolar nerves supply posterior wall of the sinus, anterior superior alveolar nerve supply anterior wall of the sinus, infraorbital nerve supply superior wall and part of medial wall, and the greater palatine nerve supply ostium and inferior wall of the sinus **(Wang & Katranji, 2008; Danesh-Sani *et al*., 2016)**.

1.4 Antral mucous membrane (*Schneidrian membrane*)

The MS bony cavity is lined with the sinus membrane, also known as the *Schneiderian membrane* (SM) **(Van Den Bergh *et al*., 2000)**.

In **1660, *Schneider*** who was a German anatomist first described the nasal mucous membrane. It is characterized by periosteum overlaid with a thin layer of pseudociliated stratified respiratory epithelium constituting an important barrier for the protection and defense of the sinus cavity. In normal conditions, the membrane has a thickness of approximately 0.8 mm **(Pandit & Chopra, 2016)**.

Antral mucosa is thinner and less vascular than nasal mucosa **(Van Den Bergh *et al*., 2000)**, while; in smokers, it diverges from very thin and nearly absent to very thick with a squamous type of epithelium. This can be measured effectively by cone beam computed tomography (CBCT) **(Janner *et al*., 2011)**.

Usually normal membrane consists of ciliated and nonciliated pseudostratified columnar epithelium intermingled with goblet cells. The ciliated cells comprise about 50 to 200 cilia per cell **(Misch *et al*., 2008)**. The beat frequency of cilia is around 60 kHz (1000 beat per minute), thus moving mucus and debris actively **(Janner *et al*., 2011)**.

They did their function in a mass action making coordinated chronological beating so generating a wave like motion usually in the path of the ostium. The mucus runs repetitively and pushed by the underneath cilia. A fresh mucinous blanket is formed every 30 minutes. The SM shows few elastic fibers connected to the bone which make simpler rising of this tissue from the bone **(Pandit & Chopra, 2016)**.

The integrity of the SM is essential in maintaining the healthy and normal function of the MS. The mucociliary apparatus protects the sinus against infection while the membrane also acts as a biologic barrier **(Ardekian *et al*., 2006).**

Overfilling of the sinus during sinus augmentation (SA) procedures may cause membrane necrosis **(Pandit & Chopra, 2016)**.

1.5 Maxillary sinus bacterial flora

Healthy maxillary sinuses have been judged to be sterile but bacteria may inhabit within them without making symptoms. However, the incidence of pathogenic bacteria on the sinus floor at the time of sinus elevation was confirmed by microbiological analysis in 18.1% **(Carreño *et al*., 2016)**.

As reported by **Misch *et al*., 2008,** theoretically the mechanism by which a sterile situation is preserved consists of:

1. The mucociliary clearance structure.
2. Production of nitrous oxide within the sinus cavity.
3. Immune system.

1.6 Maxillary sinus functions

1. Humidification.
2. Filtering inhaled air in the nose **(Parks, 2014)**.
3. Pressure damping.
4. Vocal resonance.
5. Reduction weight of the skull and growth of the face **(Al-Salman & Almas, 2015)**.

1.7 Sinus compliance

Although the prompt postsurgical recovery of the maxillary mucosa with a rapid return to preoperative sterility is frequent **(Misch *et al*., 1991; Timmenga *et al*. 2001)**, it must be pointed out that the “sinus compliance” which represents the intrinsic potential of recovery of the normal maxillary sinus homeostasis after sinus floor elevation (SEF) depends on its baseline anatomo-physiological condition: the better the starting condition (high sinus compliance), the lower the risk of complications **(Torretta *et al*., 2013)**.

However, given the strict anatomical relationship between the alveolus and the overlying MS and the fact that any surgical procedure may lead to a transient inflammatory reaction, the possibility of post-grafting infectious sequelae should be considered. In particular, SFE may impair physiological antral drainage into the middle meatus by inducing transient inflammatory periosteal swelling or other mechanisms predisposing to acute maxillary sinusitis (the most frequent post-lifting complication) and possibly lead to bone graft loss **(Timmenga *et al*., 2001)**.

Preoperative anamnestic, clinical and possibly radiological assessments, are the precious instruments needed to define the sinus compliance, therefore, they are desirable to identify all of the situations that may predispose to post grafting complications. Moreover, rare conditions significantly (and presumably irreversibly) impairing sinus drainage are responsible for an excessive risk of SFE failure and need to be preoperatively detected as current contraindications to the procedure **(Torretta *et al*., 2013)**.

1.8 Sinus pnuematization (SP)

Deficiency in bone volume in the posterior maxilla is one of the most common problems to the implantodontist to plan an implant supported prosthesis. This is because the MS in the absence of teeth tends to be pneumatized reducing the height of alveolar ridge, hindering the installation and/or initial stability of the implant required to the prosthetic support is sophisticated. Against this problem, authors have created a procedure to increase bone volume of atrophic jaws through the maxillary sinus lifting (**Boyne & James, 1980; Tatum, 1986)**.

The cause for this phenomenon of the maxillary sinus has been explained as a type of disuse atrophy. The decrease of functional forces transferred to the bone after tooth loss causes a shift in the remodeling process toward bone resorption according to ***Wolff's law***, this result in an increase of the sinus volume at the expense of the edentulous alveolar ridge **(Sharan & Madjar, 2008)**.

Sharan & Madjar in **2008** reported that histologic examination has shown the pnuematization process occurs by osteoclastic resorption of cortical walls of the sinus and the layering of osteoid inferior to it. The reasons for sinus pneumatization are poorly understood. Among the factors that influence this process are: 1. Heredity. 2. Craniofacial configuration. 3. Density of the bone. 4. Growth hormones. 5. Sinus air pressure 6. Sinus surgery.

Tolstunov *et al*. in **2012** classified sinus pnuematization into five types according to the degree of pnuematization in edentulous regions (the distance from the midline of the maxilla to the anterior sinus border):

SP0, or ‘‘clear’’ (> 30 mm).

SP1, mild degree of enlargement: 26-30 mm.

SP2, moderate enlargement: 21-25 mm.

SP3, severe SP: 16-20 mm.

SP4, extreme SP: ≤ 15 mm, as in (Fig.) (1.2):

Figure (1.2): Frontal section of the maxillary sinuses. Hyperpneumatization of the left sinus and atrophy of the alveolar ridge subsequent to tooth loss is evident (Testori1, 2012).

1.9 Cone beam computed tomography (CBCT)

The technology transfer of CBCT to dentistry first occurred in **1995**. Italian coinventors, ***Tacconi* & *Mozzo*** developed a CBCT system for the maxillofacial region that was designed and produced by QR Srl of Verona, *Italy* **(Tyndall & Rathore, 2008)**.

It is a new diagnostic tool that has revolutionized diagnosis and treatment planning in the dental field. CBCT provided an alternate method of cross-section image production to fan-beam CT using a comparatively less expensive radiation detector than conventional CT **(Jaju & Jaju, 2014)**.

Shanbhag *et al*. in **2013** stated that although CT is considered as the "gold standard" in imaging for visualization of the maxillary sinus, CBCT is gaining increasing popularity in this respect.

Currently, the utility of CBCT encompasses field of dental implantology, oral surgery, orthodontics, endodontics, sleep apnea, temporomandibular joint disorders, and periodontics, and it is expanding its horizon in the field of ear, nose, and throat medicine **(Zöller & Neugebauer, 2008; Barghan *et al*., 2010)**.

CBCT is the preferred option for implant dentistry as it provides greater measurement accuracy when compared to two-dimensional imaging, while utilizing lower doses of radiation **(Macleod & Heath, 2008; Tischler, 2008)**.

It should be considered when clinical conditions indicate a necessity for augmentation procedures or site development before the placement of dental implants.

In implant dentistry, recent guidelines recommend the use of CBCT for three dimensional treatment planning, especially prior to SFE for evaluating both residual alveolar and sinus conditions **(Benavides *et al*., 2012; Harris *et al*., 2012)**. These guidelines also suggest that extending the "field of view" to include the ostiomeatal complex may be justified to avoid postoperative complications resulting from a compromised drainage system **(Harris *et al*., 2012)**.

1.9.1 CBCT applications:

1. Ridge morphology

The buccolingual ridge pattern cannot be viewed on two dimensional radiographs, but CBCT provides the advantage of showing the type of alveolar ridge pattern present **(Jaju & Jaju, 2014)**.

2. Quality of bone at implant sites

The term "bone quality" is commonly used in implant treatment and in reports on implant success and failure. It has been emphasized that bone density (bone mineral density) and bone quality are not synonymous. Bone quality encompasses factors other than bone density such as skeletal size, bone architecture, the three dimensional orientation of the trabecula, and matrix properties. Bone quality is not only a matter of mineral content, but also of structure **(Lindh *et al*., 2004)**.

3. Gray scale for density estimation in CBCT

For bone density measurement CBCT recommended as a "Gold standard" for assessing bone morphology and microarchitecture **(Burghardt *et al.*, 2011; Ibrahim *et al*., 2013)**.

4. CBCT-guided implant surgery

Computer-generated surgical guides can be fabricated from the virtual treatment plan. These surgical guides are used by the implantologist to place the planned implants in the patient's mouth in the same position as in the virtual treatment plan allowing for more accurate and predictable implant placement and reduced patient morbidity **(Orentlicher & Abboud, 2011)**.

5. Bone graft analysis

The morphology of a traumatic defect is critical in developing the implant site before planned implant placement. Defect size and shape affect the factors that guide treatment-planning decisions and encounter the basis for calculating how much graft material is required **(Quereshy *et al*., 2008)**.

1.9.2 Features specific to MS observed in CBCT

Rahpeyma & Khajehahmadi in **2015** clarified that the features other than the height and the width of residual alveolar ridge that can commonly be observed in CBCT are:

a. Thickness of the lateral maxillary sinus wall.

b. Presence of alveolar antral artery and its diameter.

c. Maxillary sinus floor width.

d. Irregularity of sinus floor.

e. Intimate relation of SM with the roots of the adjacent teeth.

f. Maxillary sinus septum.

In addition to these features there are other points to be observed:

g. Membrane thickness: **Rapani *et al*.** in **2016** classified the thickness of the SM on CBCT images:

1. Type I (not recordable) 62%.
2. Type II (0-2 mm) 18%.
3. Type III (3-4 mm) 34%.
4. Type IV (>4 mm) 23%.

h. Postion of ostiomeatal complex **(Kubal, 1998)**.

i. Degree of sinus pnuematization **(Tolstunov *et al*., 2012)**.

1.10 Indications for sinus lift procedure:

Kim & Ho in **2014** claimed that in selecting the treatment approach lateral window or transalveolar technique to perform maxillary sinus floor elevation, the clinician needs to consider the following factors:

First, one needs to determine the amount of residual bone height (RBH) that is available for the implants to be placed with primary stability. RBH is defined as the height of bone immediately below the sinus cavity. It is commonly accepted that a residual bone height of less than 4 mm warrants a lateral window sinus elevation approach without simultaneous implant placement, as the primary stability of the implant at the time of placement may be jeopardized **(Fugazzotto, 2003; Chiapasco *et al*., 2008)**.

Second, the length of the implant planned also influences the treatment approach.

1.11 Classification of alveolar bone availability:

Wang & Katranji in **2008** presented an **ABC** system based on that the implants will be of minimum specifications; 4 mm in diameter and 10 mm in length, numerous studies showed higher success rates in implants with a length of 10 mm or greater.

It is also generally acknowledged that a larger-diameter implant provides better stability and makes clinical success more likely **(Degidi *et al.*, 2007)**.

Wang & Katranji, 2008 classification:

Class A: Abundant Bone

Indicates that the sinus floor is located at least 10 mm from the crest, with a width of 5 mm or greater. The distance from the bone crest to the adjacent cementoenamle junction (CEJ) is 3 mm or less. In this clinical scenario, implants can be placed without further grafting.

Class B: Barely sufficient bone

The sinus floor is located 6-9 mm from the crest of the bone. The width is at least 5 mm and does not require further horizontal augmentation. The bone crest is 3 mm or less from the adjacent CEJ. In this scenario, the sinus can be augmented using either osteotome or lateral wall (window) procedure, and the implant may be placed simultaneously.

Class B situations can be subclassified into one of the three divisions:

1. Division h (horizontal defect): Sinus floor is 6-9 mm from the crest of the bone, and the width is less than 5 mm, the bone crest is 3 mm or less from the adjacent CEJ. Requires horizontal augmentation such as guided bone regeneration (GBR) to achieve proper width. The width should be augmented to at least 5 mm so that the class B protocol can be followed.

2. Division v (vertical defect): Sinus floor is 6-9 mm from the crest of the bone with normal bone width (≥ 5mm). The bone crest is more than 3 mm from the adjacent CEJ and requires vertical augmentation.

3. Division c (combined defect): Sinus floor is 6-9 mm from the crest of the bone, the width is less than 5 mm and the bone crest is greater than 3 mm from the adjacent CEJ. In this scenario, a combined vertical and horizontal component requires grafting procedures.

Class C: Compromised bone

The bone crest is 5 mm or less from the sinus floor, the bone width is 5 mm or more, and the bone crest is 3 mm or less from the adjacent CEJ. Lateral wall sinus augmentation is often recommended for a more predictable outcome, if implant stability is achieved, then immediate implants may be placed in a two-stage approach. If implant stability cannot be achieved, a sinus graft should be allowed to heal for at least 6 months. Implants are placed after the healing period.

1.12 Sinus lift approaches:

The surgical procedure was first described by ***Tatum*** in **1975 (Boyne & James, 1980; Woo & Le, 2004)**.

There are two main approaches: the lateral window and the transalveolar (crestal), however, several authors have published modifications of both techniques **(Wallace & Froum, 2003; Sotirakis & Gonshor, 2005)**.

1.12.1 Lateral approach

Tatum in **1986** was the first to report penetration of the maxillary sinus with a modified Caldwell-Luc approach which makes use of an unfinished fenestration osteotomy in the maxilla's lateral face to raise the sinus membrane creating an empty hole in the floor of the antral cavity. This area is then filled with different grafting materials **(Misch, 1995; Raja, 2009)**.

The inferior border of the window in the lateral wall should be about 3 mm from the floor of the sinus. The posterior extension of the window can be over the tuberosity, while the anterior border should be about 3 mm from the anterior wall of the sinus **(Tarnow *et al*., 2000)**.

The osteotomy can be prepared using a high-speed hand piece or piezoelectric instruments. Using a piezoelectric tip during preparation of the bony window will considerably reduce the risk of perforation of the membrane **(Wallace *et al*., 2007; Wallace *et al*., 2012)**.

There are 3 techniques for lateral window preparation:

A. Trap door technique

Kao, 2014 reported this procedure as *"incomplete fracture"*. The prepared osteotomy window is raised apically and medially providing a new sinus floor and will be as a roof for implant if it is placed immediately but at same time the bony island may impinge the medial sinus wall or cause injury to the membrane during bending.

B. Wall off technique

It is also called "Access Hole" technique in which the bony window is completely removed from underlying SM by bur so it allows for more access **(Batal & Norris, 2013; Kao, 2014)**.

C. Trephine osteotomy

Emtiaz *et al.* in **2006** reported maxillary SA using trephine connected to straight hand piece to create bone cut 4-5 mm above the crest of alveolar bone, then the prepared bony window is carefully and completely detached from the underlying sinus membrane. The elevation of sinus membrane is continued to create the required space for augmentation then the bony piece is readapted to its original position and fitted well that no need for further replacement of absorbable membrane.

Sohn, 2011 discussed the use of saw with thin blade connected to piezotom to make a *"replaceable bony window*".

1.12.1.2 Disadvantages of lateral window technique:

1. More invasive and expensive approach **(Nedir *et al.*, 2006)**.
2. Time consuming procedure **(Kao, 2014)**.
3. Is considered to be a technique-sensitive due to the possible tearing of the AAA which result in hemorrhage and more risk of sinus membrane perforation **(Solar *et al.*, 1999)**.
4. Need surgical skills and equipment **(Kfir *et al.*, 2009)**.

1.12.2. Crestal (Transalveolar or Transcrestal) approach:

The transcrestal approach was first presented in **1977** by ***Tatum*** and published in **1986 (Tatum, 1986)**.

The technique consisted of preparing the implant site with a “socket former” selected according to the implant size to be placed. A “green-stick fracture” of the sinus floor was performed by hand tapping the socket former in a vertical direction until a fracture of the sinus floor was obtained.

Crestal approach modifications:

1. Osteotome technique

Summers in **1994** modified this technique suggesting the use of a specific set of osteotomes for preparing the implant site and elevating the sinus floor **(Summers, 1994)**.

In **2002**, **Fugazzotto** suggested that the pristine bone at sites of implant placement could be drilled up to the sinus floor with a trephine bur and used to fracture the sinus floor by hydraulic pressure through osteotomes. Since then, many surgical techniques with specially designed instruments for the transcrestal approach were reported in the literature **(Trombelli *et al.*, 2015)**.

The surgeon experience and skills are fundamental for achieving a controlled fracture without perforation **(Toffler, 2004)**.

In the majority of the articles published, indirect osteotome maxillary sinus floor elevation (OMSFE) is generally employed when the residual bone height is equal to or greater than 6 mm **(Jurisic *et al.*, 2008; Pjetursson *et al.*, 2008)**. However, some of the reviewed studies included cases of sinus elevation made with less than 6 mm of residual bone **(Romero-Millán *et al*., 2012)**.

2. Zimmer sinus lift balloon technique

In **2010**, the ***Zimmer*** sinus lift balloon was developed to gently elevate the SM with minimum trauma and without the use of sharp instruments. The apparatus is a pneumatic device consisting of a 5 mL syringe, polyvinyl chloride tubing, and a metal shaft with a tip connected to a latex miniballoon with an inflation capacity of approximately 5 cm.

The amount of saline placed in the lure syringe was determined by the number of millimeters that the antral membrane to be elevated and corresponded to the amount of graft material in cubic centimeters that were needed to fill the lifted area **(Rodrigues *et al*., 2010; Lateef & Asmael, 2016)**.

3. Press-fit bone block:

Draenert & Eisenmenger in **2007** developed a new technique for the transcrestal sinus floor elevation and alveolar ridge augmentation with press-fit bone cylinders (bone dowels).

The use of press-fit bone dowels is known in orthopedic spinal surgery for interbody fusion since **1957** and is now a standard procedure **(Wiltberger, 1957; Cauthen *et al.*, 1998,)**. The use of press-fit dowels was described in craniomaxillofacial surgery only once by **Umstadt *et al.* (1994)** when testing polylactide cylinders for fixation in sagittal split osteotomies in vitro.

4. Sinus lift procedure by hydraulic pressure:

Kim *et al.* in **2013** reported devices using hydraulic pressure for sinus membrane elevation have demonstrated a low risk of sinus membrane perforation as well as ease of application. Recently, companies have developed devices for the sinus lift procedure by the crestal approach using a special drilling system and hydraulic pressure. Although several newly developed sinus lift devices have been used widely and successfully, only a few reports on the devices developed in evaluating clinicians' opinions on the available sinus lift devices is undoubtedly important for the further development of safer and more user-friendly sinus lift devices.

Li *et al.*, 2013 supposed that to reduce complications, piezosurgery was used to expose the maxillary sinus mucosa through the alveolar crest pathway in maxillary sinus floor elevation with hydraulic pressure for xenograft and simultaneous implant placement in cases with a ridge bone height of 2-5 mm. Some potential advantages of the method are reduced trauma and a reduced rate of sinus membrane perforation during surgery, and no malleting. In their study they demonstrated that maxillary sinus floor elevation using the water lift system via the crestal approach is a predictable procedure with a low complication rate compared with the lateral approach with piezoelectric surgery.

Sotirakis & Gonshor in **2005** described a new method using hydraulic pressure to elevate the antral floor for bone grafting between the sinus floor and the SM before placement of endosseous osseointegrated implants. The method was first modeled experimentally in hen eggs, acting as a surrogate sinus, and then in human cadaver preparations. Several clinical case reports are also presented. This technique successfully combines the advantages of the Caldwell-Luc window approach which permits the placement of high bone graft volume and the simplicity of the osteotome technique by way of the alveolar ridge crest.

Broadly speaking, the hydraulic pressure technique follows the ***Summers*** method designed to reach the sinus bone floor and fracture it applying osteotomes in a specific sequence to both deepen and widen the osteotomy site and create an in-fracture of the sinus floor. Next, injecting normal saline solution under hydraulic pressure beneath the SM with a suitably fitted syringe creates simultaneous detachment and elevation of the membrane **(Sotirakis & Gonshor, 2005)**.

Subsequently, various modifications to the original technique have been reported in order to improve the reliability and the safety of the membrane elevation using inflation of a balloon catheter and “hydraulic” or “negative pressure” **(Summers, 1994; Chen & Cha, 2005; Soltan & Smiler, 2005; Suguimoto *et al*., 2006)**.

This technique may provide high predictability in clinical outcome, together with extremely low morbidity and shortened surgery **(Sotirakis & Gonshor, 2005)**.

Chen & Cha, 2005 emphasized the concept of hydraulic sinus condensation, as a variant of the osteotome technique. An osteotomy is initially drilled into the crestal ridge at the planned site, the fluid-dynamic technique is characterized by the hydraulic detachment of the mucosa and simultaneous filling of the sub-*Schneiderian* space with a fluid consistency bone graft material.

Kim *et al*., 2012 in a clinical study evaluated the effectiveness of the water lift system and concluded that it could be considered as a sinus surgical instrument which ensures safety in the sinus membrane-lifting operation.

The shortcomings of the ***Summers*** technique have motivated the development of a great variety of new methods over the past 15 years **(Summers, 1994)**.

Recent publications on these modifications covered the use of balloons **(Hu *et al*., 2009; Rodrigues *et al*., 2010),** hydraulic pressure in humans **(Sotirakis & Gonshor, 2005)**, the appliance of a hydraulic sinus condensing technique **(Chen & Cha, 2005)**, Gel-pressure technique **(Pommer *et al*., 2009)**, as well as, the use of "intelligent drills" **(Kim *et al*., 2008; Kim *et al*., 2013)**, as pictured in in Fig. (1.3):

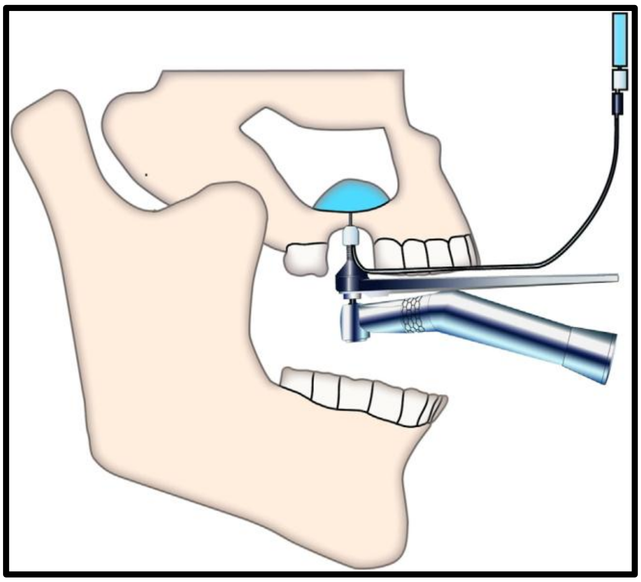

Fig. (1.3): The high pressure pushes the *Schneiderian membrane* away from the drill (Jesch *et al*., 2013).

1.12.2.1 Advantages of crestal approach:

1. Surgical simplicity and minimal invasiveness because of undisturbed vascularization of the graft resulting in minimal postoperative morbidity **(Mazor *et al*., 2013)**.
2. Less time consuming **(Mazor, 2012)**.

3. The technique is essentially heatless and improve tactile sensitivity to changes in bone texture and density **(Summers, 1994)**.

1.12.2.2 Disadvantages:

1. Perforation of sinus membrane during drilling and bone compaction by osteotome.

2. Benign positional paroxysmal vertigo could be produced by the damage to the internal ear from striking osteotomes and surgical mallet when sinus floor is broken **(Peñarrocha-Diago *et al.*, 2008)**.

3. Blind technique and limited amount of elevation when compared with the lateral approach so SA is limited **(Nakajima & Kusama, 2016)**.

1.13 Endoscopic sinus lift surgery:

Endoscopy has changed the philosophy and practice of modern surgery, all types of maxillofacial surgery are now commonly done endoscopically **(Pedroletti *et al*., 2010)**.

A technique to raise the sinus membrane during the operation under endoscopic control was introduced in the late **1990s (Engelke &Deckwer, 1997; Wiltfang *et al*., 2000)**.

The intraoperative use of sinuscopy as described by **Grunenberg & Gerlach** in **1990** for maxillary sinus elevation procedures allows for exclusion of sinus pathology intraoperatively, control of the bone graft position, a reduced risk of sinus membrane perforations, and fewer postoperative complications **(Grunenberg & Gerlach, 1990; Ritter *et al*., 2011)**.

The introduction of the endoscope into dental implant procedures, particularly transalveolar sinus lifts has made advances in implantation techniques possible **(Zheng *et al*., 2014)**.

The endoscope was inserted into the sinus by a laterobasal approach through a small osteotomy. The membrane was raised and the bone grafts inserted using a transalveolar approach **(Wiltfang *et al*., 2000).**

Nahlieli *et al*. in **2011** described the **Modular Implant Endoscope** in working options, endoscopic observations, possibilities and highlighted its potential for the development of innovative endoscopic techniques for dental implant procedures. The advantages of using it in dental implant procedures were described, and examples of how miniature visualization and surgical endoscopic techniques can be applied to increase the success of implantation are outlined. The new **modular implant endoscope** accurately identified all microanatomical and pathological structures, and simplified dental implant procedures.

Fisher *et al*. in **1989** stated that sinuscopy has been used as a **diagnostic tool** in cases of maxillary sinus diseases for more than 20 years. It can be performed after a local anesthesia had been induced with a minimum of postoperative discomfort by using a transalveolar or laterobasal approach, the graft material is applied under direct endoscopic view of the elevated mucoperiosteum.

Wiltfang *et al*. in **2000** claimed that the surgical intervention requires two surgeons, the first performing the continuous endoscopy and the second performing the augmentation of the sinus floor through the implant cavity.

Nahlieli *et al*., 2011 introduced a simple compact direct visualization and working technology for assisting the surgeon during the implantation procedure. In the past, pathologies of the implant cavity's wall could not be diagnosed by direct observation because of the rapid beclouding of the optical system. A technique to intraoperatively examine prepared implant sites was presented in the early **2000s**, and it facilitated diagnosis. Examination of implant cavities was performed with immersion endoscopy. In **2006**, a microendoscope (Visio Scope, Ulm, Germany) was introduced for multidisciplinary use in dentistry, including dental implantology. Overall, the usefulness of similar endoscopes in maxillofacial surgery and dentistry has already been established. It has been used as diagnostic, therapeutic, and observational purposes.

Zheng *et al*. in **2015** reported that endoscopy enabled the development of minimally invasive operations. The introduction of the endoscope into dental implant procedures has made advances in implantation techniques possible. Endoscopic lifting of the floor of the maxillary sinus is a safe and effective approach based on direct observation in beagles.

Garbacea *et al*. in **2012** clarified that endoscope controlled sinus floor augmentation may actually have a lower postoperative complication rate for the transcrestal procedure in patients with 4.0 to 8.0 mm of vertical bone height below the sinus floor.

The intraoperative use of sinuscopy as described by **Grunenberg & Gerlach** in **1990** for maxillary sinus elevation procedures allows for:

1. Exclusion of sinus pathology intraoperatively.
2. Control of the bone graft position.
3. Reduced risk of sinus membrane perforations.
4. Fewer postoperative complications.

Schleier, 2011 determined whether endoscope guided sinus elevation procedures can be consistently used to create sufficient bone support for stable implant placement and long-term implant success. The minimally invasive internal sinus floor elevation procedure visually guided by an endoscope helped to prevent, diagnose and manage complications such as sinus membrane perforation. The clinical outcomes show that endoscope controlled internal sinus floor elevation combined with implant placement results in:

1. Low intraoperative trauma.
2. Good implant stability upon placement.
3. Low incidence of postoperative symptoms.
4. High success rates.

Zheng *et al*. in 2015 stated that the sinus membrane was lifted and the perforations inspected with the endoscopic injection cannula for dental implants. Even though this innovative endoscope could be inserted into the sinus through **the implant cavity**, it did not enable to see the actual sinus lift, therefore the author wanted to find out how to raise the sinus membrane under direct vision to get more height, but also to avoid an additional laterobasal osteotomy for insertion of the endoscope.

1.14 Sinus augmentation:

A. Graftless sinus lift.

B. Grafted sinus lift.

A. Graftless sinus lift

The surgical technique of maxillary sinus *Schneiderian membrane* lifting with immediate/simultaneous installation of dental implants, generally results in significant bone formation. The recently reported graftless elevation procedure and the subsequent augmentation of bone have greatly changed the expectancy of bone neoformation potential. The blood clot formed under the lifted membrane appears to be of critical importance in bone neoformation potential precluding the need for exogenous graft materials **(Falah *et al*., 2016)**. However, in non-grafting sinus lifting, the formation of blood clot in the region can be compromised by sinus static forces caused by air pressure associated with respiration **(Kaneko *et al*., 2012)**.

CBCT data have demonstrated no difference in bone density following the utilization of allogeneic filling materials versus following a graftless sinus procedure **(Altintas *et al*., 2013)**.

B. Grafted sinus lift

The sinus augmentation procedure is a successful and predictable approach for the augmentation of the posterior maxilla (pneumatized sinus) with deficient crestal bone **(Del Fabbro *et al*., 2008)**.

1.14.1 Biomaterials in sinus augmentation procedures

Different types of biomaterials have been utilized for sinus augmentation including autograft, allograft, xenograft, alloplast, and growth factors, and the selection of the ideal graft materials is controversial **(Avila-Ortiz *et al*., 2012)**.

1. Autogenous grafts

Can be harvested from intraoral or extraoral sources and considered as the gold standard for sinus augmentation **(Precheur, 2007)**. Their main advantage is their osteogenic capacity; however, increased morbidity, limited availability, and high resorption rate of the graft (up to 40%) make them less desirable in sinus augmentation **(Wallace & Froum, 2003; Tosta *et al*., 2013)**.

2. Allogenic bone grafts (Allografts)

Are obtained from cadavers of the same species as the recipient of the graft. They are osteoconductive materials that also act as space-maintaining scaffolds for regeneration of the bone **(Chaushu *et al*., 2010; Avila-Ortiz *et al*., 2012)**.

3. Xenografts

Are obtained from different species of animals and they act as semipermanent or slowly resorbing osteoconductive grafts that have been used for sinus augmentation in various clinical trials **(Chaushu *et al*., 2010; Bassil *et al*., 2013)**.

4. Alloplasts

Buser *et al*. in **1993** introduced the basic principles of “Guided bone regeneration” (GBR) that is providing the cells from bone tissue with a space intended for bone regeneration away from the surrounding connective tissue by inserting barrier membranes to a bone defect.

Among various bone graft materials, calcium phosphate (Ca-P) bone substitutes such as hydroxyapatite (HA) and beta-tricalcium phosphate (β-TCP) have been widely used because their chemical and structural characters are similar to those of human bone **(Erbe *et al*., 2001)**.

Indeed, they have shown favorable biocompatibility and osteoconductivity when used as bone graft materials among (Ca-P, HA) which is very stable and can maintain the space effectively but has low osteoconductivity **(Lee *et al.*, 2015)**.

In contrast, β-TCP is more biodegradable and rapidly replaced by newly formed bone but has low capacity of space maintaining **(Dorozhkin, 2009)**, therefore, biphasic calcium phosphate (BCP) which is composed of HA and β-TCP was introduced to overcome limitations of each material and several studies have been demonstrated that BCP can be used as bone substitutes successfully **(Lee *et al.*, 2015)**. Osteon is a newly developed alloplastic material containing 70% HA and 30% β-TCP **(Kim *et al*., 2008)**.

5. Growth factors

Tissue-engineered materials have also been used for sinus augmentation bone morphogenetic protein (BMP). Bone morphogenetic protein 2 is one that has been sequenced and recreated as a recombinant human protein growth factors can be added to all grafting materials **(Cochran *et al*., 1999)**.

6. Platelet-rich fibrin (PRF)

Choukrouns protocol is a simple and free technique that allows one to obtain fibrin clots and membranes enriched with platelets and growth factors after starting from an anticoagulant-free blood harvest **(Choukroun *et al*., 2006)**.

Platelets are a known source of growth factors such as platelet derived growth factors (PDGF) and transforming growth factors (TGF-β) **(Browaeys *et al*., 2007)**.

The clinical applications of PRF have already been described in periodontal regeneration surgery, sinus augmentation, and bisphosphonate-related osteonecrosis of the jaw **(Chang & Zhao, 2011; Zhao *et al*., 2015; Tsai *et al*., 2016)**.

7. Autogenous blood

It have been reported that the use of blood clot as filling material by means of the guided bone regeneration technique promoting bone neoformation in the maxillary sinus areas **(Palma *et al*., 2006; Ahn *et al*., 2011)**.

8. Surgicel: (oxidized regenerated cellulose)

Is a sterile fully resorbable knitted hemostatic agent prepared by the controlled oxidation of regenerated cellulose **(Simunek *et al*., 2005)**. It briefly among materials that can be used to close perforations of the *Schneiderian membrane*, **(Smiler *et al*., 1992)**.

Gray *et al*. in **2001** used it in one case report as a graft material, furthermore, **Hussein & Hassan (2017)** in their study utilized surgicel as a grafting material in 33 sinusal implants via transalveolar sinus lift approach with quietly encouraging results.

1.15 Complications associated with crestal approach:

1. Schneiderian membrane perforation:

Kim *et al*. in **2008** stated that the most common intraoperative complication seems to be *Schneiderian membrane* perforation, which occurs in it happens in 7–10% to 35% **(Arad *et al*., 2004; Shlomi *et al*., 2004)**.

Failure to atraumatically elevate the SM may result in graft migration or loss, exposure of the graft or the implant to the sinus, and postoperative site infection. In addition to contaminating the recipient site, disruption of the mucosa may alter the normal mucociliary flow patterns causing retention of secretions and infections around the foreign body **(Ward *et al*., 2008)**.

The occurrence of iatrogenic sinus membrane perforations during surgery does not seem to be related to sinusitis in healthy people **(Ardekian *et al*., 2006)**, however, large tears can cause sinusitis, graft infection, or graft displacement into the sinus which could compromise new bone formation and implant survival **(Reiser *et al*., 2001)**.

Following sinus membrane damage, initial postsurgical bleeding causes vasoactive substance release leading to primary clot formation underneath it. This is followed by inflammatory phase characterized by membrane transitory swelling that predominates at 48 hours and subside over a period of several days **(Makary *et al*., 2016)**. At times, perforation of the sinus membrane is even not detected **(Kim *et al*., 2008)**.

Variables that influence the risk of perforation:

1) Anatomical variations:

a) Presence of septa, spine, or sharp edges.

b) Root projections in the area of the sinus.

c) Morphology of the sinus floor and the presence of sharp angles between inner walls of the sinus.

2) Choice of operation **(Zijderveld *et al*., 2008)**.

Classification of membrane perforation:

Fugazzotto *et al.* in **2015** classified perforation according to site into: **class I** occur at apical area of osteotomy window; **class II** located at crestal, mesial, or distal area of osteotomy window and further subdivided into class II A, B depending on their position in relation to sinus wall (class II A if 4-5 mm available space away from sinus wall and class II B when perforation at the end of osteotomy window and no available space remain to reach sinus wall); and **class III** perforation located at any area within the center of prepared osteotomy.

Management of schniederian membrane perforations:

Depending on the size of perforation:

A. Small perforations < 5 mm:

1) Collagen or fibrin adhesive **(Karabuda *et al*., 2006)**.

2) Absorbable haemostatic agent containing oxidised regenerative cellulose can be used to manage perforated membranes because of its excellent physical and biological properties **(Simunek *et al*., 2005)**.

3) Utilizing resorpable barrier membrane and complete the SL procedure **(Batal, 2013)**.

B. Large perorations ≥ 5 mm:

1) Abandoning the procedure for 6-9 months while the membrane regenerates **(Karabuda *et al*., 2006)**, or at least 3 months before relifting **(Ferrigno *et al*., 2006)**.

2) Using shorter-than-planned implants (6-8 mm) to avoid intrusion of the implant into the sinus acting as temponade **(Nedir *et al*., 2006)**.

3) Application of collagen sponges at the end of the osteotomy above the implant **(Toffler, 2004)**.

2. Hemorrhage:

Bleeding during sinus augmentation is rare because the main arteries are not within the surgical area. Although accidental laceration of the PSAA is not life-threatening because of the small size of the artery, it is rarely happened during transalveolar approach unless there is anatomical variations. An impaired visualization may compromise the elevation of the SM and interfere with the placement of the graft material **(Elian *et al*., 2005; Testori *et al*., 2010)**, as exemplified in Fig. (1.4).

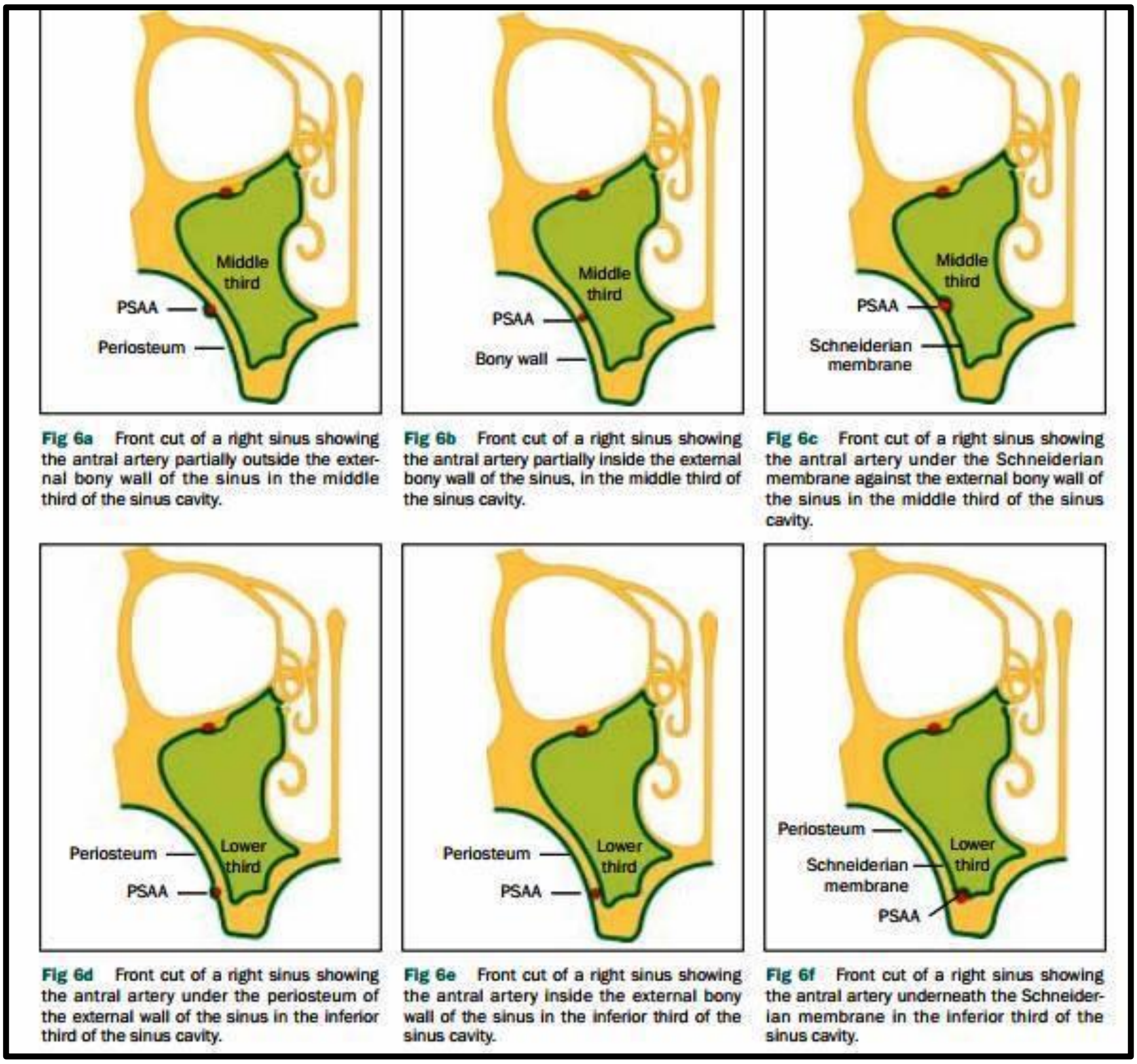

Fig. (1.4): Demonstration of varying distances at which the PSAA is located (Ella *et al*., 2008).

3. Benign paroxysmal positional vertigo (BPPV):

Preparation of implant beds with osteotomes and surgical mallets transmits percussive and vibratory forces capable of detaching the otoliths (i.e. heavy, inorganic grains of calcium carbonate involved in the sensation of movement and verticality) from the otoconial layer of the utricular macula causing them to float around in the endolymph **(Saker & Ogle, 2005**; **Pjetursson *et al*., 2009a; Pjetursson *et al*., 2009b)**.

Sammartino *et al*. in **2011** said that moreover, the patient's surgical head position, with the face up and the head hyper-extended and tilted opposite to the side where the surgeon is working, favors the displacement of these free-floating particles into the posterior semicircular canal of the implanted side; when the patient later adopts a seated position, the otoconia descend into the ampullar crest triggering an anomalous stimulus causing vertigo, also called **iatrogenic BPPV**, a common vestibular and organ disorder characterized by short-term recurrent episodes of vertigo associated with intense nystagmus due to the anatomical features of the district involved.

The usual age of onset of BBPV is 50-60 years, with incidence increasing with age. It is benign because it is not a progressive condition and is not life-threatening, paroxysmal because it is sudden and unpredictable in onset positional because it occurs with certain changes in head position, and vertigo because there is a sense of spinning or whirling of the room. Because the symptoms may be very incapacitating, immediate referral to an otolaryngologist is highly recommended to identify it correctly and manage it properly. Spontaneous remission of symptoms can occur within 6 months of onset **(Saker & Ogle, 2005)**.

4. Loss of the implant or graft materials into the maxillary sinus

The displacement of implants or graft materials into the maxillary sinus can result in a foreign-body reaction and cause serious complications. Migration of a dental implant into the maxillary sinus may present a risk for the development of maxillary sinusitis. Immediate implant insertion should be performed only if the residual bone is stable and high enough to ascertain high primary stability **(Becker *et al*., 2008)**.

Various mechanisms have been proposed to explain the migration of an implant into the maxillary sinus, which fall under three main categories:

1) Changes in intrasinal and nasal pressures.

2) Autoimmune reaction to the implant causing periimplant bone destruction and compromising osseointegration.

3) Resorption produced by an incorrect distribution of occlusal forces **(Galindo-Moreno *et al*., 2005)**.

5. Sinusitis:

Can occur as a result of sinus contamination during the operation **(Misch *et al*., 1991)**. Osteal obstruction due to postoperative swelling of maxillary mucosa, nonvital bony fragments freely floating in the maxillary sinus, and altered anatomy after the grafting affecting the sinus normal physiology **(Manor *et al*., 2010)**.

Timmenga *et al*. in **1997** evaluated 156 patients for sinusitis after sinus augmentation and found transient (subacute) maxillary sinusitis in 4% when using general accepted ear nose and throat criteria for diagnosing sinusitis. Chronic maxillary sinusitis has been reported to occur in 1.3% of the patients.

Manor *et al*. in **2010** stated that the main susceptive reason for maxillary postoperative acute sinusitis is hematoma or seroma filling the sinus reducing patency of the maxillary ostium and the ostiomeatal complex. The clinical diagnosis of sinusitis is characterized by a triad of symptoms: ***nasal congestion***, ***secretion*** or ***obstruction***, and ***headache***. Detection of maxillary siusitis according to conventional radiographs is difficult. Direct visualization of the sinus and the ostiomeatal unit by endoscopy preoperatively and postoperatively is beyond doubt. However, the accessibility of using endoscopy is limited owing to economics, ethics, and professional training.

6. Infection:

Chiapasco *et al*., 2009 advocated that implant migration in the sinuses may not be followed by relevant signs and symptoms of infection, but it can be associated with oroantral communication and/or infection that may involve the maxillary sinus and the ethmoidal, frontal and sphenoidal sinuses. These displaced foreign bodies should be removed as soon as possible to prevent such complications. Two main treatment modalities have been proposed for the removal of displaced implants in the sinuses and to treat the associated infectious complications: an intraoral approach with the creation of a bony window in the anterior-lateral wall of the maxillary sinus and a transnasal approach with functional endoscopic sinus surgery.

7. Schneider membrane thickening:

Makary *et al.*, (2016) found a significant transient swelling of sinus membrane at first week after sinus lift and then decreased at 3, 6 and 12 months with positive correlation between graft volume and membrane thickness and no correlation with type of alloplast. This thickening may be a result of altered physiologic function after surgical trauma.

Quirynen *et al*. in **2014** reported that the antral membrane responded with a significant swelling (5-10 times) during first week of operation.

Lateef & Asmael in **2016** concluded that it is important to know that antral mucosal thickening is often seen on routine radiological examination in individuals who are otherwise asymptomatic and healthy.

8. Others:

a. Wound dehiscence.

b. Paresthesia (along the distribution of infraorbital nerve).

c. Flap necrosis.

d. Oroantral fistula.

e. Cyst formation.

f. Osteomyelitis.

g. Cavernous sinus thrombosis and orbital cellulitis.

h. Insufficient new formed bone for implant placement.

i. Failure of dental implants.

Chapter Two

Materials and Methods

Materials and Methods

2.1 Study sample

This prospective randomized clinical study accomplished by (simple-block method with the use of flipping coins) was organized from December 2017 to December 2018 in the College of Dentistry Teaching Hospital, Department of Oral & Maxillofacial Surgery/Dental Implant Unit/University of Baghdad.

The sample involved patients with single or multiple missing and hopeless teeth in the sinus zone of atrophic maxilla (pneumatized sinuses) in which the subantral bone height was 3-7 mm for one stage sinus lift surgery utilizing Osung crestal approach (OCA) kit and Osteotome technique. This is followed by examination of SM patency with the aid of endoscope accompanied by simultaneous DI placement and sinus augmentation.

A total of 30 Iraqi patients aged 19-72 years, 5 males & 25 females met the eligibility criteria were enrolled in this study receiving 52 DI.

These cases (sites) allocated in two groups, **Group A (Osung)** in which sinus lifting was performed by (OCA-KIT), and **group B (Osteotome)** which constituted the use of osteotomes to achieve sinus lift surgery. For both, the SM was examined with the benefit of endoscope for the presence of any perforation accompanied by photos and videos captured for confirmation. Furthermore, sinus augmentation with DI placement completed with the use of NucleOss DI plus Osteon III collagen (β-tri calcium phosphate) as an augmentation material and barrier membrane.

The total performed SL cases in the group A were 27 sites, while they were 25 for group B, as explained in table (2.1).

Table (2.1): Study sample.

30 Patients	
Group A- 15	**Group B- 15**
Total performed SL cases (27 sites)	Total performed SL cases (25 sites)

2.1.1 Eligibility criteria

1. Good general health without any disease that compromising bone healing potential as heavy smoking, hyperparathyroidism, fibrous dysplasia, etc…
2. Patient's age ranged from 19-72 years of both genders.
3. Partially or completely edentulous maxilla with delayed implant placement protocol.
4. Adequate subantral bone height to ensure primary stability for the placement of implants between 3-7 mm (single stage surgery for sinus augmentation).

2.1.2 Exclusion criteria

1. Medical conditions that could interfere with normal healing or inability to withstand surgery including current pregnancy at the time of the surgical procedure, psychosis, uncontrolled systemic diseases like uncontrolled diabetes, irradiation of the head and neck region or chemotherapy over the past 5 years…etc.
2. Presence of acute/chronic infection or local pathological conditions in the implant zone.
3. Patients with clinical and/or radiological evidence of rhinosinusitis.
4. Anatomical elements that preclude SL mainly underwood septa of more than 4 mm and membrane thickening more than 6 mm.
5. Patients required a sinus elevation that necessitate two-stage approach (when the SAD < 3 mm).
6. Patients with previous history of vertigo (for group B only).
7. Parafunctional habits such as severe bruxism and clenching.

2.2 Armamentariums & medications

1. Complete surgical set

The main constituents were scalpel, blade No.15, molt periosteal elevator, cheek retractor, flap retractor, tweezer, toothed forceps, surgical curette, needle holder, iris scissor, normal saline solution 0.9%, as in Fig. (2.1).

Fig. (2.1): The surgical set.

2. DI micromotor engine

DI engine set at 600-800 round/minute (rpm) and torque of 35 N/cm coupled with external irrigation system, Fig. (2.2).

Fig. (2.2): Dental implant engine (Dentium Co., Korea) illustrating settings of the device.

3. OCA-KIT

The kit contained: drills for the crestal approach (OCA drills: pilot drill ⌀ 2.0 mm, cannon drills ⌀ 2.4, ⌀ 2.8, ⌀ 3.2 mm), there are nine stoppers at drilling depth from (2-10 mm) length. The kit also consist of three aqua taps (⌀ 3.15S, ⌀ 3.15, and ⌀ 3.5 mm) with two adapters (manual, engine). Other tools of the kit were sensor gauge (⌀ 2.8 mm), bone condenser (⌀ 3.1, ⌀ 2.7 mm), bone carrier (⌀ 3.5, ⌀ 3.9 mm), finally the kit is equipped with pressure loading metal syringe along with plastic tubes, Fig. (2.3).

Fig. (2.3): (A, B, C) OCA-KIT (Osung Co., Germany).

4. Implant surgical kit & DI

NucleOss DI system was assigned in this study, Fig. (2.4).

Fig. (2.4): (A) Implant surgical kit (NucleOss T6 Co., Turkey). (B) DI with S.L.A surface inside its package (NucleOss T6 Co., Turkey).

5. Osteotome kit & surgical mallet

The kit was supplied with 5 color-coded osteotomes with different diameters 2, 3.4, 3.8, 4.3, and 4.8 mm. Type A osteotomes with convex tips were used with the aid of a surgical mallet, as in Fig. (2.5).

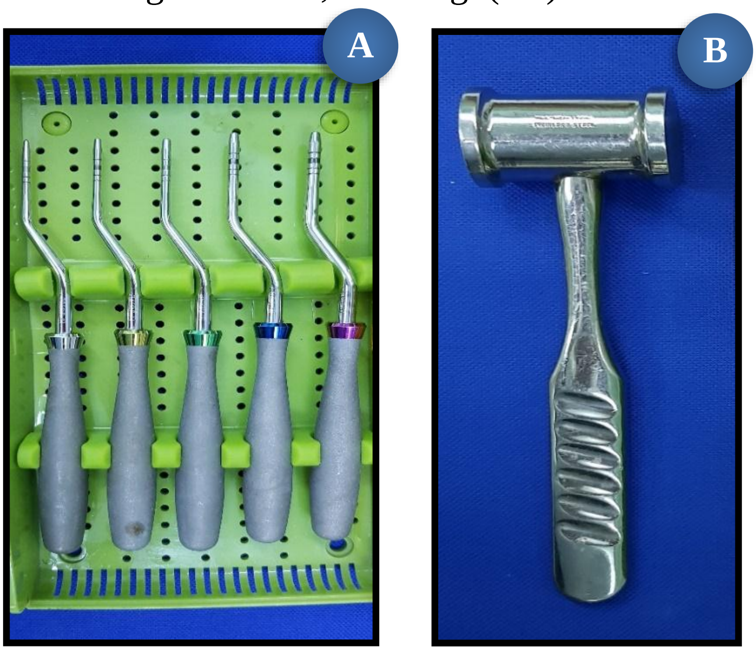

Fig. (2.5): (A) Sinus osteotomes kit type A (Dentium Co., Korea), (B) Surgical mallet used with osteotomes to create a greenstick fracture of the antral floor (Leeds Co., England).

6. Endoscope

SY-P029-1 medical video endoscope with flexible fiberscope was used to inspect *Schnieder* membrane patency with specifications of 2.8 mm diameter camera lens (camera resolution was 10.5 Ip/mm at 7 mm and 300000 pixels count). Endoscopic probe articulation up to 180^{o} and down to 130^{o}, it's insertion tube covered with polyurethane match the medical standard, in addition to LCD monitor with high resolution supplied with memory card to capture photos and record videos for documentation purposes, Fig. (2.6)

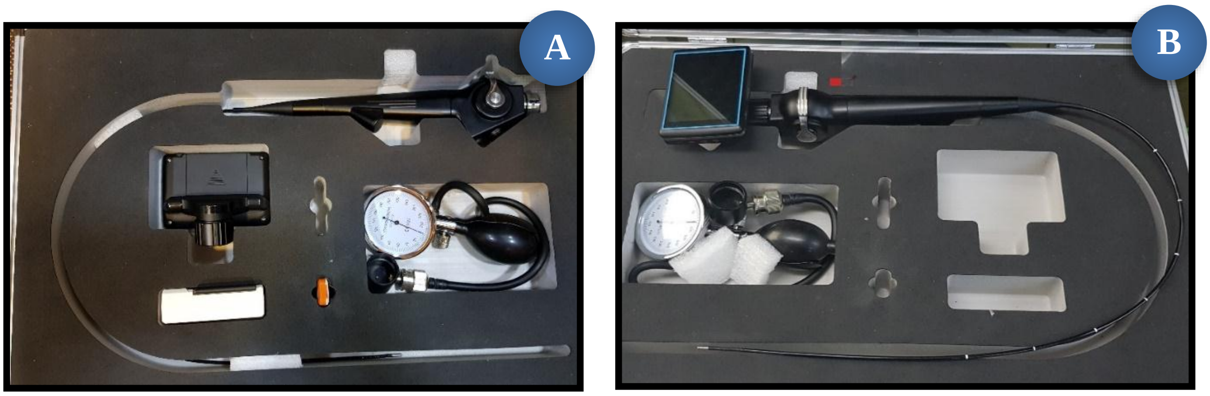

Fig. (2.6): (A, B) SY-P029-1 medical video endoscope (Sunny Medical Equipment Ltd. Co., China).

7. Barrier membrane

Genoss collagen membrane is a resorbable to be used during GBR procedure and sinus lift sterilized in a vacuum wrap by gamma-radiation. This is a thin membrane (300 µm in thickness) with dimensions of 20×30 mm, multilayered biroughed surface with sufficient mechanical strength for simpler handling. The resorption period is about 6 months to afford enough time for stabilizing bone graft and new bone growth, Fig. (2.7).

Fig. (2.7): (A, B) Collagen membrane (Genoss Co., Korea).

8. Particulate bone graft material

Osteon III sinus is a synthetic oseoconductive bone graft substitute 0.5 cc, comprised of HA & β-TCP. It is an interconnected porous structure, asymmetrical shaped particle size ranged 0.5-1.0 mm and is supplied sterile by gamma radiation, Fig. (2.8).

Fig. (2.8): Osteon III lifting in its package (Genoss Co., Korea).

9. Vernier

Is a measurement tool, Fig. (2.9).

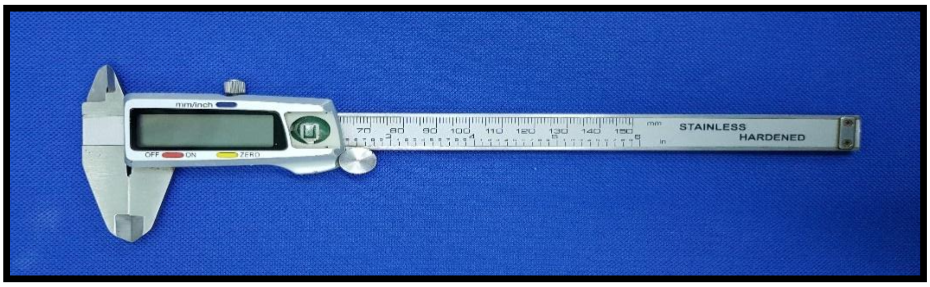

Fig. (2.9): Vernier (Hardened Co., China).

10. CBCT and OPG device:

CBCT set at 84 kV, 4.00 mA & 150 μm voxel size;

OPG set at 73 kV, 10.0 mA & 11.9 s, Fig. (2.10).

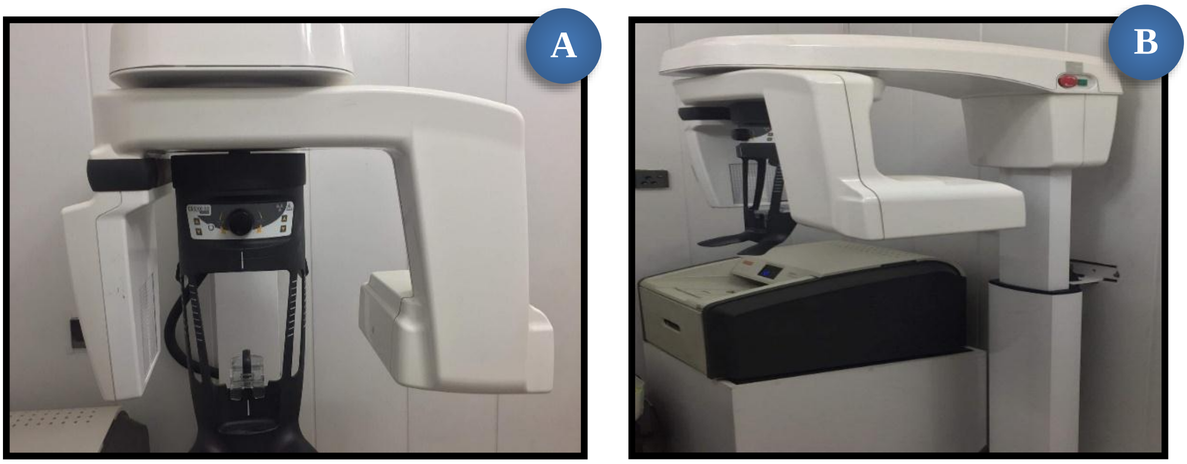

Fig. (2.10): (A) & (B) Kodak 9500 Cone Beam 3D System with effective dose 92 μSv & Orhtopantogram system with effective dose 11.9 (Carestream CS 8100 3D Health Inc., France).

11. Medications

a. Topical spray anaesthesia (Lidocaine 10%).
b. Lidocaine hydrochloride 2% with Adrenaline 1:80,000 in 2.2 mL glass cartridge (Septodont, France).
c. Cefixim (Suprax) 400 mg tablet (tab) or Azithromycin 200 mg tab.
d. Metronidazole 500 mg tab.
e. Panadol extra (Caffiene 65 mg + Paracetamol 500 mg) tab.
f. Nasophrin 0.5% (decongestant) nasal drops.
g. Clorhexidine digluconate mouth wash 0.2%.
h. Povidone iodine skin disinfectant 10%.

2.3 Methodology

2.3.1 Study design

A prospective observational randomized clinical study, the steps summarized in the algorithm, Fig. (2.11).

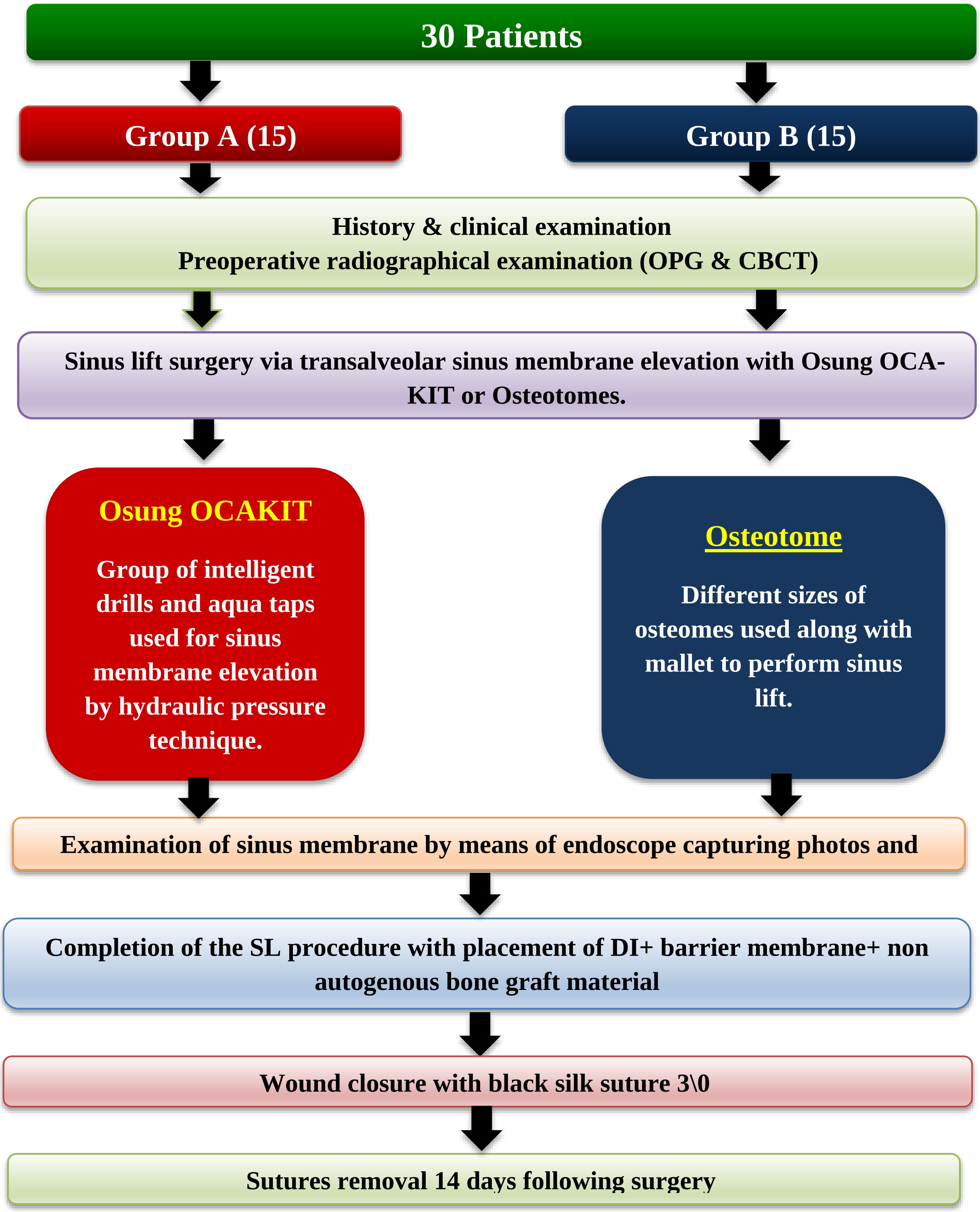

Fig. (2.11): Sequential flow chart.

2.3.2 Preoperative assessment

2.3.2.1 History

A detailed medical, family and dental history were taken from the patients regarding any systemic diseases that could influence bone healing & sinus health. (appendix I & II).

2.3.2.2 Clinical examination

Extraoral:

A clinical examination of the MS evaluates the middle third of the face for the presence of asymmetry, nasal congestion or obstruction are noted, regional lymph nodes, facial profile and smile line.

Intraoral:

The intraoral examination assesses the floor of the antrum for any pathology as alveolar ulceration, expansion, paresthesia, tenderness or oroantral communication. Mouth opening, oral hygiene, periodontal status and any evidence of clinical signs of parafunctional habits. All teeth being inspected for caries, gingival condition and biotype.

Space analysis for the proposed implant site was performed in which the width of ridge is measured by blunt osteometer (bone caliper), intercoronal (mesiodistal) distance, height between alveolar ridge and opposing teeth or ridge where estimated by using a special Vernier.

2.3.2.3 Radiological examination

Preoperative OPG was taken as a standard radiograph for documentation. CBCT was essential for sinus lift procedure in order to provide a roadmap for assessment of the available alveolar bone height, width of the planned implant site, condition of the MS, presence of antral septa, ostium patency and other pathologies that may involve the alveolar bone or the MS, also the type and degree of sinus pneumatization, thickness of *Schneiderian* membrane as in Fig. (2.12), (2.13), (2.14) & (2.15). **Note:** if there is any suspicious evidence about the sinus compliance clinically or radiographically, an ENT surgeon consultation for fitness was made for this purpose. The overall treatment plan was formulated accordingly.

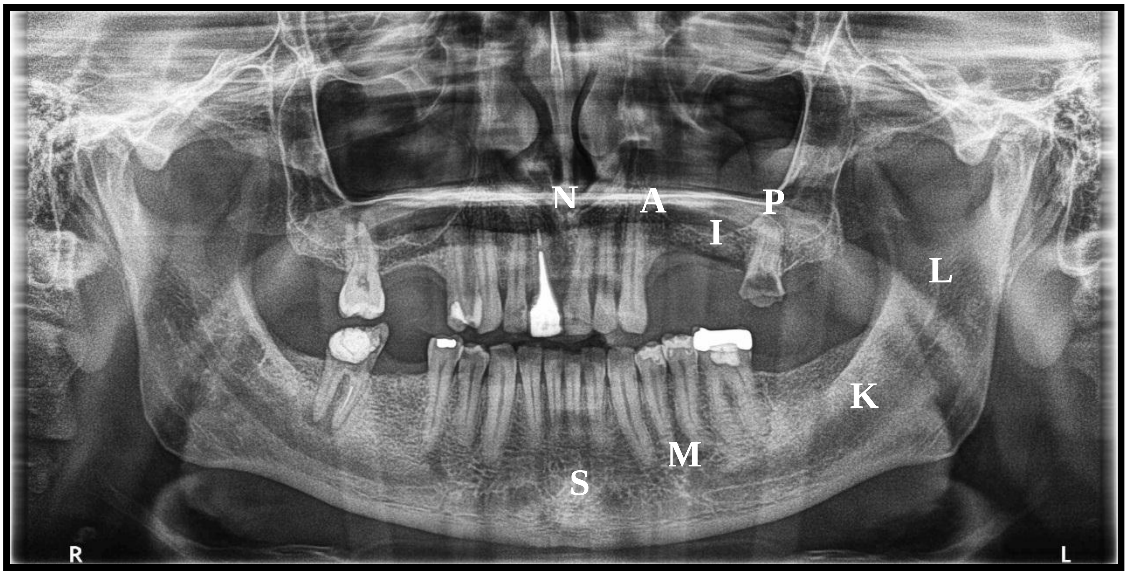

Fig. (2.12): Preoperative panoramic view demonstrating a general preliminary outline of the MS for initial assessment and interpretation for the anatomical limitations (MS, nasal cavity, mandibular canal and mental foramen).

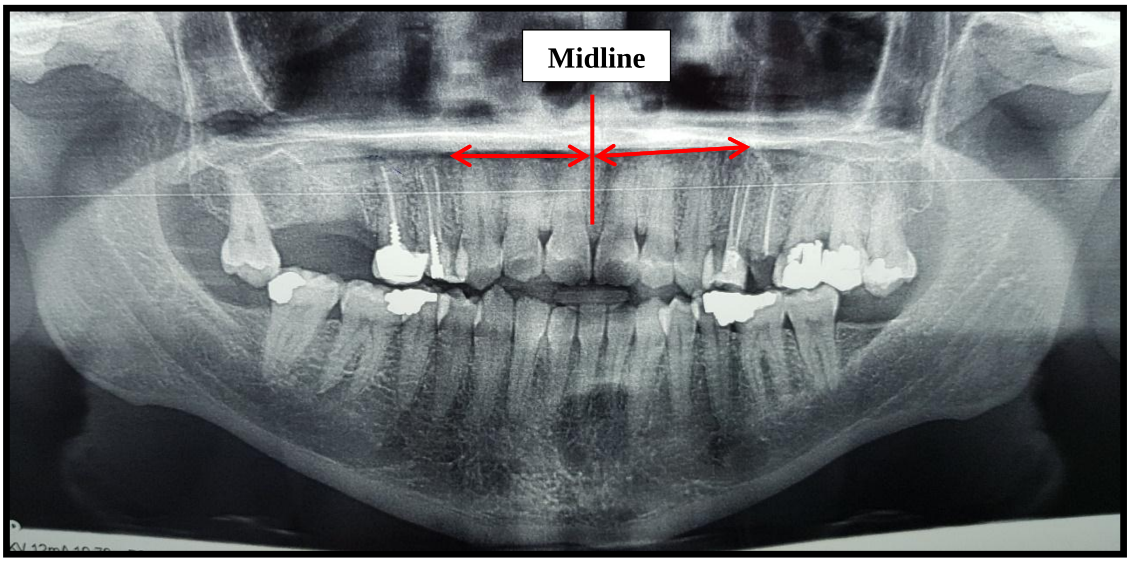

Fig. (2.13): Preoperative panoramic view showing the distance from the midline of maxilla to the anterior sinus border. SP3 degree of sinus pneumatization in the left side (23 mm).

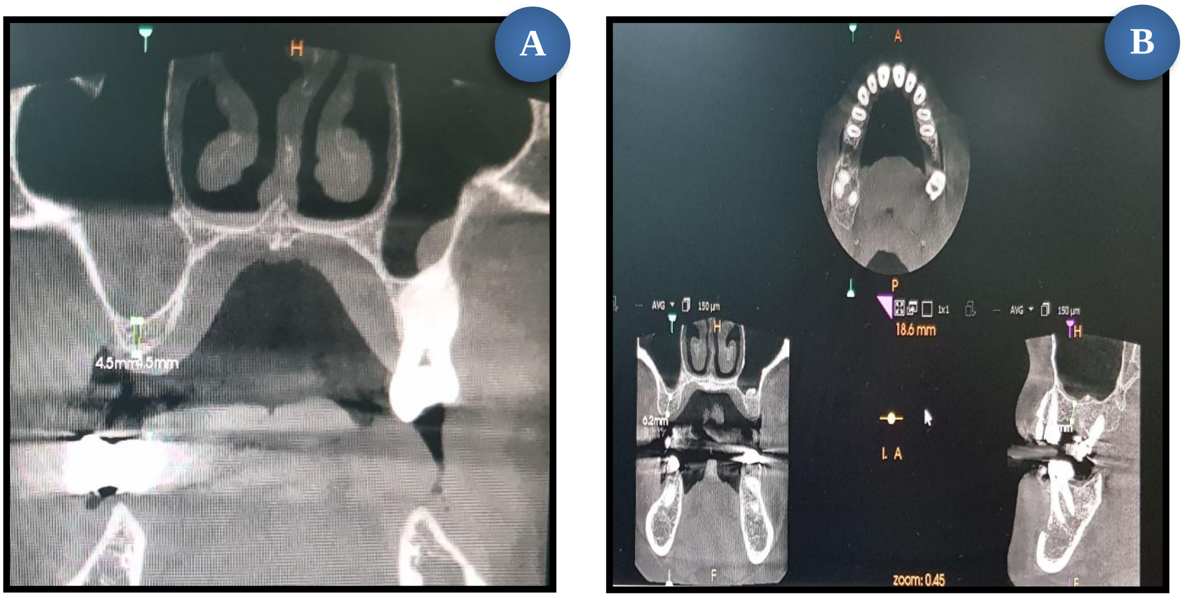

Fig. (2.14): Preoperative CBCT scan: (A) Axiel view illustrating general sinus view, any sinus abnormality, subantral distance & membrane thickness. (B) Illustrating axial, coronal, 3D views presenting jaw orientation and determining width and bone height of the implant recipient site.

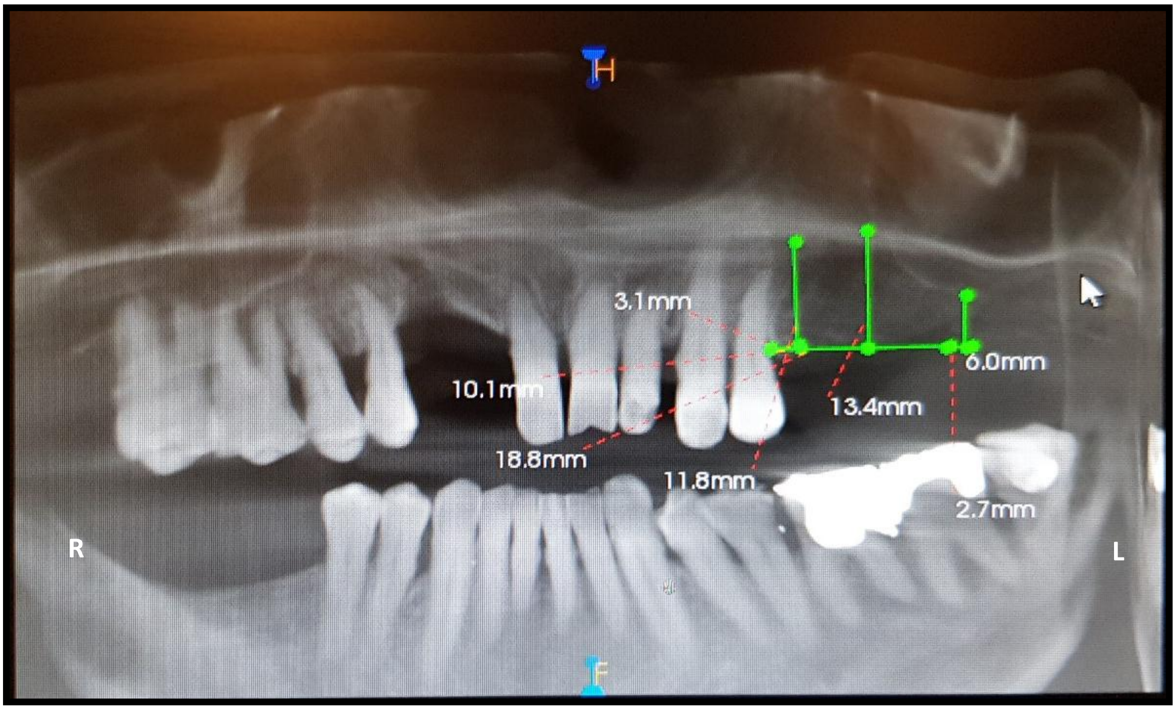

Fig. (2.15): Preoperative CBCT scan (panoramic view) revealing the subantral distance (SAD) at different points to determine the lowest height and where SL should be performed.

2.4 Patient's preparation

First of all the surgical operation was explained for the patient in simple few expressing with the likelihood of intraoperative and postoperative complications. Following vocabulary approval of the patients to participate with the current study, they signed a special consent. Disposable sterile surgical drapes, then were applied head cup and protective glasses, followed by rubbing the skin of the face with Povidone iodine 10%. Instructing the patient to gargle with Clorhexidine mouth rinse 0.2% for 1 minute immediately before the installation of local anesthesia.

2.5 Surgical procedure

Topical spray anesthesia of Lidocaine 10% to the buccal\palatal mucosa applied to lessen pain during injection. Anaesthetization of the planned surgical field with Lidocaine 2% commencing one tooth before and after the site of tissue flap for the anterior, middle & posterior superior alveolar nerves, starting with infiltration technique over buccal\palatal sides followed by infraorbital and greater palatine nerves block.

Three sided flap (extensive or limited flap design) was made initiating via paracrestal incision with palatal bias for better visibility, preserving a wider band of keratinized attached gingiva avoiding wound dehiscence and reducing wound contamination. Full thickness mucoperiosteal flap reflected to expose crestal and buccal alveolar bone using Molt # 9 and\or Haworth periosteal elevator, Fig. (2.16).

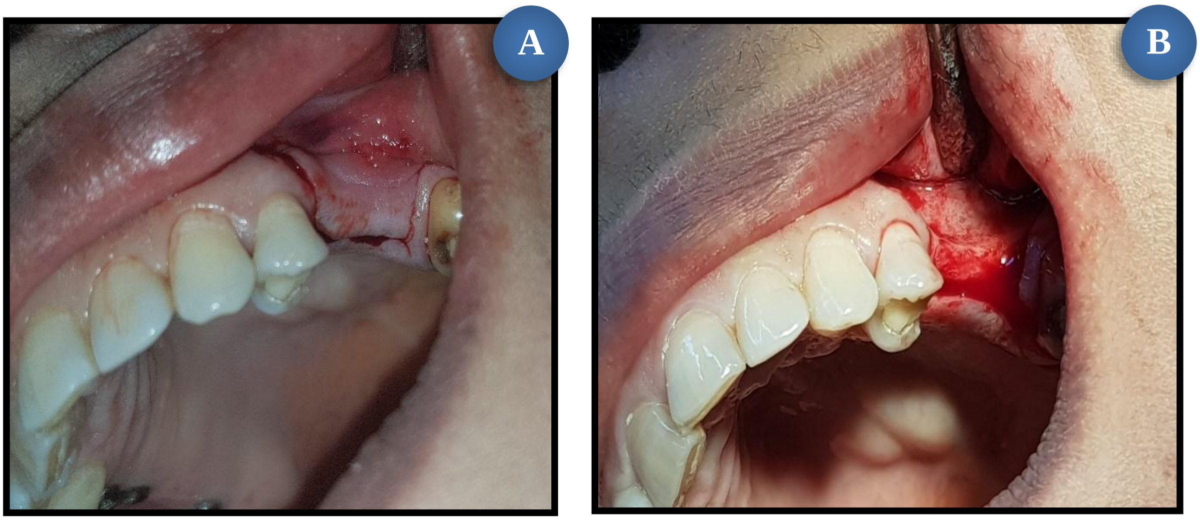

Fig. (2.16): (A) Three sided flap (limited flap design commences from tooth #12, to tooth #14. (B) Reflection of full mucoperiosteal flap noticing the bulge of the lateral wall of the sinus which clarify it's extension.

For group A: (OCA-KIT)

The procedure had been accomplished via the OCA-kit, after measurement of the subantral distance accurately by means of CBCT, Fig. (2.17).

Fig. (2.17): OCA-KIT with drills & stoppers.

According to the kit company guide, the procedure was started with the use of pilot drill Ø 2.0 mm (first drill) applied to the dental engine handpiece set at 600-800 rpm and torque equals to 35 N/cm in order to precisely determine the preparation site. Then the operator turned to cannon drill Ø 2.4 mm with the application of a stopper 1 mm shorter than the SAD performing drilling to the full stopper length. The next step was the use of the second cannon drill A.I Ø 2.8

mm which is a spring loaded drill with a stopper 1 mm more than the SAD, Fig. (2.18).

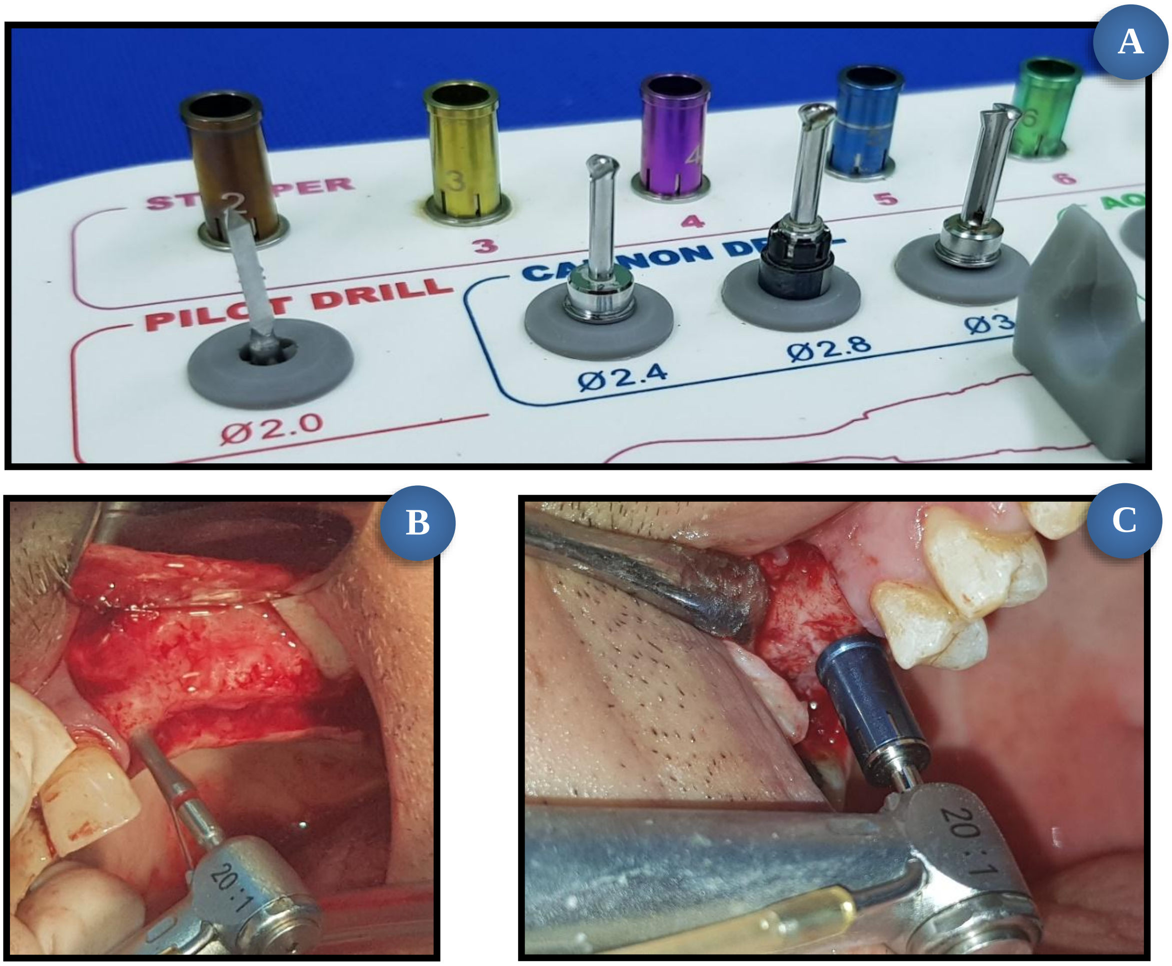

Fig. (2.18): (A) OKA-KIT pilot and cannon drills. (B): Pilot drilling initiated at osteotomy site verifying the proposed implant site. (C): Cannon drill Ø 3.2 mm and stopper at the site of tooth #3.

If cannon drill A.I (Ø 2.8 mm) stopped during the preparation, this did not necessarily mean that sinus inferior board is opened. To confirm this fact, sensor gauge with the same stopper used was; feeling the spring action which means opening has not occurred yet, Fig. (2.19).

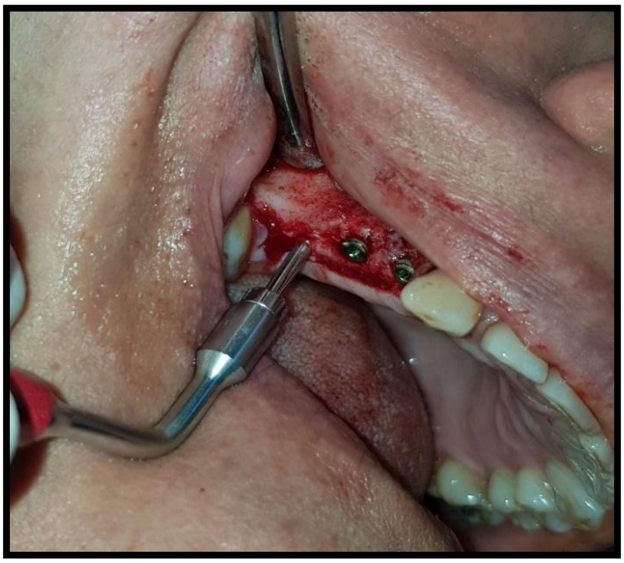

Fig. (2.19): Portraying the use of sensor gauge in order to ensure sinus floor opening.

Subsequently, turning to the final cannon drill A.I (Ø 3.2 mm) with stopper of 1mm longer than the SAD and the preparation continued until autostop occurred. This meant that the sinus inferior board had been opened. No feeling of spring action with the sensor gauge meant that the sinus floor was opened, Fig. (2.20) illustrating features of this drills.

Fig. (2.20): Cannon drill A.I (Ø 3.2 mm) with its edge cutting features and non-traumatic apical end.

For *Schniedrian membrane* elevation, the next step was accomplished by Aqua taps group, Fig. (2.21).

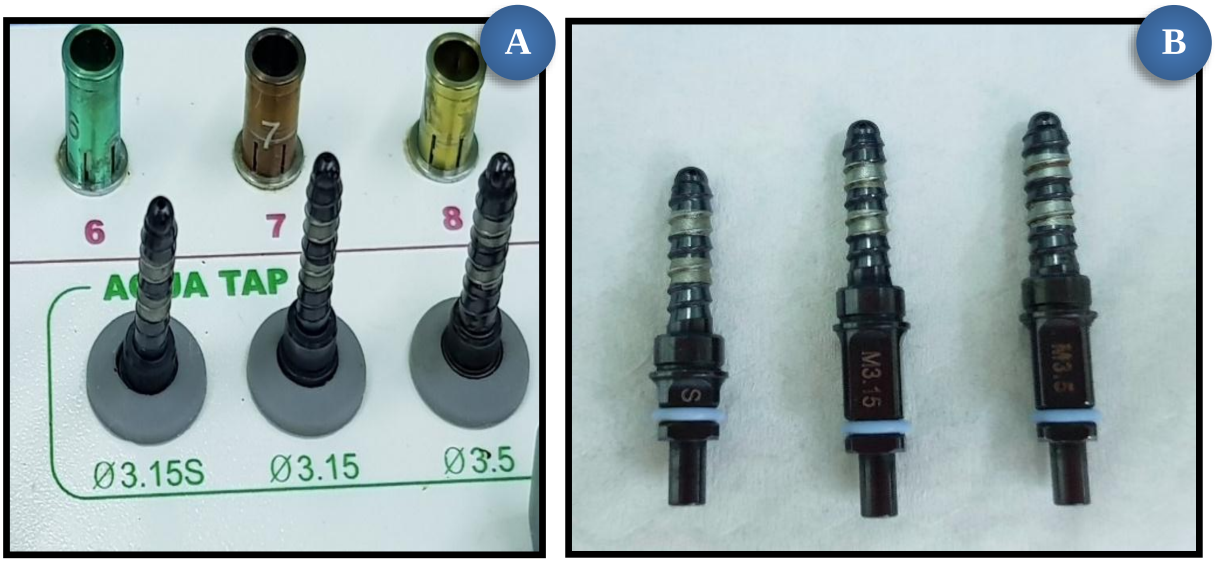

Fig. (2.21): OKA-KIT aqua tap with their diameters.

Proceeding by choosing ⦰ 3.5 mm aqua tap, dipping it in a cup of normal saline emptying from air bubbles, Fig. (2.22).

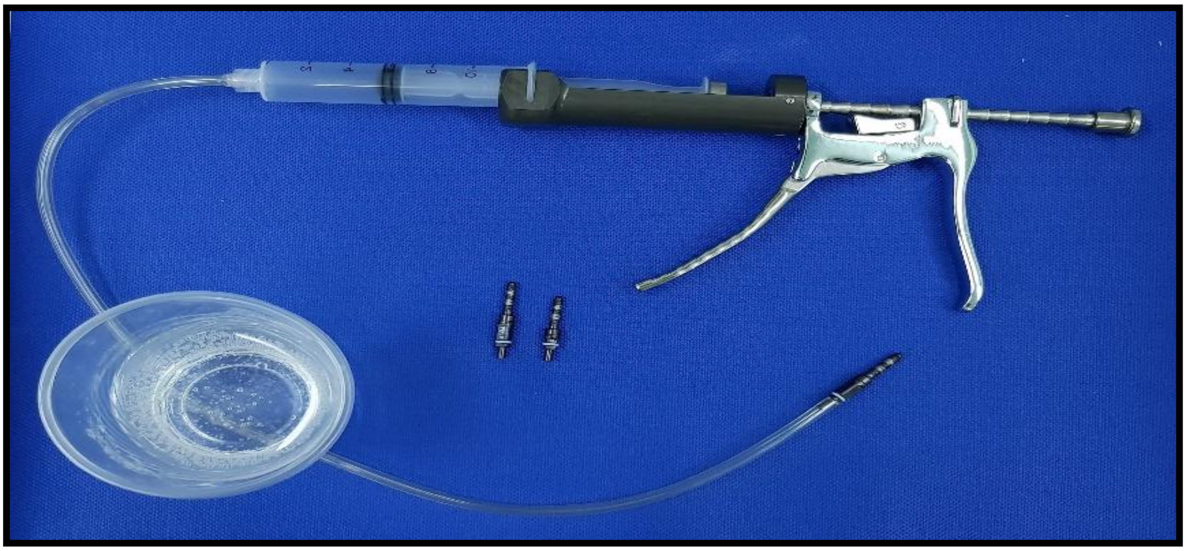

Fig. (2.22): Aqua tap connected to the tube that already connected to a plastic syringe loaded on aqua syringe so as to get rid of air bubbles.

A stopper used either 1 or 2 mm longer than SAD was attached to the aqua tap then assembled to its engine adapter which then applied to the engine handpiece with slow speed (35 rpm, 35 N/cm), Fig. (2.23).

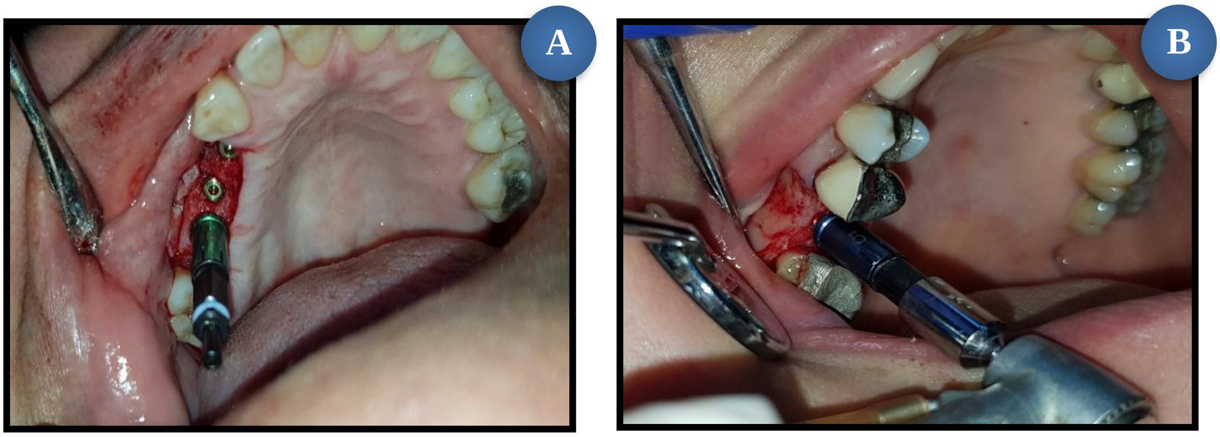

Fig. (2.23): (A) & (B) Insertion of final aqua tap assembled with the specific stopper and adaptor in order to perform the aqua lift of sinus membrane.

Maintaining the same parallelism during insertion is vital to preserve the full engagement with the prepared socket in order to achieve successful hydraulic elevation. Detaching the adapter along with the handpiece from the aqua tap and connecting the plastic tube to the end of the aqua tap, while the second free end of the tube is connected to the plastic syringe filled with 5 cc of normal saline solution which itself loaded and locked by aqua syringe. Injection technique was gradually done by boosting normal saline through the tube and the inner aqua tap canal toward the sinus membrane by pressing on the aqua syringe handle. The syringe handle is provided with lock shaft device divided into equaled sequenced ledges to control boosting the saline gradually under pressure beneath the membrane. In addition, the aqua tap is designed to produce even pressure against the membrane by tiny holes distributed around the apical end of the tap in order to achieve safe elevation, Fig. (2.24).

Fig. (2.24): Aqua syringe connected to the aqua tap boosting normal saline solution gradually to accomplish membrane lifting at tooth site # 3.

Once elevation process is completed, the tube is removed from the tap and the adapter along with handpiece is assembled with the tap and retrieved from the socket by reverse torque system, Fig. (2.25).

Fig. (2.25): Aqua syringe locking device.

After sinus lifting was done by the OCA-KIT, the prepared socket is completed by the Nucleoss dental surgical kit drills to the desired implant dimensions that is installed at the end of the procedure in a motorized way with controlled speed and torque.

For group B:

Utilizing NucleOss surgical kit, starting with pilot drill to the predetermined height (1 mm below sinus floor) then the parallelism and angulation of drilling holes checked with the aid of parallel pins followed by sequential drilling maneuver, Fig. (2.26).

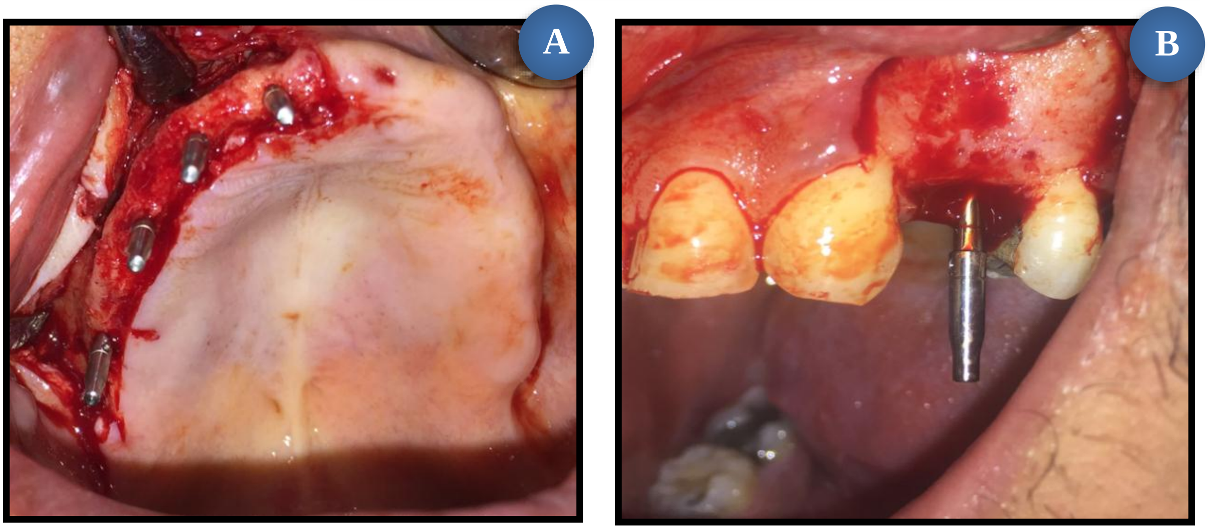

Fig. (2.26): (A) & (B) Parallel pins in initial osteotomy sites verifying the proposed implants position and angulation.

Proceeding with larger drills until reaching the requested final drill diameter. Then a greenstick fracture of the sinus floor with ⦰ 3.4 mm osteotome and ⦰ 3.8 mm with gentle and controlled firm tapping by surgical mallet while asking the assistant to support the patient's head. Careful attention paid in this step as tactile sense and voice resonance (of prime importance) will be changed indicating entrance into sinus membrane space (SMS) as further tapping would perforate sinus membrane, Fig. (2.27).

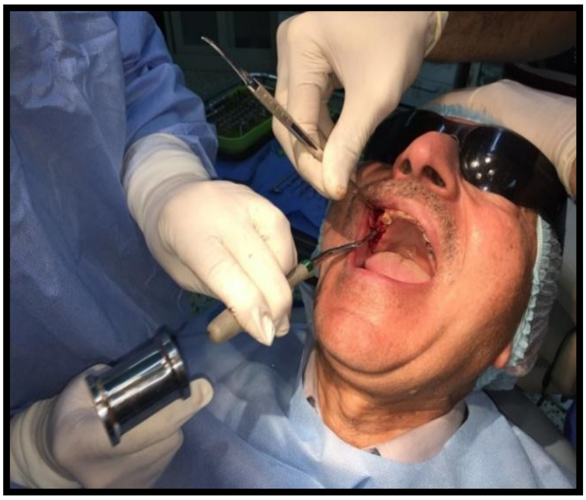

Fig. (2.27): Gentle and controlled firm tapping of the sinus floor utilizing 3.4 mm osteotome & mallet with the assistant supporting patient's head.

The vital point in this procedure, was checking for the patency of *Schneiderian membrane* for the presence of any perforation for both groups and it was implemented by means of **the endoscope**. Endoscopic parts assembled (display screen + flexible fiberscope), the lens wiped with 75% alcohol and turned on to be ready for use. Following the reverberation of the fluid into the oral cavity, the operator dried up the socket hole with cotton swab to eliminate the blood and fluid that remained inside in order not pervert the lens and influence its resolution, Fig. (2.28).

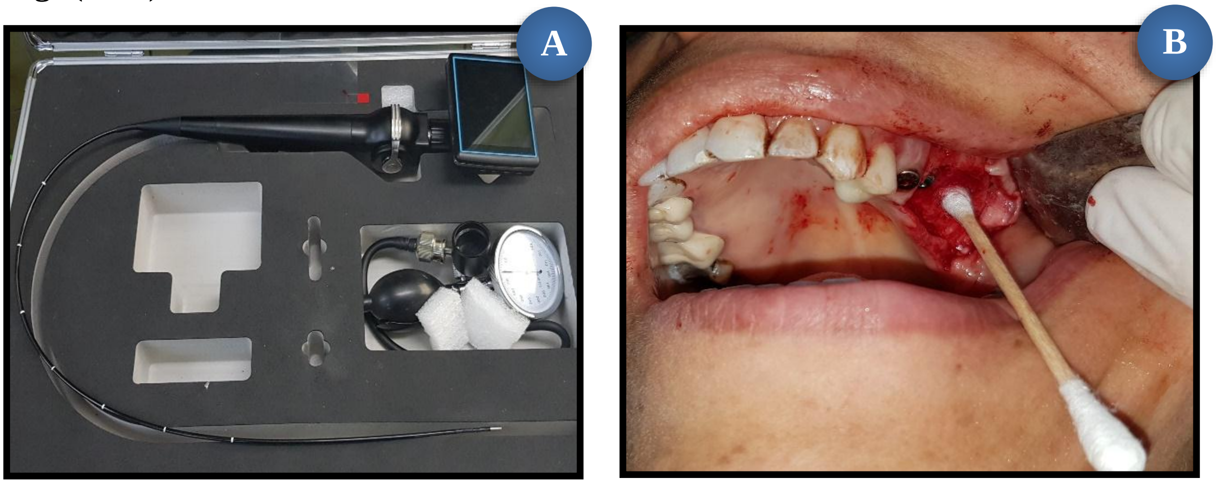

Fig. (2.28): (A) Endoscopic parts assembled together, (B) Drying the socket by cotton swabs to prevent lens beclouding.

Endoscopic lens introduced into the implant bed or at the edge of the drill hole (parascope) was utilized depending on SAD for observing and illustrating the membrane, asking the patient to take deep respiration to watch the membrane movement upon inspiration if there is any perforation to be detected or, however the perforation may be obvious once viewed by the endoscope capturing photos and registering videos for documentation, Fig. (2.29 And 2.30).

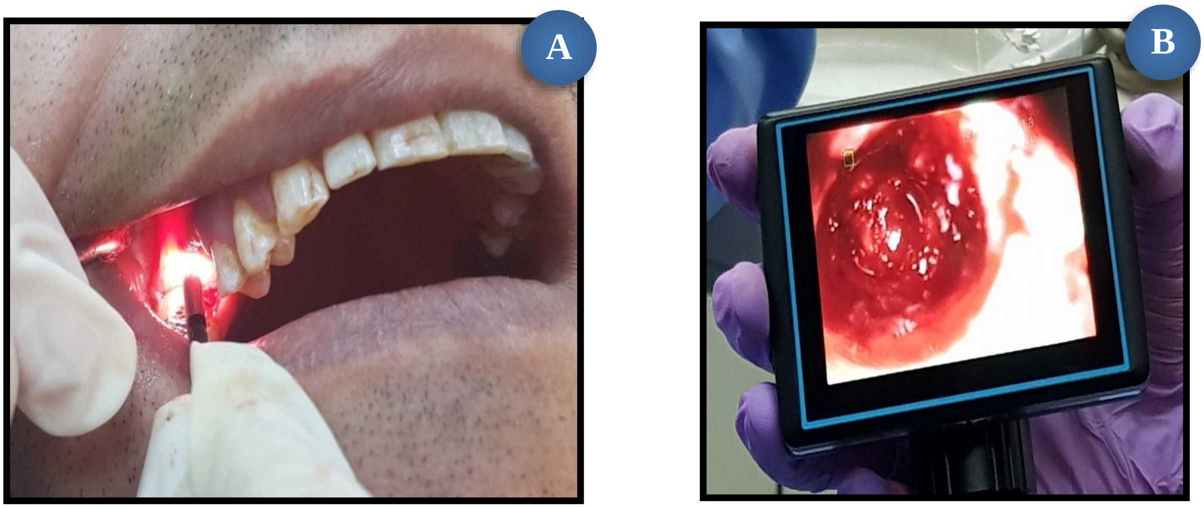

Fig. (2.29): (A) Introducing the endoscopic camera into the socket, (B) Endoscopic monitor turned on displaying implant bed and membrane with clarity.

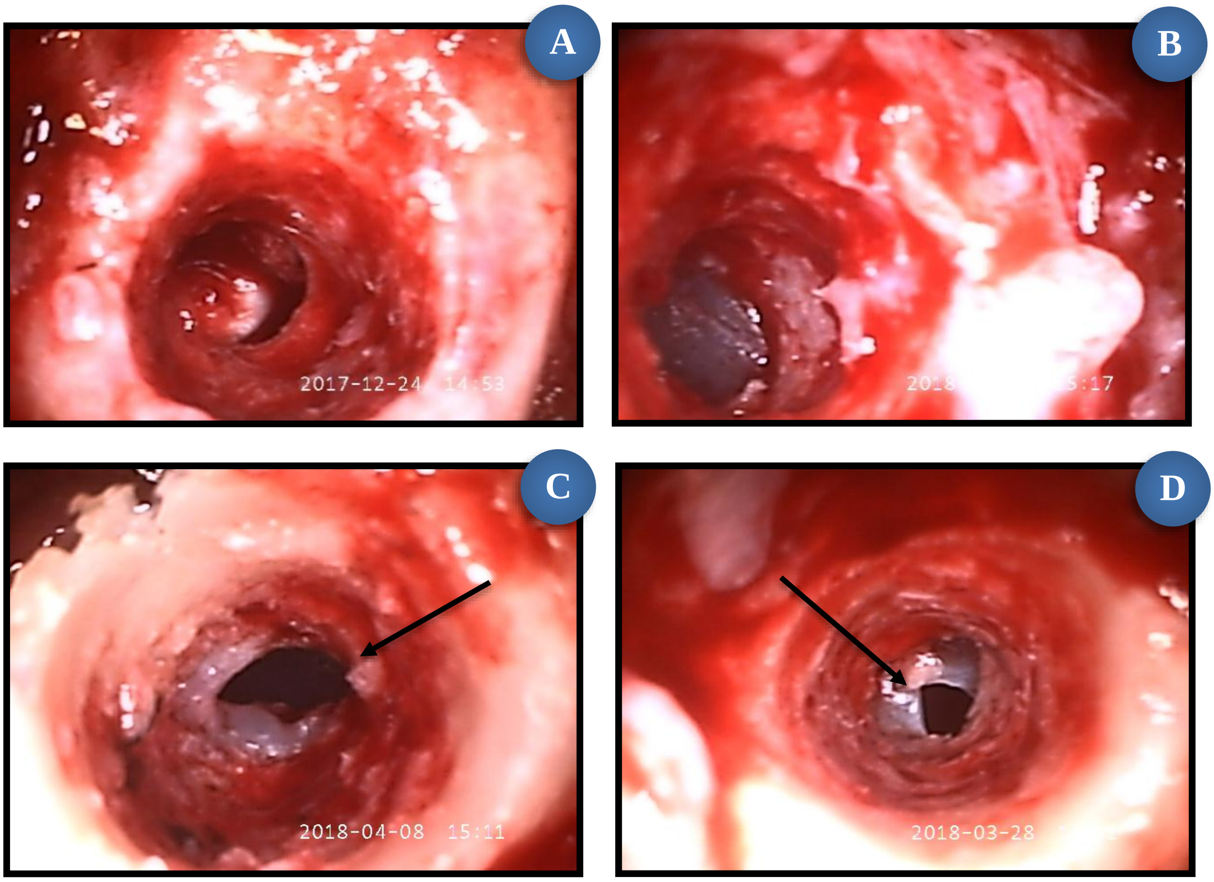

Fig. (2.30): (A) Intact Schneider membrane with grayish-bluish hue (B) Piece of sinus floor following fracture with part of Schneider membrane that is intact (this picture mostly seen when SL is performed by the OCA-KIT). (C) & (D) Displaying obvious sinus membrane perforation during osteotome and Osung techniques respectively.

In both groups barrier membrane placed for about 2 minutes in a cup of physiological saline solution to prevent osmotic damage before use (according to the manufacturer instruction). The membrane is shaped (trimmed) all around with surgical scissor to the desired size and shape removing any sharp edges that could irritate the *Schneider* membrane, stacked for easy introduction through the hole after folding and introduced with the tweezer into the SMS, Fig. (2.31 A, B).

The following step was to inject the nonautogenous bone graft material (osteon III) incrementally loaded with bone carriers of OCA-KIT and introduced through osteotomy hole into the SMS with the aid of bone condenser or osteotome, Fig. (2.31 C, D).

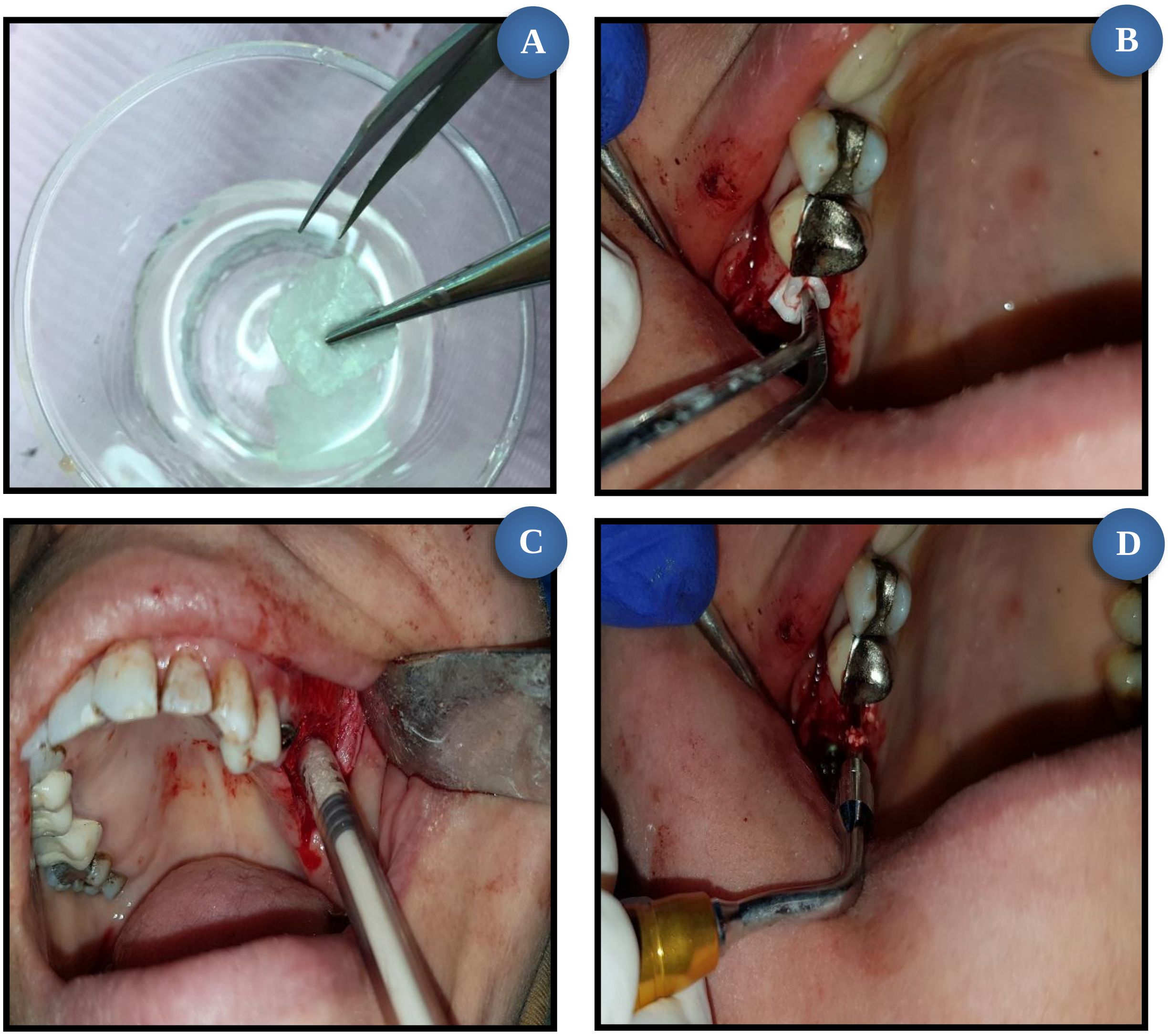

Fig. (2.31): (A) Resorbable collagen membrane soaked in normal saline solution. (B) The membrane is folded and hosted into SMS in tooth site # 3. (C) Osteon III sinus bone graft installed through implant bed into the SMS in tooth site # 14. (D) Successive insertion of the bone graft with the aid of OKA-KIT bone condenser in tooth site # 3.

The predetermined DI size mounted in implant engine handpiece (35 rpm, 35 N/cm) and installed in its position. Final seating could be achieved with ratchet if required followed by subjoining the cover screw into the fixture, Fig. (2.32).

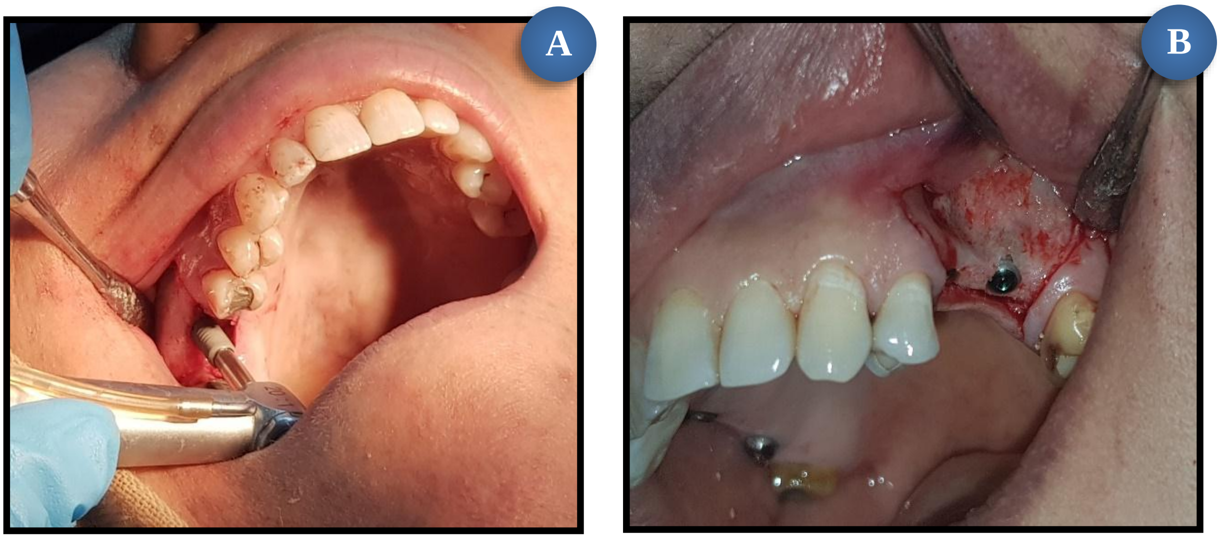

Fig. (2.32): (A) Motorized installation of DI at tooth site # 3. (B) Connecting the cover screws to the DI.

Note: In all cases the DI outside the sinus zone fitted in their position before proceeding with the sinus steps.

With normal saline solution, the surgical field was irrigated for clearance of any remnants of bone substitute & debris. Wound closure is achieved with 3/0 black silk non absorbable suture (simple interrupted technique), Fig. (2.33).

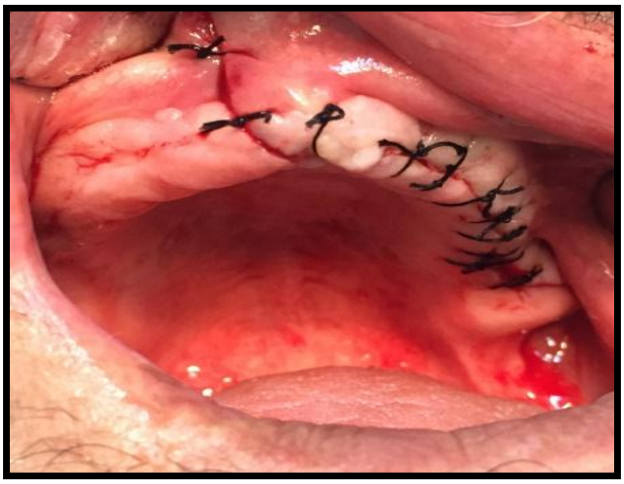

Fig. (2.33): Wound closure.

2.6 Instructions & postoperative care

1. Oral gauze pads placed after surgery and kept in situ for 30 minutes.

2. Application of cold packs over the skin of the face (at the surgical side) for 15 minutes on and left for a period of time and this action is repeated respectively. As swelling is a normal sequelae after oral surgery that normally reaches its peak by the 3rd day and then starts to resolve; it can be diminished with ice packs over the operated area. Ice packs are useful for the 1st day only. These measures will not eradicate swelling but help immensely to reduce its severity.

3. Do not rinse mouth at the 1st day. Starting in the second day, gently rinse for 30 seconds every morning after breakfast, at bedtime with Chlorihexidine mouth rinse 0.2% for 10 days. During the daytime rinse with warm salty water every 3 hours for 3 days with approximately 1 teaspoonful of salt dissolved in a cup of warm water.

4. Do not eat for 2 hours after surgery (allow blood clotting not to be disturbed) then begin with clear liquids such as orange juice. Gradually upgrade the diet as tolerated. Always cool any hot foods or liquids during the first 24 hours. The patient should eat only soft food for the 1st postoperative week. Avoid any hard & chewy foods for 2 weeks. Avoid blowing & using straws for couple of weeks.

5. For all patients, the same regimen was prescribed (Cefixime 400 mg once daily and Metronidazole 500 mg one tab every 8 hours (both for 7 days), Panadol extra 500 mg 1-2 tabs on need, Nasophrin 2 drops in each nostril every 6 hours for 4 days & Clorhexidine gargling twice daily for 10 days).
6. Some discomfort is normal after the operation. Panadol extra tab is administered as a pain killer.
7. Begin brushing teeth on the day following surgery but gently close to the surgical area. It is important to brush all the teeth for proper healing that plaque and food are not allowed to collect near the surgical field.
8. The patients instructed to attend for the follow up 14 days postoperatively for sutures removal & checkup.

Statistical analysis

The data analyzed using Statistical Package for Social Sciences (SPSS) version 25. The data presented as mean, standard deviation and ranges. Categorical data presented by frequencies and percentages.

Chapter Three

Results

Results

The total number of patients in this study was 30 with 52 sites of sinus lift. The sample is divided into two groups according to the crestal sinus lift procedure assigned; **Group A** using hydraulic pressure **(Osung)** kit including 27 cases and **Group B** performed by **Osteotome kit** including 25 using sinus endoscopy as a diagnostic aid for the visualization of sinus membrane perforation for both groups.

3.1. Sinus lift procedure

The distribution of study patients by type of sinus lift procedure used is represented in table (3.1) and Fig. (3.1). In this study, 51.9% of cases (27) were managed by Osung procedure.

Table 3.1: The distribution of study patients by type of sinus lift procedure.

Sinus lift procedure	No. (52)	%
Osung	27	51.9
Osteotome	25	48.1

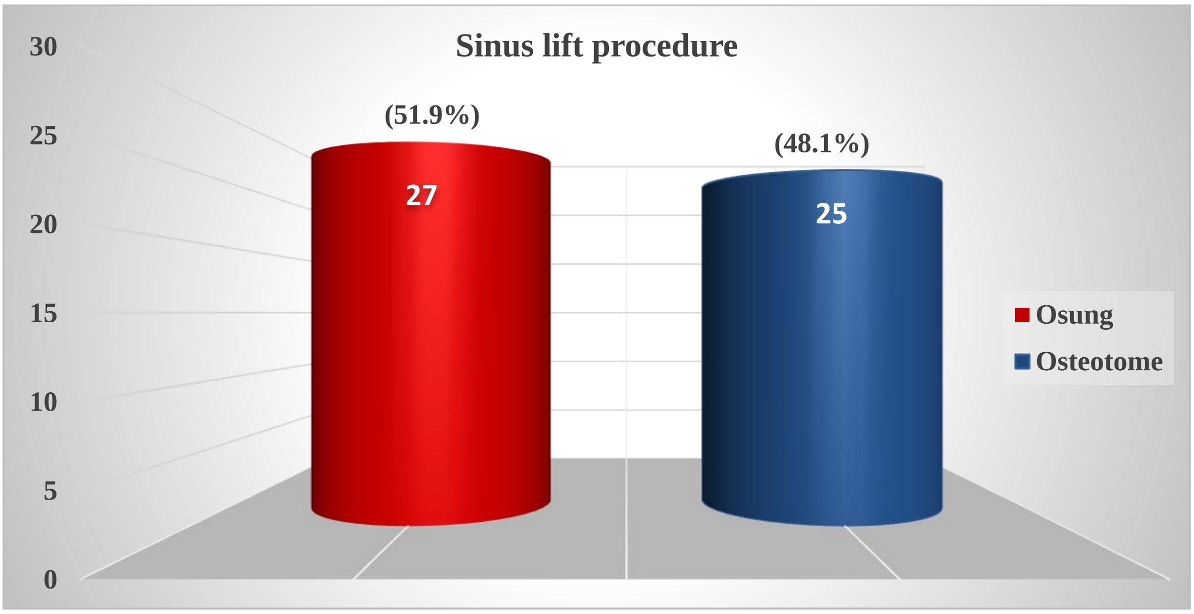

Fig. (3.1): Distribution of study patients by type of sinus lift procedure.

3.2. Age and Gender

The distribution of study patients by age and gender is displayed in table (3.2) and Fig. (3.2 & 3.3). The study patient's age was ranging from 19-72 years with a mean of **46.86** years and standard deviation (SD) of ± 13.46 years. The highest proportion of patients was aged between 45-59 years (43.4%).

Regarding gender, the proportion of females was higher than males (83.3% versus 16.7%) with a female to male ratio of 5:1.

Table 3.2: The distribution of study patients by age and gender.

Variable	No. (30)	%
Age (years)		
≤ 29	4	13.3
30 - 44	7	23.3
45 - 59	**13**	**43.4**
≥ 60	6	20.0
Gender		
Male	5	16.7
Female	25	83.3

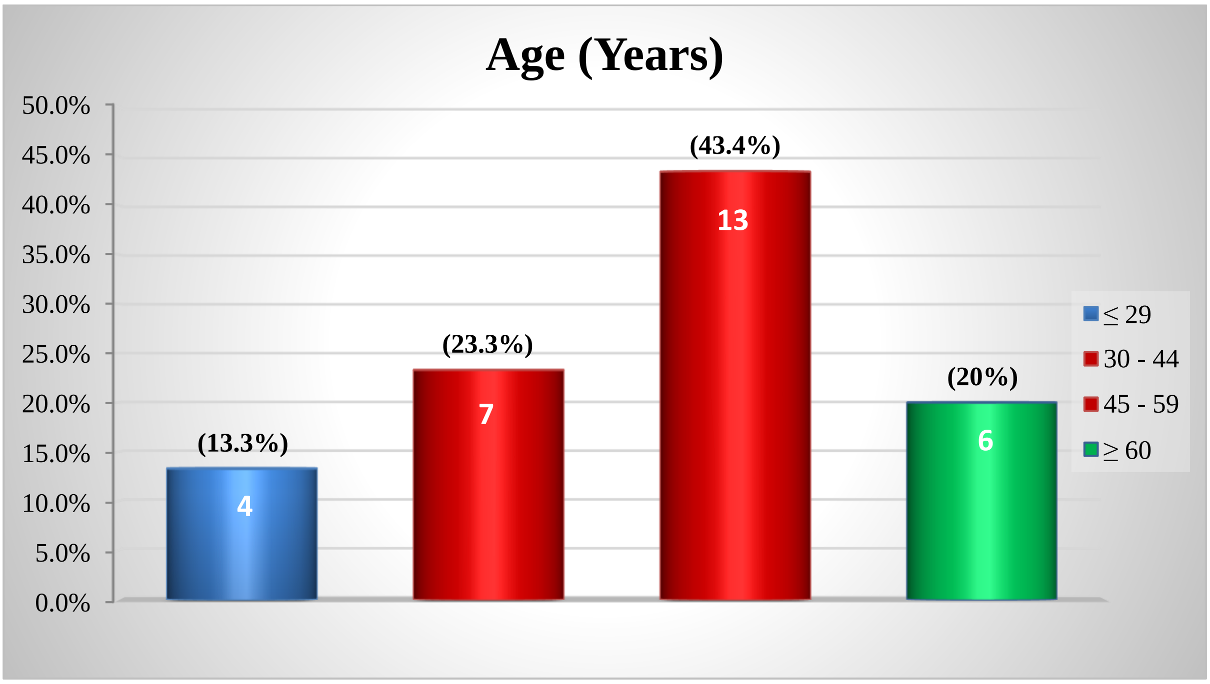

Fig. (3.2): Distribution of study patients by age.

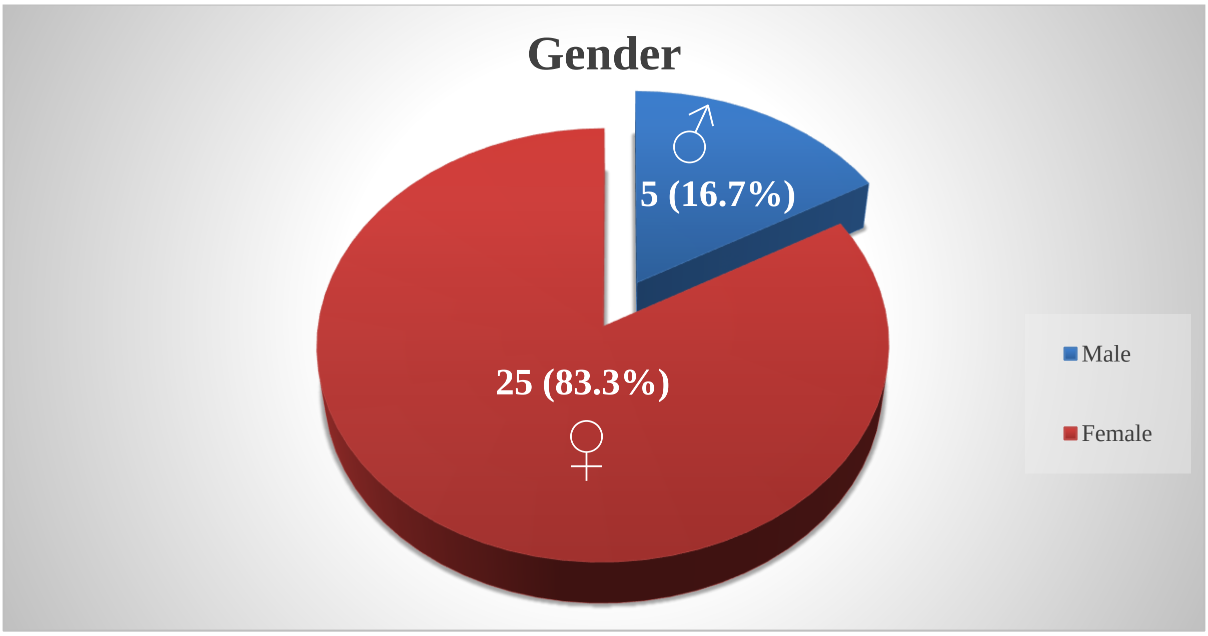

Fig. (3.3): Distribution of study patients by gender.

3.3. Preoperative CBCT examination

3.3.1. SP degree

Table (3.3) and Fig. (3.4) demonstrates the distribution of cases by SP degree. In this research, the highest proportion of patients showed SP1 degree (56.7%).

Table 3.3: The distribution of study patients by SP degree.

SP degree	No. (30)	%
1	**17**	**56.7**
2	11	36.7
3	1	3.3
4	1	3.3

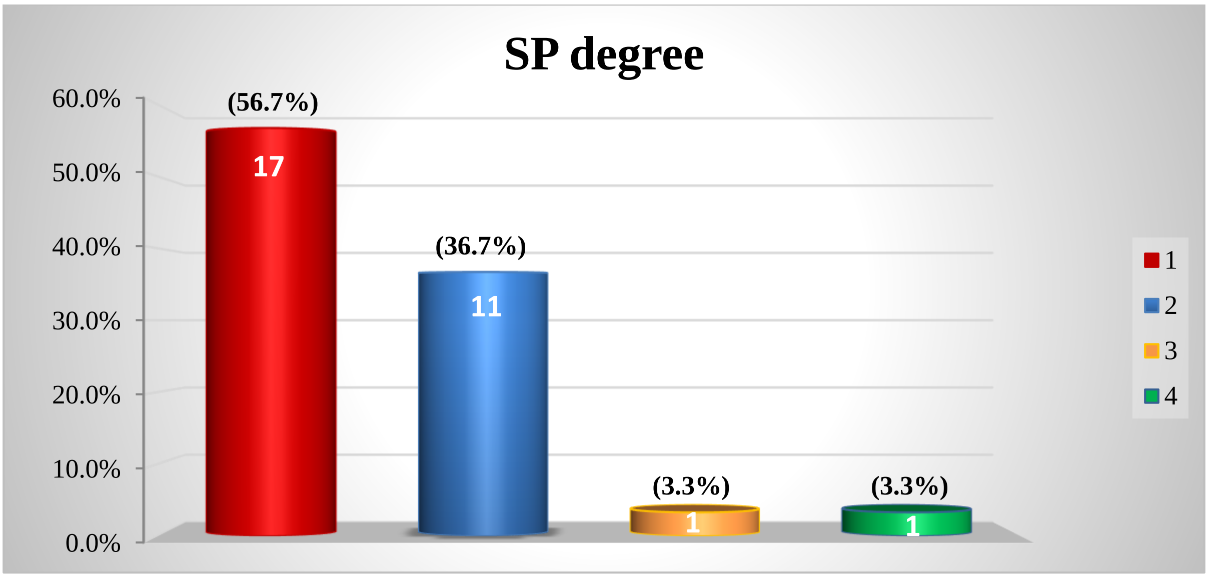

Fig. (3.4): Distribution of study patients by SP degree.

3.3.2. Subantral bone height

Comparison in the mean of subantral bone height between patients managed by Osung SL procedure and those who were managed by Osteotome SL is advertised in table (3.4) and Fig. (3.5). In the current study, there was no statistical significant differences (P value= 0.72) in the means of subantral bone height between the two groups.

Table 3.4: The comparison in the mean of subantral bone height between group A & B.

SL Procedure (group)	Subantral bone height Mean ± SD	P-Value
Osung (A)	4.77 ± 1.17	**0.72**
Osteotome (B)	4.89 ± 1.32	

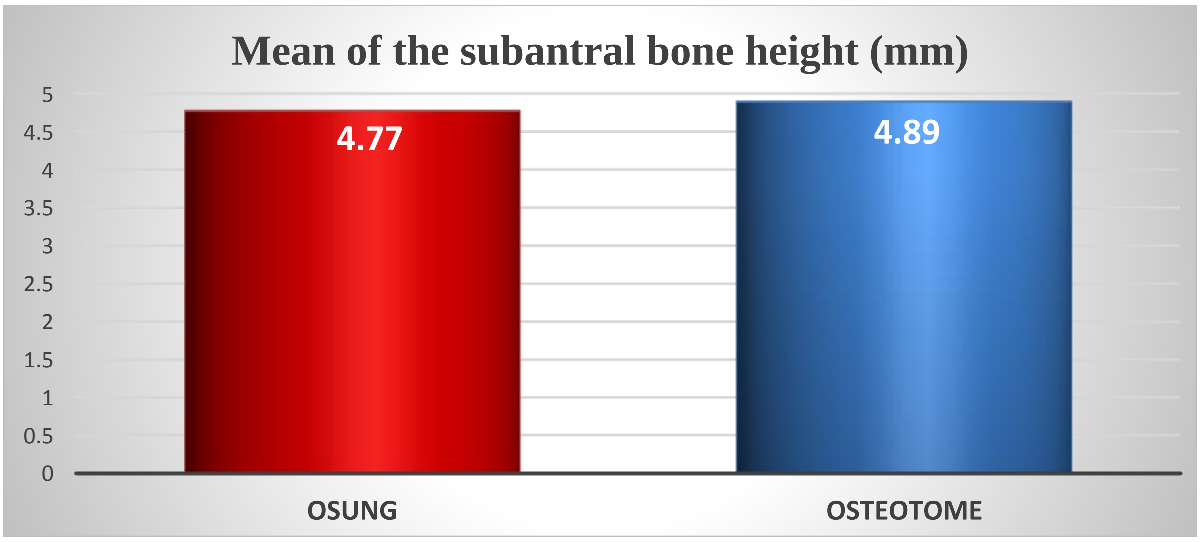

Fig. (3.5): Difference in mean the of subantral bone height between patients in group A and B.

3.4. Tooth site No.:

The distribution of cases by tooth site No. is shown in table (3.5) and Fig. (3.6).The researcher noticed that tooth site # 14 was the most dominant site managed in this study **(40.4%)**.

Table 3.5: The distribution of study patients by tooth site No.

Tooth Site No.	No. (52)	%
2	7	13.5
3	7	13.5
13	2	3.8
14	**21**	**40.4**
15	15	28.8

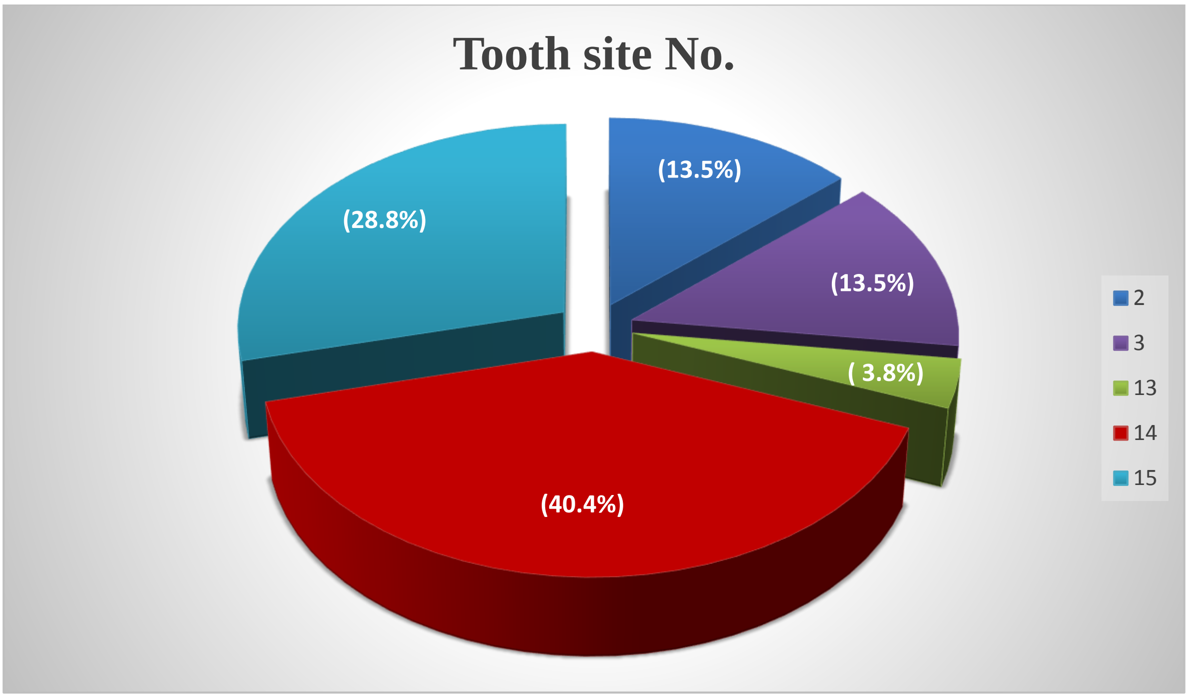

Fig. (3.6): Distribution of study patients by tooth site No.

3.5. Dental implant dimensions

The distribution of cases by dental implant dimensions is attested in table (3.6) and Fig. (3.7).In this study, dental implant **(4110)** was utilized in 32.7% of cases followed by (4810), as in table (3.6).

Table 3.6: The distribution of cases by dental implant dimensions.

Dental implant dimensions	No. (52)	%
4110	**17**	**32.7**
4112	5	9.6
4810	**16**	**30.8**
4812	14	26.9

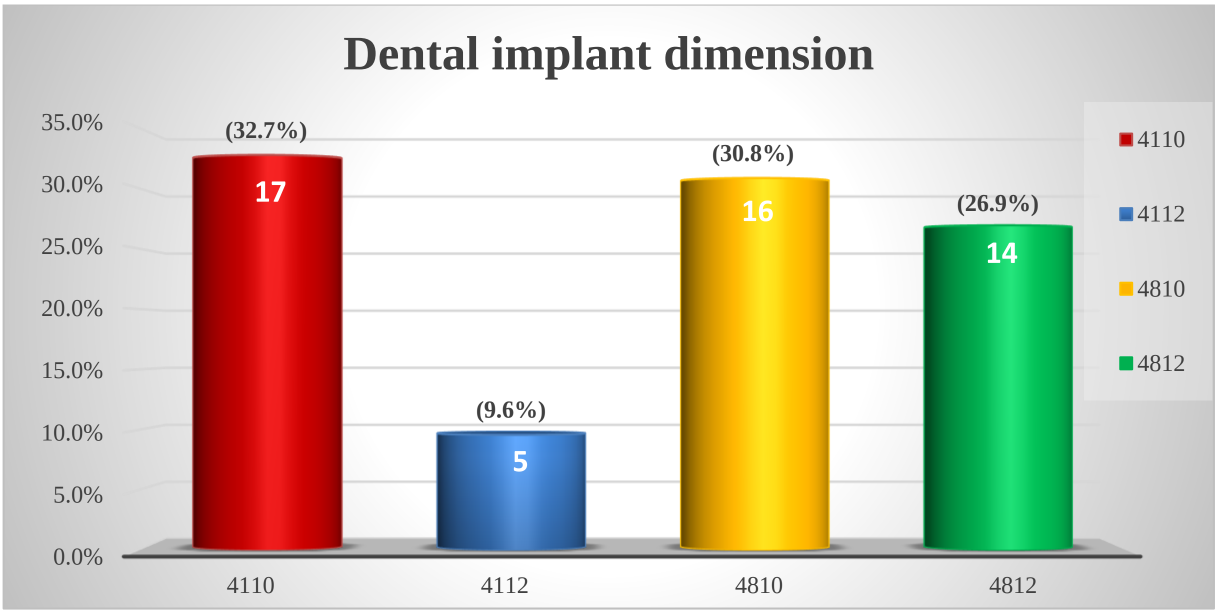

Fig. (3.7): Distribution of cases by dental implant dimensions.

3.6. Perforation of sinus membrane

The comparison between SL procedures for both A & B groups according to perforation of sinus membrane observed is registered in table (3.7) and Fig. (3.8). In this research, perforation of sinus membrane observed with endoscopy of cases managed by Osung were only 3.7%, while occurred in 12% of cases managed by Osteotome SL, however, this difference was statistically not significant (P value= 0.22).

Table 3.7: The comparison between SL procedures by perforation of sinus membrane.

Perforation of sinus membrane	SL Procedure		Total 52 (%)	P- value
	Group A (Osung) 27	Group B (Osteotome) 25		
yes	**1 (3.7)**	**3 (12.0)**	4 (7.7)	**0.22**
no	26 (96.3)	22 (88.0)	48 (92.3)	

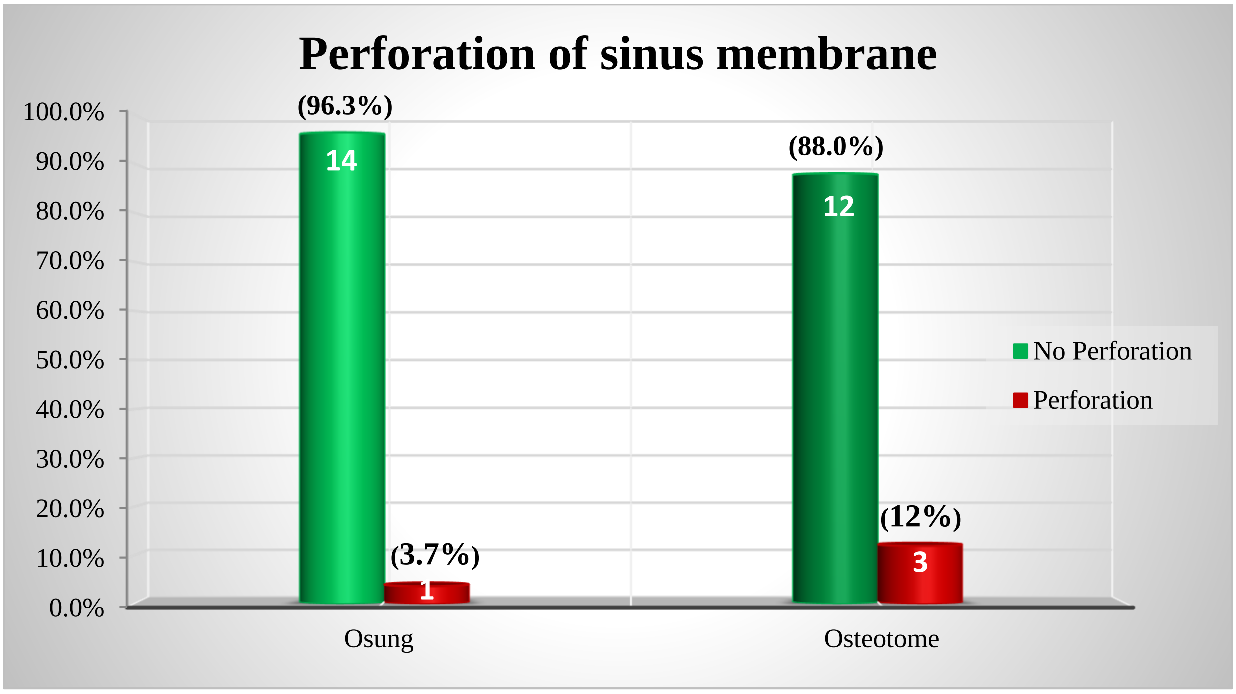

Fig. (3.8): The difference between SL procedures by perforation of sinus membrane.

Table (3.8) illustrates the association between perforation of sinus membrane as a complication and general characteristics of study patients. It has been noticed that there was no statistical significant association ($P \geq 0.05$) between perforation of sinus membrane with both age and gender.

Table 3.8: The association between perforation of sinus membrane and general characteristics.

Variable	Perforation of sinus membrane		Total 30 (%)	P- Value
	Yes 4 (%)	No 26 (%)		
Age (Years)				
≤ 29	0 (0)	4 (100.0)	4 (13.3)	**0.867**
30 - 44	1 (14.3)	6 (85.7)	7 (23.3)	
45 - 59	2 (15.4)	11 (84.6)	13 (43.4)	
≥ 60	1 (16.7)	5 (83.3)	6 (20.0)	
Gender				
Male	0 (0.0)	5 (100.0)	5 (16.7)	**0.462**
Female	4 (16.0)	21 (84.0)	25 (83.3)	

Table (3.9) corroborates the association between perforation of sinus membrane and SP degree. There was no statistical significant association noticed (P value= 0.531) between perforation of sinus membrane and SP degree.

Table 3.9: The association between perforation of sinus membrane and SP degree.

SP degree	Perforation of sinus membrane		Total 30 (%)	P- Value
	Yes 4 (%)	No 26 (%)		
1	1 (5.9)	16 (94.1)	17(56.7)	0.531
2	3 (27.3)	8 (72.7)	11 (36.7)	
3	0 (0.0)	1 (100.0)	1(3.3)	
4	0 (0.0)	1 (100.0)	1 (3.3)	

Table (3.10) demonstrates the association between perforation of the sinus membrane and tooth site number. There was no statistical significant association noticed (P value= 0.171) between them.

Table 3.10: The association between perforation of sinus membrane and tooth site No.

Tooth Site No.	Perforation of sinus membrane		Total 52 (%)	P- Value
	Yes 4 (%)	No 48 (%)		
2	0 (0)	7 (100.0)	7 (13.5)	0.171
3	2 (28.6)	5 (71.4)	7 (13.5)	
13	0 (0.0)	2 (100.0)	2 (3.8)	
14	2 (9.5)	19 (90.5)	21 (40.4)	
15	0 (0)	15 (100.0)	15 (28.8)	

Table (3.11) displays the association between perforation of sinus membrane following SL and dental implant dimensions. There was no significant association (P value= 0.535) between perforation and dental implant dimensions.

Table 3.11: The association between perforation of sinus membrane and dental implant dimensions.

Dental implant dimensions	Perforation of sinus membrane		Total 52 (%)	P- Value
	Yes 4 (%)	No 48 (%)		
4110	1 (5.9)	16 (94.1)	17 (32.7)	**0.796**
4112	0 (0)	5 (100.0)	5 (9.6)	
4810	2 (12.5)	14 (87.5)	16 (30.8)	
4812	1 (7.1)	13 (92.9)	14 (26.9)	

Table (3.12) express the comparison in mean of subantral bone height between cases with perforated sinus membrane and those with intact one. The mean of subantral bone height in cases with perforated sinus membrane was lower than that associated with intact membrane, however, this difference was statistically not significant (3.62 versus 5.075 mm, with P value= 0.248).

Table 3.12: The comparison in mean of subantral bone height between cases with perforated sinus membrane and those with intact one.

Perforation	Subantral bone height Mean ± SD (mm)	P - Value
Perforated sinus membrane	3.62 ± 1.15	0.248
Intact sinus membrane	5.075 ± 1.22	

Table (3.13) make obvious the comparison in mean of membrane thickness between cases with perforated sinus membrane and those with intact membrane. The mean of membrane thickness in the 1st category was higher than that in the 2nd one, however, this difference was statistically not significant (0.97 versus 0.69 mm, with P value= 0.516).

Table 3.13: The comparison in mean of membrane thickness between cases with perforated sinus membrane and those with intact membrane.

Perforation	Membrane thickness Mean ± SD (mm)	P - Value
Perforated sinus membrane	0.97 ± 0.74	**0.516**
Intact sinus membrane	0.69 ± 0.71	

Chapter Four

Discussion

Discussion

Transalveolar osteotome technique has been documented to be a predictable treatment option to develop adequate bone height for dental implant placement in atrophied posterior maxilla. However, other techniques were developed to improve surgical outcome by avoiding common complications associated with conventional sinus lifting approach. Thus, this study was aimed to evaluate the efficacy of using hydraulic pressure in transalveolar sinus lift with the use of soung kit compared to beaten osteotome technique utilizing sinus endoscopy. The latter aids in turning this usual technique from invisible approach to visibility, thereby assessing the presence of maxillary sinus membrane perforation, this study is randomly organized by envelops method.

4.1. Sinus lift procedure:

In this research, the distribution of study patients by type of sinus lift procedure utilized, 51.9% (27 sites) were managed by **Osung** procedure and 48.1% (25 sites) were managed by the standard **Osteotome** technique.

Bensaha, 2011 in his study, reported that 50 sinus membrane lifting procedures were performed; 25 lateral and 25 crestal, single stage procedure was used for all cases and 64 implants were placed. The residual crest bone under sinus floor assessed by tomography was at least 1.2 mm (mean 3.9 - 1.2 mm) in the sinus infiltration technique group.

It is well known that the **Osteotome** crestal SL is less invasive than the lateral approach but require a highly experienced surgeon to deal with the application of gradual controlled firm tapping with right forces applied, in addition it is a blind procedure request high tactile sensation. It need also a cooperative patient to tolerate this process with the absence of any history or evidence of vertigo. This technique require another kit for initial drilling procedure preceding osteotome tapping.

On the other hand, regarding Osung technique:

It has been noticed by the researcher that the procedure even is less invasive than osteotome SL with the use of intelligent drills. The kit is quite easy to be used with sequential drilling procedure and large No. of stoppers with the final drill being quite safe in which the drilling procedure is concentrated on the peripheries (sides) of the implant bed (socket hole) with it's flat top surface allowing fracture and elevation of the sinus floor with obvious safety.

One important point to note, is that the operator worked according to the kit instructions in the first case with the use of depth gauge to check for completion of sinus floor elevation, however, the case of perforation occurred in the 1^{st} case with the use of Osung SL, this can be explained by 2 possibilities:

1. Imperfect use of the flexible (compressible) depth gauge.

2. The use of the final drill (Cannon drill ⦰ 3.2 mm) with 2 mm difference from the previous drill (Cannon drill ⦰ 2.8 mm) which may induce this complication.

As a result of that, the operator decided to use the stoppers gradually for every 1 mm, and hence no perforation occurred in the remaining 14 cases with the use of hard depth gauge rather than and flexible one.

For sinus membrane hydraulic elevation it was better with the use of aqua taps with Osung kit since it can reach as near as possible to the membrane to ensure adequate elevation (owing to the presence of 3 holes in the apical end of the aqua tap) with the use of OCA- syringe, and this is supported by;

Chen & Cha, 2005 who stated that the elevation of the *Schneiderian membrane* using the water infiltration system can be explained by **Pascal's principle**, which states 'a change in the pressure of an enclosed incompressible fluid is conveyed undiminished to every part of the fluid and to the surfaces of its container', the use of an equal liquid pressure in every point of the *Schneiderian* *membrane* can reduce the stress applied to the membrane's surface which results in less risk of perforation. The sinus infiltration technique described differs from other reported techniques that are based on fluid injection **(hydrodissection)**, the force is applied to only one part of the *Schneiderian membrane*. Therefore, the even distribution of tension is not possible, and premature rupture or bursting of the *Schneiderian membrane* may occur. The use of a fluid jet causes pressure peaks at those sites where the jet impacts the *Schneiderian membrane*.

The present author's opinion that the sinus membrane can be elevated safely through the crestal approach with a minimal bone height averaging 3 mm with simultaneous DI placement, hydraulic *Schneiderian membrane* elevation shows a high rate of surgical success, with very low frequency of complications, and high implant survival rate and patient satisfaction. The height of membrane elevation may be superior to that obtained with osteotome-mediated techniques **(Chan *et al*., 2013).**

Guillot *et al*., 2007 advocated that the most challenging part of sinus lifting procedures is the separation of the *Schneiderian membrane* from the internal surface of the maxillary bone, the confined flow of the liquid provides stability for the infiltration jet with equal pressure in every point of the sinus membrane reducing the risk of rupture.

4.2. Age and gender:

In the present research, study patient's age was ranging from 19-72 years with a mean of **46.86** years and SD of ±13.46 years. The female to male ratio was 5:1. There was no significant association with age (P=0.867) and gender (P=0.462).

The peak age group was 45-59, (43.4%), this is quite ordinary because this is the peak age for teeth loss which need for DI placement (treatment), followed by 30-44 (7%), these two age groups represented early teeth loss in this country due to the absence of preventive care by medical institutes with low education level in the society.

Hussein & Hassan, 2017 in their study, found that the patients aged from 20-65 years with a mean age of **47.4** years, the highest percentage was reported in the sixth decade of life and the lowest in the third and fourth decades, 50-59 (36.4%).

Lateef & Asmael, 2016 the age distribution in their study was ranged from 28-55 years. The highest percentage of patients enrolled in this study was in the age group 50-59 years **(46.15%)**, accordingly the current study was so close to the previous studies in contribution to the mean age.

Regarding gender, proportion of females was higher than males (83.3% versus 16.7%) with a ratio of 5:1, this may be mainly belonged to that females are keener about their oral hygiene and teeth replacement for the sake of esthetic and functional purposes.

4.3. Preoperative CBCT examination:

4.3.1. SP degree:

In the current study, mild expansion (SP1) was found in 17 (56.7%) out of 30 sinuses and a percentage of (3.3%) seen for each of SP3 and SP4, there were no significant association between perforation of sinus membrane and SP existed, (P=0.531).

The degree of SP is important to have an idea about the size and extent of the sinus with the amount required for non-autogenous bone graft material.

Tolstunov *et al*., 2012 in a radiographic anatomic study established that most of sinuses with mild or moderate expansion and there was a direct relation between age and sinus expansion.

Sharan & Madjar, 2008 reported that the loss of maxillary posterior teeth results in alveolar bone resorption as well as maxillary SP. The loss of two adjacent upper posterior teeth or loss of upper 2^{nd} molar were found to be associated with greater degree of pneumatization, also inferior direction of SP occurs after extraction and its degree increased with increasing number of missing posterior teeth.

4.3.2. Subantral bone height

The mean of subantral bone height was 3.62 ± 1.15 mm for cases with perforated sinus membrane when compared with intact membrane 5.075 ± 1.22 mm, however this difference was statistically not significant (P=0.248).

Also there was no statistical significance (P=0.72) between cases managed by osung (4.77 ± 1.17 mm) or by osteotome (4.89 ± 1.32 mm) techniques regarding SAD.

In the present study, sinus membrane perforation was observed in 4 cases:

3 of them occurred with Osteotome group with the respective SAD (3 mm, 3.5 mm, and 3 mm), while only 1 was encountered in Osung group with SAD of 5 mm.

Ardekian *et al*., 2006 found that the perforation rate of sinus membranes with a residual ridge of 3 mm to be 85%, whereas residual ridges of 6 mm had a perforation rate of only 25%, and this went with the present study.

However, according to the personal operator experience, generally, perforation noticed out of this study with osteotome technique being more with the longer subantral distances.

4.4. Dental implant dimensions:

All dental implants introduced following SL related to one system (NucleOss, Turkey) with S.L.A surface (Sand blasted, large grit, acid etched).

The most widely diameter used in the present study was 4.8 mm (57.7%) in 30 DI, while 22 DI with 4.1 mm, (42.3%) utilized via crestal sinus lift to obtain better primary stability, usually with under drilling size technique utilized to gain adequate implant stability so 4.8 mm was the dominant one.

Regarding the length, 23 DI with 10 mm & 19 DI with 12 mm utilized. As usual in SL surgery 10 mm & 12 mm are more common to be inserted. Shorter implants less than 10 mm greatly influence the long-term success, while DI longer than 12 mm may increase the possibility of SM perforation.

A wider diameter DI should be chosen for molar sites. The minimum length for predictable DI success is 10 mm or what's called the "**standard implant length**".

In clinical studies of sinus lift nearly comparable DI dimensions (length & radius) were employed by **(Hu *et al*., 2009; Bensaha & Mjabber, 2016; Lateef & Asmael, 2016)** to the present study.

Lemos *et al*., 2016 reported that standard implants (i.e. longer than 8 mm) provides more contact area and thus osseointegration therefore associated with higher success rate than shorter implants. This explains the greater amount of gained bone when implant inserted immediately with sinus lift procedure was more than when delayed placement was performed.

It is well known that posterior maxilla is subjected to higher stress so that wider implant diameter is used to decrease this mechanical stress **(Morand & Irinakis, 2007; Goiato *et al*., 2014)**.

In the present study, there was no significant association (P= 0.796) between perforation of sinus membrane in SL procedure and DI dimensions.

4.5. Perforation of sinus membrane:

Pikos, 2008 stated that *Schneiderian membrane* perforation has been reported as the most common complication of sinus lift augmentation, with a prevalence from 10-55%, also **Zheng *et al*., 2014** said that perforation is the most common intraoperative complication and it has been registered in (7-35%) of sinus lift. This has been associated with postoperative complications such as, infection, nasal bleeding, and even failure of implants.

In the present study, perforation of sinus membrane observed in 12% of cases managed by Osteotome procedure, while it occurred in 3.7% of those dealt with Osung SL. The total percentage was **7.7 %**, however, this difference was statistically not significant (P=0.22), this may be attributed to that the whole procedures were performed by an expert surgeon who had performed about 200 SL surgeries.

In regards to the relation between perforation and procedures used:

1. Osteotome technique was more invasive, requiring high skill demands and tactile sensation. Osung technique was less invasive and the requirement for the skill demands was not so important, the skill and tactile sensation was of a

little importance since the intelligent drills and the stoppers made this technique easier.

2. For Osteotome technique, Dentium Kit was used with even lengths of 8, 10, 12, and 14, while in Osung kit for every 1 mm stoppers was available, so the later was more precise and by this way the likelihood of SM perforation being logically less.

There was no significance regarding the relationships between the perforation and other variables age, gender, tooth site #, SP, DI dimensions, SAD, and sinus membrane thickness. The rate of membrane perforation in this review was (7.7%), no significant association between membrane integrity and gender ($P \geq 0.05$) or sinus laterality (SP) existed ($P=0.531$.), also there was no statistical significant association noticed ($P= 0.171$) between perforation of sinus membrane and tooth site, disagreeing with the **Nolan *et al*., 2014** reported in their study a higher rate of membrane perforation was 41.8%.

Several reported studies had shown that the thinner the sinus membrane, the higher the risk of perforation **(Van Den Bergh *et al*., 2000; Ardekian *et al*., 2006),** however, others, registered a significant correlation between perforation and sinus membrane <1 mm thick **(Yilmaz & Tözüm, 2012).**

4.6. The role of endoscopy:

The number of sinus lifts done world-wide is on the increase, so there is a need for less invasive techniques to optimize the late results of implants in the posterior maxillary area **(Zheng *et al*, 2014).**

The use of an endoscope helps the sinus lift to overcome the shortcomings of the blind technique and achieve a safe and effective procedure, **(Pedroletti *et al*., 2010; Nahlieli *et al*., 2011).** The number of reports on the application of endoscopy in dental implantology has been minimal **(Wiltfang *et al*., 2000).**

Nahlieli *et al*., 2011 claimed that currently diverse endoscopic applications remain a specialized technique practiced by a minority of surgeons in few specialized centers. At the same time, these publications had reported that endoscopic assistance resulted in minimal invasive surgery, low intraoperative trauma, good implant stability upon placement, few postoperative symptoms, and high success rates after years of loading. Nevertheless, the need for intensive training might be considered a disadvantage.

The endoscopic examination in this study revealed intact membranes in **92.3%** of cases with only 4 (**7.7%**) sinus membrane perforations. Pictures and videos for all the cases were obtained and membrane mobility and status were examined clearly in each case.

These figures represented the lowest when compared with the reported literature by **Pikos, 2008** (10-55%) and **Zheng *et al*, 2014** (7-35%).

This was in spite of that the later studies didn't utilized endoscopy for registration of the complication that is it may be even more with the use of such precise diagnostic tool.

In the present study the researcher introduced a minimally invasive technique for sinus lift with the assistance of an endoscope, the 2.8 mm diameter endoscopic camera has a blunt apical end with illumination allows it's use in a site prepared with only ⦰ 3.2 mm cannon drill with direct visualization intraoperatively of the implant bed and sinus membrane. This facilitated the identification of membrane microstructure (vasculature) and clear visualization of SM perforation, as in Fig. (4.1 & 4.2) respectively.

Fig. (4.1): Endoscopy illustrating the microstructure of the sinus membrane.

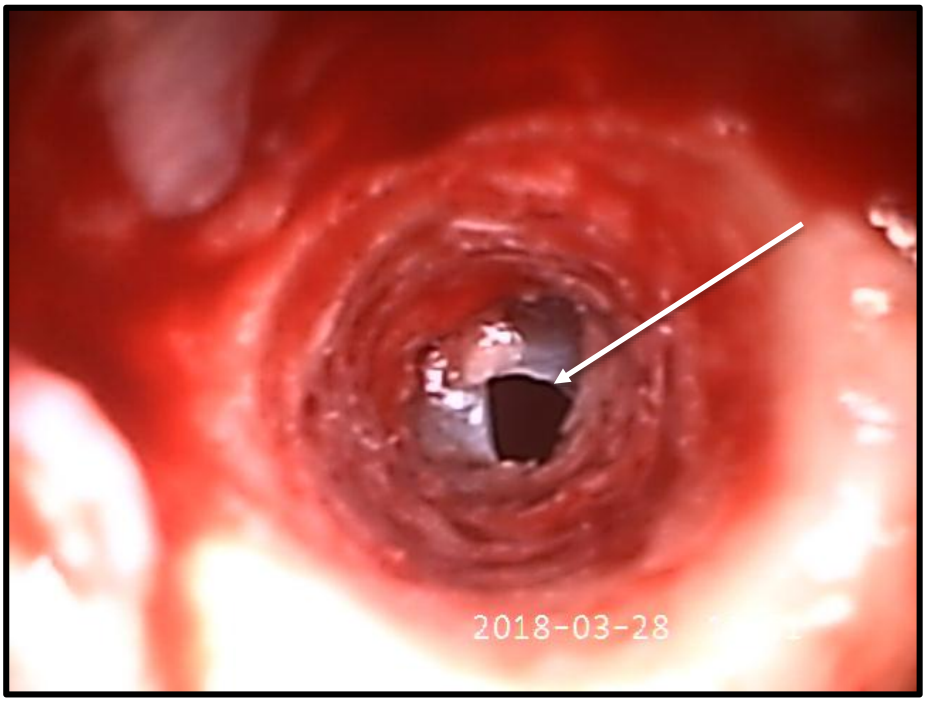

Fig. (4.2): Perforated sinus membrane clearly visualized with the aid of endoscope.

In fact, the researcher utilized endoscopy for direct visualization of the sinus membrane patency for all cases following SL achieved by osung & osteotome kit.

The main advantage is that it was introduced through the same surgical field with no need for another approach through the nasal cavity as reported in the literature previously being less invasive, quick and flexible. On the other hand, the endoscope was not usually applied as such in certain cases when SAD being usually less than 5 mm, in which conditions visualization was feasible as a parascope rather than an endoscope that was placed at the edges of the implant bed rather than inside, this relied on the device instructions that indicated a reasonable distance from the object (10 mm), although the researcher illustrated less distance in order to have a clear image.

*Certain points were important to be mentioned regarding clear vision of the sinus membrane:

1. Adequate dryness of the implant bed from blood clot and fluids that may obscure the image with the aid of cotton buds or sticks is vital.

2. The eyepiece (lens) of the endoscope should be cleaned well before application.

3. The procedure required 2 operators in order to gain the desired results.

4. An invaluable sign for the patency of the sinus membrane, was to ask the patient taking a deep inspiration during examination which would clarify the presence or absence of any silent perforation since in certain situations perforation may be not evident at rest position as this was noticed in a case of perforation that induced with the use of Osung SL procedure, as in Fig. (4.3).

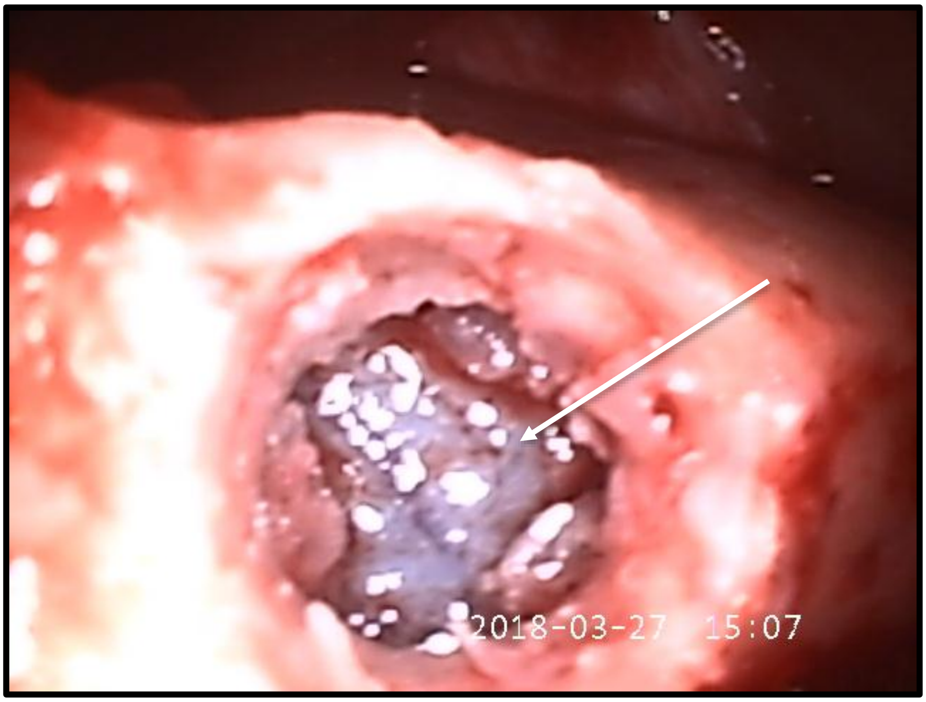

Fig. (4.3): No evidence of sinus membrane perforation at rest position.

This is supported by **Nahlieli *et al.*, 2013** when reported the role of endoscopy regarding the membrane mobility as seen via the eyepiece of the endoscope is a sign of its health and can serve as an indicator of the probable difficulty or ease of a closed endoscopic procedure.

Finally, an important note to be taken in consideration is that the endoscope was quite helpful for the management for the presence of any perforation which can clearly facilitate adequate application of the barrier membrane beneath the area of perforated membrane since all cases of perforations occurred in this study were small in size owing the size of the final drills used by Osung (Cannon drill ⌀ 3.2 mm) and Osteotome (⌀ 3.8 mm), as in Fig. (4.4).

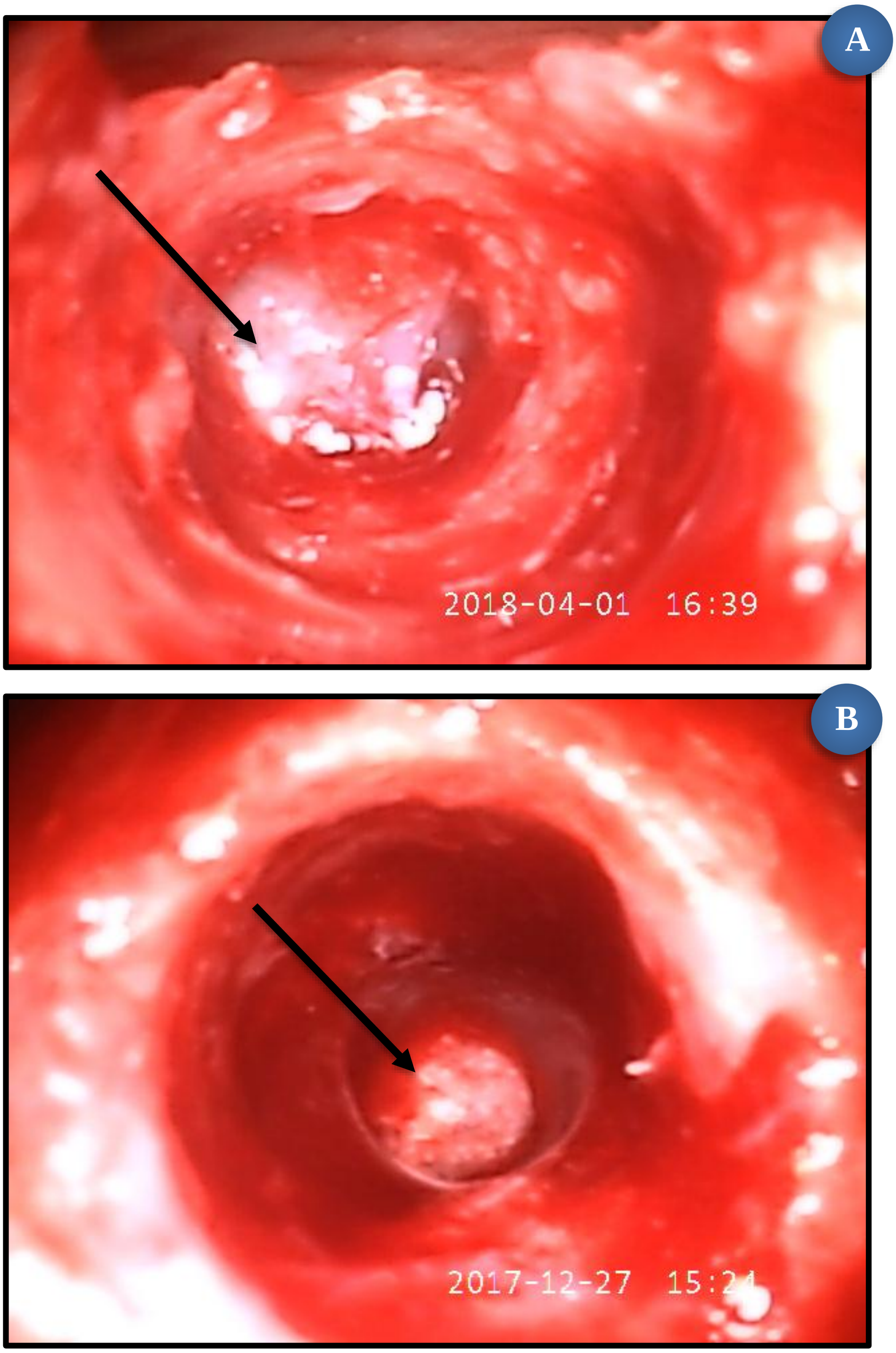

Fig. (4.4): (A) A proper application of collagen barrier membrane beneath the sinus membrane (B) The non-autogenous bone graft material can be clearly illustrated with the use of endoscope.

This is supported by **Zheng *et al*., 2014**, they stated that, in conclusion, the endoscopic approach is safer and more effective because it allows the operation to be done under direct vision and the endoscope that had been used accurately identified all microstructures and facilitated simplified dental implantation procedure. The endoscope should be considered not only for intraoperative observation and assessment of bone density, but also for active assistance during the procedures of implantation.

4.7. Sinus membrane thickness:

Sinus mucosa thickness in this study varied between (0.1-5 mm), with a mean value of (0.69 ± 0.71 mm) for intact membrane cases and a mean of (0.97 ± 0.74 mm) for perforated sinus membranes.

Makary *et al*., 2016 enrolled in his study patients with sinus mucosa thickness between 0.1 mm up to 3.6 mm with mean value of 0.7 mm and only those patients who were suitable for sinus surgery with no evident sinus pathologies; therefore, preoperative sinus membrane thickness measurements were probably lower than those described in other studies. Moreover, many factors may influence sinus membrane thickness, such as gender, climate, smoking habits, allergies, and seasonal changes.

In the current study, membrane thickness was within the normal values due to the absence of any evidence of sinusitis and other sinus pathologies which were already excluded from the research.

The *Schneiderian membrane* has a normal thickness of approximately 0.8 mm, however, others reported figures reached up to 6 mm **(Pandit & chopra, 2016).**

In the literature, it has been reported that the perforation was less with increased membrane thickening and this was logical; however, in this research perforation occurred with thicker membranes even through the figures were statistically non-significant disagreeing with **Rapani *et al*., 2016** whom clarified that looking at the thickness of the membrane according to the operation done, and according to the number of perforations during each procedure with the aim of indicating whether either of them was associated with less risk of perforation.

Thickness of the membrane between 0-2 mm may be an important factor in perforation of the *Schneiderian membrane*, regardless of the augmentation procedure used. They also illustrated that the difference in percentage of sinus perforation between the techniques utilized could be attributed to differences in the thickness of sinus membrane. The authors classified the membrane thickness into the following types: **Type I** the membrane is too thin to record the thickness, in **Type II** the thickness is less than 2 mm, in **Type III** it is between 3 and 4 mm, and in **Type IV** it is more than 4 mm.

There was no statistical significance (P=0.516) in the mean of membrane thickness between cases with perforated sinus membrane and those with intact ones, but it was higher in cases of perforation than in cases with intact membranes.

Finally in general, results from present study showed that sinus lifting procedure using hydraulic pressure yielded dissimilar outcome to that of conventional technique. This was indicated by low incidence of sinus perforation with the use of Osung kit which was lower than the Osteotome procedure. Although this difference was not statistically significant; nevertheless, this may be attributed to the small sample size in the study. Furthermore, Osung procedure is less invasive, and easier to perform which could be practiced even by novice surgeons as it does not need high skill level as compared to Osteotome technique. In addition, Osteotome technique is more stressful psychologically to the patient as it requires hammering which may cause vertigo and other undesirable emotional experience. All these factors may favor the use of hydraulic sinus lifting as a successful alternative technique to other methods commonly used.

Limitations of the study:

1. Small sample size, gave inflated results regarding the actuality of the Osung kit usefulness.

2. No previous studies related to this research in the country.

3. Little is written in the literature about endoscopic sinus lift surgery (modular implant surgery).

4. Little or no is written in the literature about the Osung kit concept in SL procedure.

Chapter Five

Conclusion and Suggestion

Conclusions and Suggestions

Conclusions:

1. The use of endoscope is simple, easy, and quick for direct visualization of the Schneider membrane.
2. The results from this study demonstrated that maxillary sinus floor elevation using Osung water lift system kit via the crestal approach is a predictable procedure with a low perforation rate as compared with Osteotome technique.
3. The endoscope facilitated proper application of barrier membrane and non-autogenous bone graft material.
4. The study demonstrated the lowest percentage of sinus membrane perforation in regards with previous studies in the literature.
5. The endoscope was not usually utilized as such since in certain situations it should be used as a parascope in order to gain the optimal result.
6. Deep inspiration was of prime importance for detection of silent sinus membrane perforations.

Suggestions:

1. A study with a lager sample confirming the relationship between the incidence of sinus membrane perforation and the subantral distance and sinus membrane thickness.
2. Measuring the difference in time consumed between the two procedures osteotome and osung.
3. Another comparative study using piezosurgery versus other methods for transcrestal sinus floor elevation surgery illustrating the difference in membrane perforation incidence with the aid of endoscope.
4. Endoscopic consideration regarding intraoperative observation and assessment of bone density for active assistance during the procedures of implantation.
5. A more sophisticated study regarding the relation between sinus membrane thicknesses and the incidence of perforation.

References

References

A

- AHN, J.-J., CHO, S.-A., BYRNE, G., KIM, J.-H. & SHIN, H.-I. 2011. New bone formation following sinus membrane elevation without bone grafting: histologic findings in humans. *International Journal of Oral & Maxillofacial Implants*, 26(1):83-90.
- AL-SALMAN, W. & ALMAS, K. 2015. Maxillary sinus and success of dental implants: an update. *General dentistry*, 63**,** 47-54.
- ALTINTAS, N. Y., SENEL, F. C., KAYıPMAZ, S., TASKESEN, F. & PAMPU, A. A. 2013. Comparative radiologic analyses of newly formed bone after maxillary sinus augmentation with and without bone grafting. *Journal of Oral and Maxillofacial Surgery*, 71**,** 1520-1530.
- ARAD SD, D., HERZBERG, R. & DOLEV, E. 2004. The prevalence of surgical complications of the sinus graft procedure and their impact on implant survival. *Journal of periodontology*, 75**,** 511-516.
- ARDEKIAN, L., OVED-PELEG, E., MACTEI, E. E. & PELED, M. 2006. The clinical significance of sinus membrane perforation during augmentation of the maxillary sinus. *Journal of Oral and Maxillofacial Surgery*, 64**,** 277-282.
- AVILA-ORTIZ, G., NEIVA, R., GALINDO-MORENO, P., RUDEK, I., BENAVIDES, E. & WANG, H. L. 2012. Analysis of the influence of residual alveolar bone height on sinus augmentation outcomes. *Clinical oral implants research*, 23**,** 1082-1088.

B

- BARGHAN, S., MERRILL, R. & TETRADIS, S. 2010. Cone beam computed tomography imaging in the evaluation of the temporomandibular joint. *Journal of the California Dental Association*, 38**,** 33-39.
- BASSIL, J., NAAMAN, N., LATTOUF, R., KASSIS, C., CHANGOTADE, S., BAROUKH, B., SENNI, K. & GODEAU, G. 2013. Clinical, histological, and histomorphometrical analysis of maxillary sinus augmentation using inorganic bovine in humans: preliminary results. *Journal of Oral Implantology*, 39**,** 73-80.
- BATAL, H. AND NORRIS, O., 2013. Lateral antrostomy technique for maxillary sinus augmentation. *Implants*, 1, 12-20.
- BECKER, S. T., TERHEYDEN, H., STEINRIEDE, A., BEHRENS, E., SPRINGER, I. & WILTFANG, J. 2008. Prospective observation of 41 perforations of the Schneiderian membrane during sinus floor elevation. *Clinical Oral Implants Research*, 19**,** 1285-1289.
- BENAVIDES, E., RIOS, H. F., GANZ, S. D., AN, C.-H., RESNIK, R., REARDON, G. T., FELDMAN, S. J., MAH, J. K., HATCHER, D. & KIM, M.-J. 2012. Use of cone beam computed tomography in implant dentistry: the International Congress of Oral Implantologists consensus report. *Implant dentistry*, 21**,** 78-86.
- BENSAHA, T. 2011. Evaluation of the capability of a new water lift system to reduce the risk of Schneiderian membrane perforation during sinus elevation. *International journal of oral and maxillofacial surgery*, 40**,** 815-820.
- BENSAHA, T. AND EL MJABBER, H., 2016. Evaluation of new bone formation after sinus augmentation with two different methods. *International journal of oral and maxillofacial surgery*, 45(1), 93-98.

- BOYNE P, JAMES R. 1980. Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg*. 17:113–116.
- BROWAEYS, H., BOUVRY, P. & DE BRUYN, H. 2007. A literature review on biomaterials in sinus augmentation procedures. *Clinical implant dentistry and related research,* 9**,** 166-177.
- BURGHARDT, A. J., LINK, T. M. & MAJUMDAR, S. 2011. High-resolution computed tomography for clinical imaging of bone microarchitecture. *Clinical Orthopaedics and Related Research®,* 469**,** 2179-2193.
- BUSER, D., DULA, K., BELSER, U., HIRT, H.-P. & BERTHOLD, H. 1993. Localized ridge augmentation using guided bone regeneration. I. Surgical procedure in the maxilla. *International Journal of Periodontics & Restorative Dentistry,* 13(1):29-45.

C

- CARREÑO, C., J., GONZÁLEZ-JARANAY, M., GÓMEZ-MORENO, G., AGUILAR-SALVATIERRA, A., MENÉNDEZ LÓPEZ-MATEOS, M. L. & MENÉNDEZ-NÚÑEZ, M. 2016. Bacterial influence on consolidation of bone grafts in maxillary sinus elevation. *Clinical oral implants research,* 27**,** 1431-1438.
- CAUTHEN, J. C., KINARD, R. E., VOGLER, J. B., JACKSON, D. E., DEPAZ, O. B., HUNTER, O. L., WASSERBURGER, L. B. & WILLIAMS, V. M. 1998. Outcome analysis of noninstrumented anterior cervical discectomy and interbody fusion in 348 patients. *Spine,* 23**,** 188-192.
- CHANAVAZ, M. 1990. Maxillary sinus: anatomy, physiology, surgery, and bone grafting related to implantology--eleven years of surgical experience (1979-1990). *The Journal of oral implantology,* 16**,** 199-209.

- CHANG, Y. C. & ZHAO, J. H. 2011. Effects of platelet-rich fibrin on human periodontal ligament fibroblasts and application for periodontal infrabony defects. *Australian dental journal*, 56**,** 365-371.
- CHAN, H.L., MONJE, A., SUAREZ, F., BENAVIDES, E. AND WANG, H.L., 2013. Palatonasal recess on medial wall of the maxillary sinus and clinical implications for sinus augmentation via lateral window approach. *Journal of periodontology*, 84(8), 1087-1093.
- CHAUSHU, G., VERED, M., MARDINGER, O. & NISSAN, J. 2010. Histomorphometric Analysis After Maxillary Sinus Floor Augmentation Using Cancellous Bone–Block Allograft. *Journal of periodontology*, 81**,** 1147-1152.
- CHEN, L. & CHA, J. 2005. An 8-year retrospective study: 1,100 patients receiving 1,557 implants using the minimally invasive hydraulic sinus condensing technique. *Journal of Periodontology*, 76**,** 482-491.
- CHIAPASCO, M., FELISATI, G., MACCARI, A., BORLONI, R., GATTI, F. & DI LEO, F. 2009. The management of complications following displacement of oral implants in the paranasal sinuses: a multicenter clinical report and proposed treatment protocols. *International journal of oral and maxillofacial surgery*, 38**,** 1273-1278.
- CHIAPASCO, M., ZANIBONI, M. & RIMONDINI, L. 2008. Dental implants placed in grafted maxillary sinuses: a retrospective analysis of clinical outcome according to the initial clinical situation and a proposal of defect classification. *Clinical Oral Implants Research*, 19**,** 416-428.
- CHOUKROUN, J., DISS, A., SIMONPIERI, A., GIRARD, M.-O., SCHOEFFLER, C., DOHAN, S. L., DOHAN, A. J., MOUHYI, J. & DOHAN, D. M. 2006. Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part V: histologic evaluations of PRF effects on bone allograft maturation in sinus lift. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 101**,** 299-303.

- COCHRAN, D. L., SCHENK, R., BUSER, D., WOZNEY, J. M. & JONES, A. A. 1999. Recombinant human bone morphogenetic protein-2 stimulation of bone formation around endosseous dental implants. *Journal of periodontology*, 70**,** 139-150.
- CORDIOLI, G., MAZZOCCO, C., SCHEPERS, E., BRUGNOLO, E. & MAJZOUB, Z. 2001. Maxillary sinus floor augmentation using bioactive glass granules and autogenous bone with simultaneous implant placement: clinical and histological findings. *Clinical Oral Implants Research*, 12**,** 270-278.

D

- DANESH-SANI, S. A., LOOMER, P. M. & WALLACE, S. S. 2016. A comprehensive clinical review of maxillary sinus floor elevation: anatomy, techniques, biomaterials and complications. *British Journal of Oral and Maxillofacial Surgery*, 54**,** 724-730.
- DEGIDI, M., PIATTELLI, A., IEZZI, G. & CARINCI, F. 2007. Wide-diameter implants: analysis of clinical outcome of 304 fixtures. *Journal of Periodontology*, 78**,** 52-58.
- DEL FABBRO, M., ROSANO, G. & TASCHIERI, S. 2008. Implant survival rates after maxillary sinus augmentation. *European Journal of Oral Sciences*, 116**,** 497-506.
- DISERENS, V., MERICSKE, E. & MERICSKE-STERN, R. 2005. Radiographic analysis of the transcrestal sinus floor elevation: short-term observations. *Clinical implant dentistry and related research*, 7**,** 70-78.
- DOROZHKIN, S. V. 2009. Calcium orthophosphate cements and concretes. *Materials*, 2**,** 221-291.
- DRAENERT, G. & EISENMENGER, W. 2007. A new technique for the transcrestal sinus floor elevation and alveolar ridge augmentation with press-

fit bone cylinders: a technical note. *Journal of Cranio-Maxillofacial Surgery*, 35**,** 201-206.

E

- ELIAN, N., WALLACE, S., CHO, S.-C., JALBOUT, Z. N. & FROUM, S. 2005. Distribution of the Maxillary artery as it relates to sinus floor augmentation. *International Journal of Oral & Maxillofacial Implants*, 20 (5):784-7.
- ELLA, B., NOBLE, R. D. C., LAUVERJAT, Y., SÉDARAT, C., ZWETYENGA, N., SIBERCHICOT, F. & CAIX, P. 2008. Septa within the sinus: effect on elevation of the sinus floor. *British Journal of Oral and Maxillofacial Surgery*, 46**,** 464-467.
- EMTIAZ, S., CARAMÊS, J. M. & PRAGOSA, A. 2006. An alternative sinus floor elevation procedure: trephine osteotomy. *Implant dentistry*, 15**,** 171-177.
- ENGELKE, W. & DECKWER, I. 1997. Endoscopically controlled sinus floor augmentation. A preliminary report. *Clinical oral implants research*, 8**,** 527-531.
- ERBE, E., MARX, J., CLINEFF, T. & BELLINCAMPI, L. 2001. Potential of an ultraporous β-tricalcium phosphate synthetic cancellous bone void filler and bone marrow aspirate composite graft. *European Spine Journal*, 10**,** S141-S146.

F

- FALAH, M., SOHN, D.-S. & SROUJI, S. 2016. Graftless sinus augmentation with simultaneous dental implant placement: clinical results and biological perspectives. *International journal of oral and maxillofacial surgery*, 45**,** 1147-1153.

- FARMAND, M. 1986. Horse-shoe sandwich osteotomy of the edentulous maxilla as a preprosthetic procedure. *Journal of maxillofacial surgery,* 14**,** 238-244.
- FERRIGNO, N., LAURETI, M. & FANALI, S. 2006. Dental implants placement in conjunction with osteotome sinus floor elevation: a 12-year life-table analysis from a prospective study on 588 ITI® implants. *Clinical oral implants research,* 17**,** 194-205.
- FISHER, E., WHITTET, H. & CROFT, C. 1989. Symptomatic mucosal cysts of the maxillary sinus: antroscopic treatment. *The Journal of Laryngology & Otology,* 103**,** 1184-1186.
- FUGAZZOTTO, P., MELNICK, P. R. & AL-SABBAGH, M. 2015. Complications when augmenting the posterior maxilla. *Dental Clinics,* 59**,** 97-130.
- FUGAZZOTTO, P. A. 2002. Immediate implant placement following a modified trephine/osteotome approach: success rates of 116 implants to 4 years in function. *International Journal of Oral & Maxillofacial Implants,* 17: 113-120
- FUGAZZOTTO, P. A. 2003. Augmentation of the posterior maxilla: a proposed hierarchy of treatment selection. *Journal of periodontology,* 74**,** 1682-1691.

G

- GALINDO-MORENO, P., SÁNCHEZ-FERNÁNDEZ, E., AVILA, G., CUTANDO, A. & EMILIO FERNANDEZ, J. 2005. Migration of implants into the maxillary sinus: Two clinical cases. *Int J Oral Maxillofac fac Implants.* 20(2):291-5.
- GARBACEA, A., LOZADA, J. L., CHURCH, C. A., AL-ARDAH, A. J., SEIBERLING, K. A., NAYLOR, W. P. & CHEN, J.-W. 2012. The incidence

of maxillary sinus membrane perforation during endoscopically assessed crestal sinus floor elevation: a pilot study. *Journal of Oral Implantology,* 38**,** 345-359.

- GOIATO, M.C., PESQUEIRA, A.A., DOS SANTOS, D.M., HADDAD, M.F. AND MORENO, A., 2014. Photoelastic stress analysis in prosthetic implants of different diameters: mini, narrow, standard or wide. *J Clin Diagn Res:* JCDR, 8(9), 86-ZC90.
- GRAY, C. F., REDPATH, T. W., BAINTON, R. & SMITH, F. W. 2001. Magnetic resonance imaging assessment of a sinus lift operation using reoxidised cellulose (SurgicelR) as graft material. *Clinical oral implants research,* 12**,** 526-530.
- GRIFFIN, T.J. AND CHEUNG, W.S., 2004. The use of short, wide implants in posterior areas with reduced bone height: a retrospective investigation. *The Journal of prosthetic dentistry*, 92(2), 139-144.
- GRUNENBERG, M. & GERLACH, K. 1990. Clinical, radiographic and endoscopic evaluation of the maxillary sinus after maxillary osteotomy. *Deutsche Zeitschrift fur Mund-, Kiefer-und Gesichts-Chirurgie,* 14**,** 202-205.
- GUILLOT, P., COLIN, A., UTADA, A. S. & AJDARI, 2007. Stability of a jet in confined pressure-driven biphasic flows at low Reynolds numbers. *Phys. Rev. Lett.* 99**,** 104502.

H

- HARRIS, D., HORNER, K., GRÖNDAHL, K., JACOBS, R., HELMROT, E., BENIC, G. I., BORNSTEIN, M. M., DAWOOD, A. & QUIRYNEN, M. 2012. EAO guidelines for the use of diagnostic imaging in implant dentistry 2011. A consensus workshop organized by the European Association for Osseointegration at the Medical University of Warsaw. *Clinical oral implants research,* 23**,** 1243-1253.

- HAUMAN, C., CHANDLER, N. & TONG, D. 2002. Endodontic implications of the maxillary sinus: a review. *International endodontic journal*, 35**,** 127-141.
- HU, X., LIN, Y., METZMACHER, A.-R. & ZHANG, Y. 2009. Sinus membrane lift using a water balloon followed by bone grafting and implant placement: a 28-case report. *International Journal of Prosthodontics*, 22 (3):243-7.
- HUR, M.-S., KIM, J.-K., HU, K.-S., BAE, H. E. K., PARK, H.-S. & KIM, H.-J. 2009. Clinical implications of the topography and distribution of the posterior superior alveolar artery. *Journal of Craniofacial Surgery*, 20**,** 551-554.
- HUSSEIN, L. A. & HASSAN, T. A. 2017. The Effectiveness of Oxidized Regenerated Cellulose as a Graft Material in Transalveolar Osteotome Sinus Lift Procedure. *Journal of Craniofacial Surgery*, 28**,** 1766-1771.

I

- IBRAHIM, N., PARSA, A., HASSAN, B., VAN DER STELT, P. & WISMEIJER, D. 2013. Diagnostic imaging of trabecular bone microstructure for oral implants: a literature review. *Dentomaxillofacial Radiology*, 42 (3): 1-5.

J

- JAJU, P. P. & JAJU, S. P. 2014. Clinical utility of dental cone-beam computed tomography: current perspectives. *Clinical, cosmetic and investigational dentistry*, 6**:** 29-43.
- JANNER, S. F., CAVERSACCIO, M. D., DUBACH, P., SENDI, P., BUSER, D. & BORNSTEIN, M. M. 2011. Characteristics and dimensions of the Schneiderian membrane: a radiographic analysis using cone beam computed

tomography in patients referred for dental implant surgery in the posterior maxilla. *Clinical oral implants research*, 22**,** 1446-1453.

- JESCH, P., BRUCKMOSER, E., BAYERLE, A., EDER, K., BAYERLE-EDER, M. & WATZINGER, F. 2013. A pilot-study of a minimally invasive technique to elevate the sinus floor membrane and place graft for augmentation using high hydraulic pressure: 18-month follow-up of 20 cases. *Oral surgery, oral medicine, oral pathology and oral radiology*, 116**,** 293-300.
- JURISIC, M., MARKOVIC, A., RADULOVIC, M., BRKOVIC, B. M. & SÁNDOR, G. K. 2008. Maxillary sinus floor augmentation: comparing osteotome with lateral window immediate and delayed implant placements. An interim report. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 106**,** 820-827.

K

- KANEKO, T., MASUDA, I., HORIE, N. & SHIMOYAMA, T. 2012. New bone formation in nongrafted sinus lifting with space-maintaining management: A novel technique using a titanium bone fixation device. *Journal of Oral and Maxillofacial Surgery*, 70**,** 217-224.
- KANNAPERUMAN, J., NATARAJARATHINAM, G., RAO, A. V. & MUTHUSAMY, N. 2015. Cross-sectional study estimating prevalence of maxillary sinus septum in South Indian population. *Journal of Dental Implants,* 5 (1), 16-18.
- KAO, D. W. 2014. *Clinical Maxillary Sinus Elevation Surgery*, John Wiley & Sons.
- KARABUDA, C., ARıSAN, V. & HAKAN, Ö. 2006. Effects of sinus membrane perforations on the success of dental implants placed in the augmented sinus. *Journal of periodontology*, 77**,** 1991-1997.

- KFIR, E., GOLDSTEIN, M., RAFAELOV, R., YERUSHALMI, I., KFIR, V., MAZOR, Z. & KALUSKI, E. 2009. Minimally invasive antral membrane balloon elevation in the presence of antral septa: a report of 26 procedures. *Journal of Oral Implantology*, 35**,** 257-267.
- KIM, D. M. & HO, D. K. T. 2014. Decision Tree for Maxillary Sinus Elevation Options. *Clinical Maxillary Sinus Elevation Surgery***,** 149-156.
- KIM, D. Y., ITOH, Y. & KANG, T. H. 2012. Evaluation of the Effectiveness of a Water Lift System in the Sinus Membrane-Lifting Operation as a Sinus Surgical Instrument. *Clinical implant dentistry and related research*, 14**,** 585-594.
- KIM, Y.-K., CHO, Y.-S. & YUN, P.-Y. 2013. Assessment of dentists' subjective satisfaction with a newly developed device for maxillary sinus membrane elevation by the crestal approach. *Journal of periodontal & implant science*, 43**,** 308-314.
- KIM, Y.-K., CHOE, G.-Y. & YUN, P.-Y. 2008. Management of perforated sinus membrane using absorbable haemostat and fibrin adhesive for sinus lift procedure. *Asian Journal of Oral and Maxillofacial Surgery*, 20**,** 129-134.
- KQIKU, L., WEIGLEIN, R., WEIGLEIN, A. H., KQIKU, X. & STÄDTLER, P. 2013. Arterial blood architecture of the maxillary sinus in dentate specimens. *Croatian medical journal*, 54**,** 180-184.
- KUBAL, W. S. 1998. Sinonasal anatomy. *Neuroimaging Clinics of North America*, 8**,** 143-156.

L

- LATEEF, T.A. & ASMAEL, H.M., 2016. An Assessment of the Efficacy of Sinus Balloon Technique on Transcrestal Maxillary Sinus Floor Elevation Surgery. *J Bagh Coll Dentistry*, 28(1), 109-113.

- LEE, H., LEE, S.-H., KIM, S.-J., CHOI, W.-I., LEE, J.-H. & CHOI, I.-J. 2015. Variations of the cubital superficial vein investigated by using the intravenous illuminator. *Anatomy & cell biology*, 48**,** 62-65.
- LEMOS, C.A.A., FERRO-ALVES, M.L., OKAMOTO, R., MENDONÇA, M.R. AND PELLIZZER, E.P., 2016. Short dental implants versus standard dental implants placed in the posterior jaws: A systematic review and meta-analysis. *J Dent*, 47, 8-17.
- LI, J., LEE, K., CHEN, H. & OU, G. 2013. Piezoelectric surgery in maxillary sinus floor elevation with hydraulic pressure for xenograft and simultaneous implant placement. *The Journal of prosthetic dentistry*, 110**,** 344-348.
- LINDH, C., OBRANT, K. & PETERSSON, A. 2004. Maxillary bone mineral density and its relationship to the bone mineral density of the lumbar spine and hip. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 98**,** 102-109.

M

- MACLEOD, I. & HEATH, N. 2008. Cone-beam computed tomography (CBCT) in dental practice. *Dental update*, 35**,** 590-598.
- MAKARY, C., REBAUDI, A., MENHALL, A. & NAAMAN, N. 2016. Changes in Sinus Membrane Thickness After Lateral Sinus Floor Elevation: A Radiographic Study. *International Journal of Oral & Maxillofacial Implants*, 31(2):331-7.
- MALEC, M., SMEKTALA, T., TUTAK, M., TRYBEK, G., SPORNIAK-TUTAK, K., MALEC, M., SMEKTALA, T., TUTAK, M., TRYBEK, G. & SPORNIAK-TUTAK, K. 2015. Maxillary sinus septa prevalence and morphology-computed tomography based analysis. *Int J Morphol*, 33**,** 144-148.

- MANOR, Y., MARDINGER, O., BIETLITUM, I., NASHEF, A., NISSAN, J. & CHAUSHU, G. 2010. Late signs and symptoms of maxillary sinusitis after sinus augmentation. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics*, 110**,** 1-4.
- MAY, M., SOBOL, S. M. & KORZEC, K. 1990. The location of the maxillary os and its importance to the endoscopic sinus surgeon. *The Laryngoscope*, 100**,** 1037-1042.
- MAZOR, Z. 2012. The use of minimally inveasive antral membrane ballon elevation (MIAMBE) to treat the posterior maxilla: A clinical presentation. *J Implant Reconstr Dent*, 2**,** 26-31.
- MAZOR, Z., IOANNOU, A., VENKATARAMAN, N. & KOTSAKIS, G. 2013. Minimally invasive crestal approach technique for sinus elevation utilizing a cartridge delivery system. *Int J Oral Implantol Clin Res*, *4*(2), 78-82.
- MISCH, C. 1995. Contemporary Implantology. Madrid, Mosby/Doyma.
- MISCH, C., MISCH, C., RESNIK, R., ISMAIL, Y. & APPEL, B. 1991. Post-operative maxillary cyst associated with a maxillary sinus elevation procedure: a case report. *The Journal of oral implantology*, 17**,** 432-437.
- MISCH, C. E., PEREL, M. L., WANG, H.-L., SAMMARTINO, G., GALINDO-MORENO, P., TRISI, P., STEIGMANN, M., REBAUDI, A., PALTI, A. & PIKOS, M. A. 2008. Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) pisa consensus conference. *Implant dentistry*, 17**,** 5-15.
- MORAND, M. AND IRINAKIS, T., 2007. The challenge of implant therapy in the posterior maxilla: providing a rationale for the use of short implants. *J Oral Implantol*, 33(5), 257-266.

N

- NAHLIELI, O., MOSHONOV, J., ZAGURY, A., MICHAELI, E. & CASAP, N. 2011. Endoscopic approach to dental implantology. *Journal of Oral and Maxillofacial Surgery*, 69**,** 186-191.
- NAHLIELI, O., CASAP, N., MOSHONOV, J., ZAGURY, A., MICHALI, E. AND SAMUNI, Y., 2013. A novel dental implant system with an internal port for endoscopic closed sinus augmentation: a feasibility study in pigs. *Oral & Craniofacial Tissue Engineering*, 28(6): 556-61.
- NAKAJIMA, K. & KUSAMA, Y. 2016. Cone Beam Computed Tomography Evaluation of Bone Remodeling Following the Osteotome Sinus Floor Elevation Technique for Future Site Development. *International Journal of Periodontics & Restorative Dentistry*, 36(4):497-505.
- NEDIR, R., BISCHOF, M., VAZQUEZ, L., SZMUKLER-MONCLER, S. & BERNARD, J. P. 2006. Osteotome sinus floor elevation without grafting material: a 1-year prospective pilot study with ITI implants. *Clinical oral implants research*, 17**,** 679-686.
- NOLAN, P.J., FREEMAN, K. AND KRAUT, R.A., 2014. Correlation between Schneiderian membrane perforation and sinus lift graft outcome: a retrospective evaluation of 359 augmented sinus. *J Oral Maxillofac Surg*, *72*(1), 47-52.

O

- ORENTLICHER, G. & ABBOUD, M. 2011. Guided surgery for implant therapy. *Oral and Maxillofacial Surgery Clinics*, 23**,** 239-256.

P

- PALMA, V. C., MAGRO-FILHO, O., DE OLIVERIA, J. A., LUNDGREN, S., SALATA, L. A. & SENNERBY, L. 2006. Bone reformation and implant integration following maxillary sinus membrane elevation: an experimental study in primates. *Clinical Implant Dentistry and Related Research*, 8**,** 11-24.
- PANDIT, A. & CHOPRA, S. 2016. Maxillary sinus floor elevation: review of anatomy and lateral sinus lift technique. *IOSR J Dent Med Sci,* 1**,** 29-33.
- PARKS, E. T. 2014. Cone beam computed tomography for the nasal cavity and paranasal sinuses. *Dental Clinics,* 58**,** 627-651.
- PEDROLETTI, F., JOHNSON, B. S. & MCCAIN, J. P. 2010. Endoscopic techniques in oral and maxillofacial surgery. *Oral and Maxillofacial Surgery Clinics,* 22**,** 169-182.
- PEÑARROCHA-DIAGO, M., RAMBLA-FERRER, J., PEREZ, V. & PÉREZ-GARRIGUES, H. 2008. Benign paroxysmal vertigo secondary to placement of maxillary implants using the alveolar expansion technique with osteotomes: a study of 4 cases. *International Journal of Oral & Maxillofacial Implants*, 23 (1):129-32.
- PIKOS, M. A. J. I. D. 2008. Maxillary sinus membrane repair: update on technique for large and complete perforations. *Implant Dent.* 17**,** 24-31.
- PJETURSSON, B. E., IGNJATOVIC, D., MATULIENE, G., BRÄGGER, U., SCHMIDLIN, K. & LANG, N. P. 2009a. Transalveolar maxillary sinus floor elevation using osteotomes with or without grafting material. Part II: Radiographic tissue remodeling. *Clinical Oral Implants Research*, 20**,** 677-683.
- PJETURSSON, B. E., RAST, C., BRÄGGER, U., SCHMIDLIN, K., ZWAHLEN, M. & LANG, N. P. 2009b. Maxillary sinus floor elevation using the (transalveolar) osteotome technique with or without grafting material. Part

I: Implant survival and patients' perception. *Clinical Oral Implants Research*, 20**,** 667-676.

- PJETURSSON, B. E., TAN, W. C., ZWAHLEN, M. & LANG, N. P. 2008. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation: part I: lateral approach. *Journal of clinical periodontology*, 35**,** 216-240.
- POMMER, B., UNGER, E., SÜTÖ, D., HACK, N. & WATZEK, G. 2009. Mechanical properties of the Schneiderian membrane in vitro. *Clinical oral implants research*, 20**,** 633-637.
- PRECHEUR, H. V. 2007. Bone graft materials. *Dental Clinics of North America*, 51**,** 729-746.

Q

- QUERESHY, F. A., SAVELL, T. A. & PALOMO, J. M. 2008. Applications of cone beam computed tomography in the practice of oral and maxillofacial surgery. *Journal of oral and maxillofacial surgery*, 66**,** 791-796.
- QUIRYNEN, M., LEFEVER, D., HELLINGS, P. & JACOBS, R. 2014. Transient swelling of the Schneiderian membrane after transversal sinus augmentation: a pilot study. *Clinical Oral Implants Research*, 25**,** 36-41.

R

- RAGHUNATHAN, A., GOPAL, S. & SUMATHY, C. 2016 Occurrence of abnormalities and anatomical variations in maxillary sinus detected by CBCT. *Int J Oral Health Med Res*. 2(6): 18-23.
- RAHPEYMA, A. & KHAJEHAHMADI, S. 2015. Open sinus lift surgery and the importance of preoperative cone-beam computed tomography scan: a review. *Journal of international oral health: JIOH*, 7(9): 127–133.

- RAJA, S. V. 2009. Management of the posterior maxilla with sinus lift: review of techniques. *Journal of Oral and Maxillofacial Surgery*, 67**,** 1730-1734.
- RAPANI, M., RAPANI, C. & RICCI, L. 2016. Schneider membrane thickness classification evaluated by cone-beam computed tomography and its importance in the predictability of perforation. Retrospective analysis of 200 patients. *British Journal of Oral and Maxillofacial Surgery*, 54**,** 1106-1110.
- REISER, G. M., RABINOVITZ, Z., BRUNO, J., DAMOULIS, P. D. & GRIFFIN, T. J. 2001. Evaluation of maxillary sinus membrane response following elevation with the crestal osteotome technique in human cadavers. *International Journal of Oral & Maxillofacial Implants*, 16(6):833-40.
- RITTER, L., LUTZ, J., NEUGEBAUER, J., SCHEER, M., DREISEIDLER, T., ZINSER, M. J., ROTHAMEL, D. & MISCHKOWSKI, R. A. 2011. Prevalence of pathologic findings in the maxillary sinus in cone-beam computerized tomography. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 111**,** 634-640.
- RODRIGUES, G. N., KATAYAMA, A. Y. & CARDOSO, R. F. 2010. Subantral augmentation utilizing the Zimmer® sinus lift balloon technique. *Zimmer Dent Inc*. 1-5.
- ROMERO-MILLÁN, J.,MARTORELL-CALATAYUD, L., PEÑARROCHA, M. & GARCÍA-MIRA, B. 2012. Indirect osteotome maxillary sinus floor elevation: an update. *Journal of Oral Implantology*, 38**,** 799-804.
- ROSANO, G., TASCHIERI, S., GAUDY, J. F., WEINSTEIN, T. & DEL FABBRO, M. 2011. Maxillary sinus vascular anatomy and its relation to sinus lift surgery. *Clinical oral implants research*, 22**,** 711-715.

S

- SAKER, M. & OGLE, O. 2005. Benign paroxysmal positional vertigo subsequent to sinus lift via closed technique. *Journal of oral and maxillofacial surgery,* 63**,** 1385-1387.
- SAMMARTINO, G., MARINIELLO, M. & SCARAVILLI, M. S. 2011. Benign paroxysmal positional vertigo following closed sinus floor elevation procedure: mallet osteotomes vs. screwable osteotomes. A triple blind randomized controlled trial. *Clinical oral implants research,* 22**,** 669-672.
- SARGI, Z. B. & CASIANO, R. R. 2007. Surgical anatomy of the paranasal sinuses. *Rhinologic and sleep apnea surgical techniques.* Springer Berlin Heidelberg. Ch: 2. 17-26.
- SCHLEIER, P. 2011. Endoscope guided internal sinus floor elevation and simultaneous dental implant placement. *International Journal of Oral and Maxillofacial Surgery,* 40**,** 6.
- SHANBHAG, S., KARNIK, P., SHIRKE, P. & SHANBHAG, V. 2013. Association between periapical lesions and maxillary sinus mucosal thickening: a retrospective cone-beam computed tomographic study. *Journal of endodontics,* 39**,** 853-857.
- SHARAN, A. & MADJAR, D. 2008. Maxillary sinus pneumatization following extractions: a radiographic study. *International Journal of Oral & Maxillofacial Implants,*23(1):48-56.
- SHLOMI, B., HOROWITZ, I., KAHN, A., DOBRIYAN, A. & CHAUSHU, G. 2004. The effect of sinus membrane perforation and repair with Lambone on the outcome of maxillary sinus floor augmentation: a radiographic assessment. *International Journal of Oral & Maxillofacial Implants,* 19 (4):559-62.

- SIMUNEK, A., KOPECKA, D. & CIERNY, M. 2005. The use of oxidized regenerated cellulose (Surgicel®) in closing Schneiderian membrane tears during the sinus lift procedure. *West Indian Medical Journal*, 54**,** 398-399.
- SMILER, D. G., JOHNSON, P., LOZADA, J. L. E., MISCH, C., ROSENLICHT, J., TATUM, J. O. & WAGNER, J. 1992. Sinus lift grafts and endosseous implants. Treatment of the atrophic posterior maxilla. *Dental Clinics of North America*, 36**,** 151-86; discussion 187-8.
- SOHN, D.-S. 2011. New bone formation in the maxillary sinus with/without bone graft. *Implant Dentistry-The Most Promising Discipline of Dentistry*. InTech.
- SOLAR, P., GEYERHOFER, U., TRAXLER, H., WINDISCH, A., ULM, C. & WATZEK, G. 1999. Blood supply to the maxillary sinus relevant to sinus floor elevation procedures. *Clinical Oral Implants Research*, 10**,** 34-44.
- SOLTAN, M. & SMILER, D. G. 2005. Antral membrane balloon elevation. *Journal of Oral Implantology*, 31**,** 85-90.
- SOTIRAKIS, E. G. & GONSHOR, A. 2005. Elevation of the maxillary sinus floor with hydraulic pressure. *Journal of Oral Implantology*, 31**,** 197-204.
- STRONG, C. 1934. The innervation and vascular supply of the antrum. *J R Soc Med.* 27(6): 745-751.
- SUGUIMOTO, R. M., TRINDADE, I. K. & CARVAIHO, R. M. 2006. The use of negative pressure for the sinus lift procedure: a technical note. *International Journal of Oral & Maxillofacial Implants*, 21(3).
- SUMMERS, R. B. 1994. A new concept in maxillary implant surgery: the osteotome technique. *Compendium (Newtown, Pa.)*, 15**,** 152, 154-6, 158 passim; quiz 162.

T

- TARNOW, D., CHO, S. & WALLACE, S. 2000. The effect of inter-implant distance on the height of inter-implant bone crest. *Journal of periodontology,* 71**,** 546-549.
- TATUM, J. H. 1986. Maxillary and sinus implant reconstructions. *Dental Clinics of North America,* 30**,** 207-229.
- TESTORI, T., ROSANO, G., TASCHIERI, S. & DEL FABBRO, M. 2010. Ligation of an unusually large vessel during maxillary sinus floor augmentation. A case report. *Eur J Oral Implantol.* 3(3): 255-258.
- TESTORI1T. (2012) Maxillary sinus surgery: Anatomy and advanced diagnostic imaging. International Dentistry – African edition. 2(5): 6-14
- TIMMENGA, N. M., RAGHOEBAR, G. M., BOERING, G. & VAN WEISSENBRUCH, R. 1997. Maxillary sinus function after sinus lifts for the insertion of dental implants. *Journal of Oral and Maxillofacial Surgery,* 55**,** 936-939.
- TIMMENGA, N. M., RAGHOEBAR, G. M., VAN WEISSENBRUCH, R. & VISSINK, A. 2001. Maxillary sinusitis after augmentation of the maxillary sinus floor: a report of 2 cases. *Journal of Oral and Maxillofacial Surgery,* 59**,** 200-204.
- TISCHLER, M. 2008. In-office cone beam computerized tomography: technology review and clinical examples. *Dentistry today,* 27**,** 102.
- TOFFLER, M. 2004. Osteotome-mediated sinus floor elevation: a clinical report. *International Journal of Oral & Maxillofacial Implants*, 19 (2):266-73.
- TOLSTUNOV, L., THAI, D. & ARELLANO, L. 2012. Implant-guided volumetric analysis of edentulous maxillary bone with cone-beam computerized tomography scan. Maxillary sinus pneumatization classification. *Journal of Oral Implantology,* 38**,** 377-390.

- TORRETTA, S., MANTOVANI, M., TESTORI, T., CAPPADONA, M. & PIGNATARO, L. 2013. Importance of ENT assessment in stratifying candidates for sinus floor elevation: a prospective clinical study. *Clinical oral implants research*, 24**,** 57-62.
- TOSTA, M., CORTES, A. R., CORRÊA, L., PINTO JR, D. D. S., TUMENAS, I. & KATCHBURIAN, E. 2013. Histologic and histomorphometric evaluation of a synthetic bone substitute for maxillary sinus grafting in humans. *Clinical oral implants research*, 24**,** 866-870.
- TROMBELLI, L., FRANCESCHETTI, G., TRISI, P. & FARINA, R. 2015. Incremental, transcrestal sinus floor elevation with a minimally invasive technique in the rehabilitation of severe maxillary atrophy. Clinical and histological findings from a proof-of-concept case series. *Journal of Oral and Maxillofacial Surgery*, 73**,** 861-888.
- TSAI, L.-L., HUANG, Y.-F. & CHANG, Y.-C. 2016. Treatment of bisphosphonate-related osteonecrosis of the jaw with platelet-rich fibrin. *Journal of the Formosan Medical Association*, 115**,** 585-586.
- TYNDALL, D. A. & RATHORE, S. 2008. Cone-beam CT diagnostic applications: caries, periodontal bone assessment, and endodontic applications. *Dental Clinics of North America*, 52**,** 825-841.

U

- ULM, C. W., SOLAR, P., KRENNMAIR, G., MATEJKA, M. & WATZEK, G. 1995. Incidence and suggested surgical management of septa in sinus-lift procedures. *International Journal of Oral & Maxillofacial Implants*, 10 (4):462-5.
- UMSTADT, H. E., HOCHBAN, W., AUSTERMANN, K. H. & KÜNNEKE, M. 1994. Resorbable dowels for osteosynthesis of noncongruent bone

fragments. *International journal of oral and maxillofacial surgery,* 23**,** 446-449.

- UNDERWOOD, A. S. 1910. An inquiry into the anatomy and pathology of the maxillary sinus. *Journal of anatomy and physiology,* 44**,** 354–369.

V

- VAID, S. & VAID, N. 2015. Normal anatomy and anatomic variants of the paranasal sinuses on computed tomography. *Neuroimaging Clinics,* 25**,** 527-548.
- VAID, S., VAID, N., RAWAT, S. & AHUJA, A. 2011. An imaging checklist for pre-FESS CT: framing a surgically relevant report. *Clinical radiology,* 66**,** 459-470.
- VALENTE, N. A. 2016. Anatomical considerations on the alveolar antral artery as related to the sinus augmentation surgical procedure. *Clinical implant dentistry and related research,* 18**,** 1042-1050.
- VAN CAUWENBERGE, P., VAN HOECKE, H. & BACHERT, C. 2006. Pathogenesis of chronic rhinosinusitis. *Current allergy and asthma reports,* 6**,** 487-494.
- VAN DEN BERGH, J. P., TEN BRUGGENKATE, C. M., DISCH, F. J. & TUINZING, D. B. 2000. Anatomical aspects of sinus floor elevations. *Clinical Oral Implants Research: Treatment rationale,* 11**,** 256-265.

W

- WALLACE, S. S. & FROUM, S. J. 2003. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. *Annals of periodontology,* 8**,** 328-343.
- WALLACE, S. S., MAZOR, Z., FROUM, S. J., CHO, S.-C. & TARNOW, D. P. 2007. Schneiderian membrane perforation rate during sinus elevation using

piezosurgery: clinical results of 100 consecutive cases. *International Journal of Periodontics & Restorative Dentistry*, 27(5):413-9.

- WALLACE, S. S., TARNOW, D. P., FROUM, S. J., CHO, S.-C., ZADEH, H. H., STOUPEL, J., DEL FABBRO, M. & TESTORI, T. 2012. Maxillary sinus elevation by lateral window approach: evolution of technology and technique. *Journal of Evidence Based Dental Practice*, 12**,** 161-171.
- WANG, H.-L. & KATRANJI, A. 2008. ABC sinus augmentation classification. *International Journal of Periodontics & Restorative Dentistry*, 28(4):383-9.
- WARD, B. B., TERRELL, J. E. & COLLINS, J. K. 2008. Methicillin-resistant Staphylococcus aureus sinusitis associated with sinus lift bone grafting and dental implants: a case report. *Journal of Oral and Maxillofacial Surgery*, 66**,** 231-234.
- WILTBERGER, B. 1957. The dowel intervertebral-body fusion as used in lumbar-disc surgery. *JBJS*, 39**,** 284-331.
- WILTFANG, J., SCHULTZE-MOSGAU, S., MERTEN, H.-A., KESSLER, P., LUDWIG, A. & ENGELKE, W. 2000. Endoscopic and ultrasonographic evaluation of the maxillary sinus after combined sinus floor augmentation and implant insertion. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 89**,** 288-291.
- WOO, I. & LE, B. 2004. Maxillary sinus floor elevation: review of anatomy and two techniques. *Implant dentistry*, 13**,** 28-32.

Y

- YILMAZ, H. G. & TÖZÜM, T. F. (2012), Are gingival phenotype, residual ridge height, and membrane thickness critical for the perforation of maxillary sinus?. *Journal of Periodontology*, 83: 420-425.

Z

- ZHAO, J.-H., TSAI, C.-H. & CHANG, Y.-C. 2015. Clinical application of platelet-rich fibrin as the sole grafting material in maxillary sinus augmentation. *Journal of the Formosan Medical Association*, 114**,** 779-780.
- ZHENG, J., CHIU, H., ZHANG, S., LU, E., YANG, C., ZHANG, W. & XU, W. 2015. Endoscopic lift of the maxillary sinus floor in beagles. *International Journal of Oral and Maxillofacial Surgery*, 44**,** 168.
- ZHENG, J., ZHANG, S., LU, E., YANG, C., ZHANG, W. & ZHAO, J. 2014. Endoscopic lift of the maxillary sinus floor in beagles. *British Journal of Oral and Maxillofacial Surgery*, 52**,** 845-849.
- ZIJDERVELD, S. A., VAN DEN BERGH, J. P., SCHULTEN, E. A. & CHRISTIAAN, M. 2008. Anatomical and surgical findings and complications in 100 consecutive maxillary sinus floor elevation procedures. *Journal of Oral and Maxillofacial Surgery*, 66**,** 1426-1438.
- ZÖLLER, J. E. & NEUGEBAUER, J. 2008. *Cone-beam Volumetric Imaging in Dental, Oral and Maxillofacial Medicine: Fundamentals, Diagnostics, and Treatment Planning*, Quintessence. 288-523.

Appendices

Appendix (I)

Case sheet (Sinus lift): Date:

Patient's Name:

Age: ☐ Gender: ☐ Address:

Occupation: Telephone #:

Medical History: ____

____

Dental History: ____

Clinical Examination:

Oral Hygiene: ______________________ Periodontal Condition: ______________________

Tooth (teeth) to be replaced: __________________ No. of DI Placed:

____

Placement protocol:____

Width of the Alveolar bone: ______ Inter-ridge Distance: _______ Intercoronal Distance:

____

Side of sinus lift: Right ☐ Left ☐

Preoperative CBCT examination:

- SP Degree ☐
- Subantral bone height ☐
- Buccopalatal dimensions ☐

Surgical Approach: (SL)

Type of SL elevation: Osung hydraulic pressure kit ☐ Osteotome kit ☐

Site of DI (Tooth site #)

Endoscopic findings: Intact membrane ☐ Perforated membrane ☐

DI system: ____________________________

Dental implant dimensions

Amount of bone substitute in (cc) filling the elevated area: __________________________

Barrier membrane dimensions: ______________________________________

Intraoperative Complications

Sinus membrane perforation: _________ Nasal bleeding: __________ others: ___________

1st Postoperative Appointment (after 14 days)

Postoperative Complications

Purulent exudate: _______ Nasal obstruction &/or congestion: _______ Headache: ________

Postoperative hematoma: ___________ others: ______________

اني المريض .... اوافق على إجراء عملية زراعة الأسنان ورفع الجيوب الفكية

في كلية طب الأسنان جامعة بغداد/ وحدة زراعة الأسنان/ وقد تم إبلاغي بجميع تفاصيل العملية وعواقبها الإيجابية والسلبية.

التوقيع ....

التاريخ   /   /

Appendix (II)

Dental Implant Case Sheet
College of Dentistry – Baghdad University
Department of Oral & Maxillofacial Surgery- Dental Implantology
Name:
Age:
Gender:
Occupation:
Telephone No.
Address:
General Health: BHP 1 2 3
Patient Interrogation: Obsessional neurosis - Availability
Esthetic demands: (realistic - high - unrealistic)
Etiology of Eduntulism: caries - trauma -periodontal disease- occlusal trauma
Extraoral Exam: Smile line → dental - gingival
Intraoral Exam:
Missing teeth to be replaced by DI:
Hygiene: good - moderate - poor
Pathology: no - yes
Depth of vestibule: good - moderate - poor
Alveolar crest width: wide - sharp
Vestibular concavity: no - yes
Jaw opening: 3 fingers - 2 fingers - 1 finger
Interarch distance at maximal opening: mm
Mesiodistal distance: mm
Height between alveolar crest and opposing teeth or ridge: mm
Vertical bone resorption: no - yes
Gingiva: thick & fibrous - fine
Papillae of adjacent teeth: flat - scalloped
Periodontal evaluation: gingivitis - treated periodontitis - active periodontitis
Functional evaluation: bruxism - parafunction - no
Radiographic Exam: OPG - CT - Periapical - Others
Chronic lesions: close to implant zone - distant from implant zone
Bone density: D1 (type I) - D2 (II) - D3 (III) - D4 (IV)
Vertical bone resorption: no - yes
Study models surgical template
Surgical (operative) data:
Treatment protocol → I (delayed) - II (intermediate) - III (immediate)
Jaw operated upon → maxilla - mandible
DI system: No of DI
DI dimensions:
Surgical approach →

Level of DI in relation to crest:

Bone expansion: bone condensation:

GBR→ barrier membrane space filler

Bone grafting:

Sinus Lift:

Surgical notes:

………………………………………………………………………………………………………

Length of healing phase:

2nd stage surgery:

Uncoverage → tissue punch scalpel others

Gingival former dimensions→

Follow-up and maintenance:

Complications:

Appendix (III)

موافقة المريض للاشتراك في البحث العلمي

اسم الباحث:

عنوان البحث:

مكان اجراء البحث:

انت مدعو(ة) للمشاركة ببحث علمي سريري سيجرى في________________________________

الرجاء ان تأخذ(ي) الوقت الكافي لقراءة المعلومات التالية بتأن قبل أن تقرر(ي) اذا كنت تريد(ين)

المشاركة أم لا. بإمكانك طلب إيضاحات أو معلومات اضافية عن أي شيء مذكور في الاستمارة أو عن هذه الدراسة ككل من طبيبك. في حال وافقت على المشاركة في هذه الدراسة, سيبقى اسمك طي الكتمان. لن يكون لأي شخص, مالم ينص القانون على ذلك حق الاطلاع على ملفك الطبي باستثناء الطبيب المسؤول عن الدراسة او معاونيه.

موافقة المشترك:

لقد قرأت استمارة القبول هذه وفهمت مضمونها .تمت الاجابة على أسئلتي جميعها وبناءا عليه فأنني حر مختار, أجيز اجراء هذا البحث و أوافق على الاشتراك فيه واني أعلم ان الباحث الدكتور ______________________________وزملاءه ومعاونيه او مساعديه سيكونون مستعدين للإجابة عن أسئلتي وأنه باستطاعتي الاتصال بهم على الهاتف ___________________ واذا شعرت لاحقا ان الأجوبة تحتاج الى مزيد من الإيضاح فسوف أتصل بأحد اعضاء لجنة الأخلاقيات, كما أعرف تمام المعرفة بانني حر في الانسحاب من هذا البحث متى شئت حتى بعد التوقيع على الموافقة دون ان يؤثر ذلك على العناية الطبية المقدمة لي.

اسم المشترك:

توقيع المشترك:

Appendix (IV)

Participation approval in a clinical study

Name of researcher

Location of the surgical procedure

Mr. / Ms. ____________________ you are requested to participate in a clinical research in the College of Dentistry/University of Baghdad/Dental Implantology Unit. You have the right to accept or refuse the involvement in the current study after reading the details of the procedure that will be explained by the researcher.

Any information mentioned in your file will be classified as no one have the authority to see it unless authorized by the law.

Signing the consent:

I'm Mr. / Ms. _____________ signed this consent after readings all the details related to the surgical procedure and the possible postoperative complications after every vague been clarified by the researcher and I signed in full freedom and consciousness.

Name and signature of the participant

Appendix (V)

SY-P029-1

Video Endoscope

Specifications

Main Specifications:Probe		
Outer diameter	forward view	Φ5.8mm with working channel:2.2mm
		Φ4.8mm with working channel:1.5mm
		Φ3.8mm with working channel:0.6mm
		Φ2.8mm without working channel
Camera	pixel count	300000 pixels (1/10" color CMOS)
	Resolution	10.5 lp/mm (at 7mm)
Optic system	field of view(FOV	90° ± 10°
	depth of field(DOF)	3mm~50mm
	view direction	forward
Articulation		UP 180 degree
		Down 130 degree
illumination adjustable		>10000 Lux of illumination with Fiber/ >10000Lux
Insertion tube covering		polyurethane (match medical standard)
Working length		300mm——600mm
Waterproof		IP67 (cable and holder)/ IP67
Working Temperature		5~40° C
Atmosphere Pressure		700hpa~1060hpa
Base		
Monitor		3.5" TFT LCD, high resolution/高清3.5寸
Controls		brightness adjusting, internal image processing;snapshot;video recording
Power supply	DC (battery)	lithium battery :working time ≥1.5H / ≥1.5H
		charging time: 8~10 H
Memory card		TF card 2 G (provided), Max 16G (option)
Memory volum		JPEG : 60KB; 4 hours' video recording: 1G
USB2.0		for transfer data to PC

Sunny Medical Equipment Limited

الخلاصة

الخلفية: تتأثَّر إعادة تأهيل الجهة الخلفية للفك العلوي بقصورالعظم المتبقي الناقص أفقيا و عموديا مما يؤثر سلبًا وبصورة اساسية على استقرار الزرعة السنية. ان عمليات رفع الجيوب الفكية تم تطويرها و تطبيقها على نطاق واسع في العيادات ،بالنسبة لرفع الغشاء الجيبي الفكي يتم عادة استخدام الطريقة القشرية أوالجانبية اعتمادًا على ارتفاع العظم المتبقي. كانت الطريقة القشرية بالمقارنة مع الجانبية، هي الاكثر شيوعا واستخداما بين الاطباء وذلك بسبب مزاياها العديدة التي لفتت الانظار ومع ذلك فإن أسلوب الهرم (الطريقة القشرية) له عدة عيوب ، حيث تعتمد التقنية القشرية بشكل كبير على مهارة الطبيب ، وتؤدي إلى مضاعفات مثل الصداع والدوار بعد إجراء رفع الغشائي الجيبي. وقد تم تطوير العديد من العمليات الجراحية والأجهزة للتغلب على أوجه القصور في التقنية القشرية لرفع غشاء شنايدر الجيبي. من بين هذه الإجراءات والأجهزة الجراحية، أثبتت الأجهزة التي تستخدم الضغط الهيدروليكي لرفع غشاء الجيوب الأنفية وانخفاض خطر الانثقاب للغشاء االجيبي وكذلك سهولة التطبيق. نظرًا لأن الطريقة القشرية قد تم تعريفها على أنها نهج أعمى لا يمكن من خلاله التعرف على وجود ثقب غشاء الجيوب الأنفية بوضوح ، وكان الأطباء يعتمدون على اختبار فالسالفا (النفخ من خلال الانف المسدود) للتعرُّف على ما إذا كان الغشاء مثقوبا أو سليماً ، وبالتالي فإن الجراحة بالمنظار غيرت فلسفة وممارسة جراحة زرعة الأسنان الحديثة في جميع الجوانب ، فإنه يؤدي إلى إجراء جراحات عديدة متقدمة على أساس القدرة على التصوير والعمل عبر القنوات الصغيرة ، المقدرة على الرؤية الواضحة في مجال العمليات الجراحية فتحت عالما جديدا تماما من الاستكشاف ،وذلك أدى الى التغلب على أوجه القصور في الطريقة القشرية المعدومة الرؤية.

الأهداف:

1. لتقييم فعالية رفع الجيوب الأنفية الهيدروليكية مع استخدام جهاز أوسونك للجيوب الفكية.
2. تقييم وجود الثقب في غشاء شنايدر في الجيب الفكي مع استخدام المنظار.

المواد وطرق العمل:

تم تنظيم هذه الدراسة العشوائية الاحتمالية السريرية من كانون الاول 2017 إلى كانون الاول 2018 ، في نفس الوقت تم إجراء 52 عملية زرع للجيوب الأنفية (عملية جراحية على مرحلة واحدة), الى 30 مريضا 5 ذكور و 25 أنثى مع متوسط عمر 46.86 سنة (المدى: 19-72) مقسّمة إلى مجموعتين: المجموعة (أ) (الاوسونك) تقنية الرفع بلضغك الهيدروليكي, و مجموعة (ب) تقنية الاوستيوتوم, كلا المجموعتين تمت باستخدام الطريقة القشرية.

في هذه الدراسة تم اجراء فحص,بالنسبة لكل مريض, ما قبل الجراحة بأستخدام التصوير المقطعي كتقييم أولي لارتفاع العظم المتبقي, واستخدام التصوير المقطعي المحوسب المخروطي للتخطيط الدقيق لمسافة العظم المتبقي.

يستخدم المنظار الداخلي أثناء العملية في كل حالة لتقييم وجود ثقب الغشاء الشنيدري ، متبوعًا باسناد عظم الجيب باستخدام مادة العظم الصناعية (اوستيون) بالاضافة الى الغشاء الكولاجيني, الاختبارات المستخدمة احصائيا كانت اختبارات ت (ثنائي الذيلان).

النتائج:

تم انجاز 51.9 ٪ حالة لرفع الجيوب الانفية (27 حالة) باستخدام عدة الرفع (الاوسونك), في حين تم اجراء 48.1 % (25 حالة) باستخدام تقنية الاوستيوتوم وكلا المجموعتين تمت باستخدام الطريقة القشرية.

كان متوسط ارتفاع العظم الافقي لمرضى المجموعة أ (الاوسونك) 1.17 ±4.77 ملم ,بينما كان متوسط ارتفاع العظم الافقي بالنسبة لمرضى المجموعة ب (الاوستيوتوم) 1.32 ±4.89 ملم , ولم يكن هناك فرق احصائي بينهما.

كما لم يكن هناك فرق أحصائي (0.516) فيما يتعلق بسماكة غشاء شنايدر بين الحالات التي سجلت ثقبا في الغشاء 0.69±0.71 ملم ,وبين الحالات الي لم تسجل 0.97±0.74 ملم.

كانت نسبة حدوث الثقب في غشاء الجيب الفكي 12% في الحالات التي اجريت باستخدام الاوستيوتوم, بينما كانت 3.7% فقط في الحالات التي اجريت باستخدام عدة الرفع (الاوسونك),ولكن احصائيا لم يشكل فرقا.

الاستنتاج:

استخدام المنظار بسيط وسهل وسريع للتصوير المباشر لغشاء شنايدر ، أظهرت نتائج هذه الدراسة أن ارتفاع سقف الجيوب الأنفية العلوية باستخدام مجموعة نظام الرفع بالماء (الاوسونك) عبر الطريقة القشرية وهي اجراء يمكن التنبؤ بنتائجه مع معدل انخفاض كبيرفي ثقب غشاء شنايدر للجيب الفكي مقارنة مع تقنية (الاوستيوتوم).

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة بغداد
كلية طب الأسنان

فعالية الضغط الهيدروليكي لرفع الجيوب الفكية مقارنة مع الاوستيوتوم من خلال الطريقة القشرية بأستخدام المنظار

(دراسة عشوائية سريرية)

رسالة مقدمة الى مجلس كلية طب الاسنان في جامعة بغداد كجزء من متطلبات نيل شهادة الماجستير في جراحة الفم والوجه والفكين

قدمت من قبل
أسيل حامد مدب
بكالوريوس طب وجراحة الفم والأسنان

اشراف
أ. د. ثائر عبد اللطيف حسن
بكالوريوس طب وجراحة الفم والاسنان
دبلوم عالي جراحة الفم والوجه والفكين
بورد جراحة الوجه والفكين

1440 هـ

2019 م