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Intra Oral Camera and Digital Impression in Pediatrics

A Project Submitted to

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CERTIFICATION OF THE SUPERVISOR

I certify that this project entitled Digital Impression in Pediatrics was prepared by the fifth-year student **Mohammed Taqi Abbas Abd Ali** under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the bachelor's degree in Dentistry.

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DEDICATION

I'd like to dedicate this project to my beloved **father** and to my beloved **mother** without both I would never make it to this point.

To all my **friends**, thank you for being always there for me with all you love and support.

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IOS	Intraoral scanner
CI	conventional impressions
PVS	poly-vinyl siloxanes
3D	three-dimensional
HD video	High-definition video
CLP	cleft lip and palate
STL	Stereolithography

Introduction

Although the plaster models obtained using conventional impressions (CI) in dentistry are often used in diagnosis and treatment procedures, they have disadvantages such as their size, risk of loss or fracture and difficulties during the fabrication of models (**Keating *et al*., 2008),**Due to the advantages of digital impressions and intraoral scanning systems such as the ability to store captured information indefinitely,low storage space, rapid access to 3-dimensional (3D) records, and facilitating communication with professionals and patients **(Kravitz *et al*., 2014)**.The interest in these impression methods is increasing **(Burhardt *et al*., 2016)**.Also, digital impressions combined with CAD/CAM technology allow a completely digital workflow, starting from impression to framework planning, to realization of final work. This completely digital workflow has been demonstrated to be effective in various fields of dentistry, such as prosthodontics , conservative dentistry and orthodontics **(Benic *et al*., 2019; Revilla *et al*., 2019; Rosti *et al*., 2019)**.However, the digital models obtained through intraoral scans are not fully integrated into private practices that are as durable as conventional methods **(Burzynski et al, 2018)**.Moreover, today conventional impression methods are more readilyaccepted and inexpensive practices **(Hamalian *et al*., 2011; Burzynski *et al*., 2018)**.

Since the emergence of 3D systems, research has been conducted to compare accuracy and reliability, and it has been shown that precision of conventional and digital methods have similar or clinically insignificant differences ***(Goracci et al,2016)***. With the decreasing of suspicions about the accuracy in studies on digital and conventional impressions, the research on this issue has focused on the potential benefits to the patient and the clinician, and especially on the comfort and speed of the methods **(*Wismeijer et al., 2014; Burhardt et al., 2016; Benic et al., 2016*)**.Which is not surprising as clinicians and patients demand less time-consuming and more comfortable methods, with the development of dental practices **(Wismeijer *et al*., 2014; Joda and Brägger, 2016)**.

Furthermore, the conventional impression (CI) methods have been reported by patients as disturbing and even described to be the worst treatment stage they have ever experienced **(Lee *et al*., 2015; Burhardt *et al*., 2016; Burzynski *et al*., 2018)**.This is because patient comfort may often be disturbed by the stimulation of the gag reflex during the conventional impression methods , whereas the digital impression methods have an important capacity to prevent the gag reflex **(Farrier *et al*., 2011; Gjelvold *et al*., 2016; Joda and Brägger, 2016;)**.Another factor affecting the patient and the clinician comfort concurrently during the taking of impressions is the time required to complete the process **(Grünheid *et al*., 2014; Yuzbasioglu et al., 2014; Wismeijer *et al*., 2014)**.have stated that because impressions taken by alginate require shorter chairside time than those taken by intraoral scans, the conventional impression method is considered more preferable and comfortable by patients (**Wismeijer *et al*., 2014; Gjelvold *et al*., 2016; Joda and Brägger., 2016)**.

In orthodontics and paediatric dentistry, impressions are taken from children for diagnosis and treatment procedures (such as space maintainer, habit breaker fabrication). Today, a digital change is visible in dentistry in the field of impression-taking. This is because with the development of the systems in this field, a complete change can be expected in the impression-taking procedure, which is considered as the worst experience by patients and children **(Hacker *et al*.,2015)**.

The comfort of impression methods and the time they require are important because it is known that children are more stressed in their encounter with the dentist than the elderly, and their chairside times are shorter **(Oba *et***

***al.*, 2009)**.The comparison of impression methods in terms of comfort, preference and time has been studied only in young adults or adult patients (**Wismeijer *et al.*, 2014; Schepke *et al*., 2015; Gjelvold *et al*., 2016)**.Although there are studies on adolescents and young adolescents,who most commonly undergo orthodontic treatment, to the best of our knowledge, there are no studies investigating the comfort of children during the impression-taking procedure **(Schepke *et al*., 2015; Burhardt *et al.*, 2016; Gjelvold *et al*., 2016)**.

Aim of the study

Aim of our study to review about new technology of digital imperssion in dentistry

CHAPTER ONE
review of the literature

1.1 Digital impression and scanning systems

Digital impression and scanning systems were introduced in dentistry in the mid-1980s and have evolved to such an extent that some authors predict that in five years most dentists in the U.S. and Europe will be using digital scanners for impression taking **(Polido., 2010).**

Digital impression taking, given its undeniable benefits, will transform digital intraoral scanning into a routine procedure in most dental offices in the coming years (**figure 1).** Furthermore, digital impressions tend to reduce repeat visits and retreatment while increasing treatment effectiveness. Patients will benefit from more comfort and a much more pleasant experience in the dentist's chair. Thanks to digital impressions, products fabricated in prosthetic labs will become more consistent and easier to install, requiring reduced chair time **(Polido.,2010).**

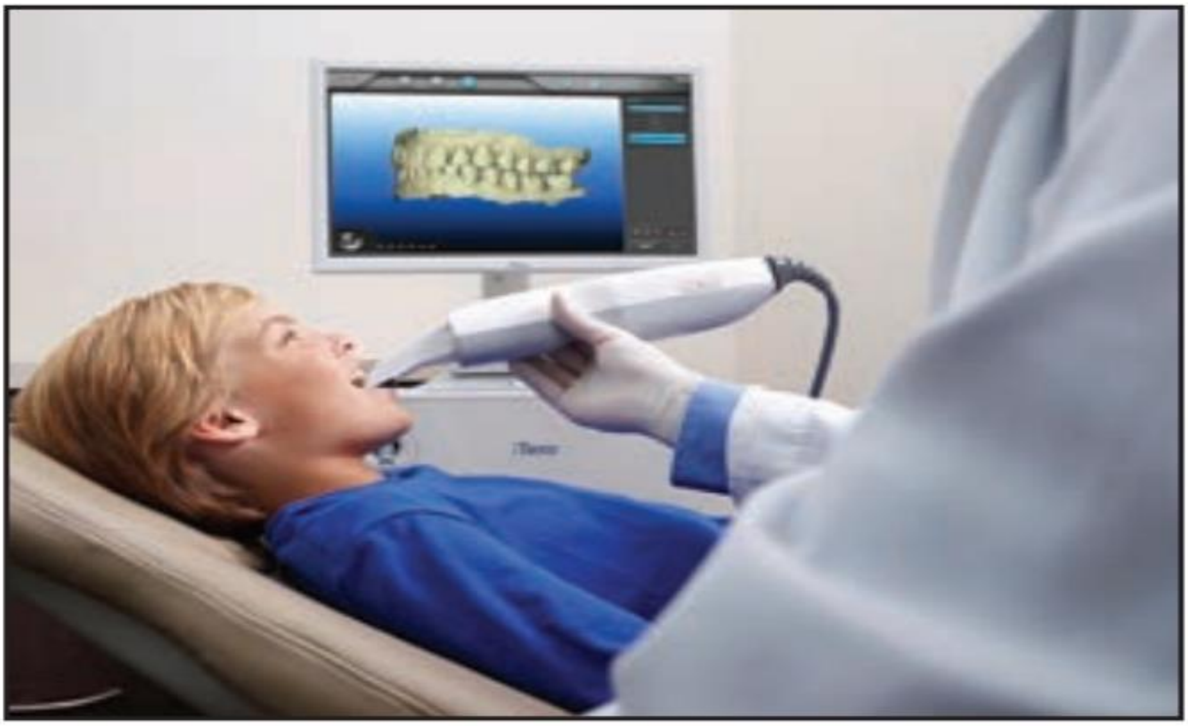

Figure 1.1 ITero intraoral digital scanner (Weise *et al*., 2021).

Since long before the Industrial Revolution men has handcrafted and manufactured millions of different products using analogical processes. In the last 30 years, many of these products have been converted to digital manufacturing-from auto parts to civil construction-given its consistent quality and lower cost. It is therefore no surprise that digital solutions are now being integrated into many dental procedures. With the popularization of digital systems, and the tremendous growth in two areas of dentistry that can potentially benefit from digital impression taking and digital models (orthodontics and dental implantology) one can confidently predict that in the coming years we will witness a true digital revolution in the dental office. A revolution that will benefit patients in terms of more efficient planning, reduced discomfort and treatment efficiency **(Polido., 2010).**

The most significant change in the dental field in recent years is,without a doubt, the development of digital dentistry regarding the fabrication of prostheses, with computer-aided design-computer-aided manufacturing (CAD-CAM) systems, it became possible to mill frameworks designed by a computer and to use aesthetic materials such as alumina and zirconia ceramics, which cannot be cast **(Logozzo8Kihara *et al.*, 2020; Kihara *et al*., 2020)**.Fabrication of prostheses using three-dimensional (3D) printing has also be reported **(Flügge *et al.*,2013; Arakida *et al*., 2018)**. In clinical application of final impressions, it has also become possible to employ an intraoral scanner as an alternative to conventional impressions using a vinyl polysiloxane material **(Ender and Mehl., 2011; Jones., 2012; Weise *et al*., 2021)**.

1.2 The advantages of digital impressions

Intraoral scanners (IOS) have many advantages as compared to conventional (CI) methods in relation to the fabricating process of prostheses **(Mehl and Lubit., 1988).**It is possible to eliminate all fabricating errors encountered by conventional methods, such as the distortion of impression material **(Mehl and Lubit., 1988; Kravitz *et al*., 2014)**.Expansion of plaster, deviation when a model to an articulator, and casting shrinkage **(Kihara *et al*., 2020)**.Intraoral scanner include it being effective for patients with strong vomiting reflexes, and it being possible to overwrite only the part where the impression is not clear.When considering remaking and polymerizing, it was reported that total clinical treatment time was reduced **(Lipp and Lipp.,1988; Logozzo *et al*., 2008)**.Data of patients can be transmitted to dental technicians using the Internet, therefore, there is no longer any need to send stone models. Thus, there is no risk of the model breaking in transit. In the field of orthodontics, intraoral scanners are considered to be a paradigm shift as an alternative to irreversible hydrocolloid and polyvinyl siloxane impressions **(Logozzo *et al*., 2008)**.

Most orthodontic treatments require long periods of treatment, and the first diagnostic model needs to be stored during the said period, the digital models acquired from intraora scanners do not occupy any physical space as in conventional gypsum models, and there is no doubt that the digital model obtained by the intraoral scanner is effective in terms of securing storage space. . Also, digital dentistry, especially digital models, has several benefits, such as quick access to 3D diagnostic information, and transfer of digital data for communication with specialists **(Logozzo *et al*., 2008).**

1.3 Advantages of Digital Scanning in Orthodontic Specially

Alginate and poly-vinyl siloxanes (PVS) impressions have been associated with problems such as pulls, tears, bubbles, voids, tray-to-tooth contact, separation from the impression tray, temperature sensitivity, limited working time, material shrinkage, inaccurate pouring, model overtrimming, and breakage during shipment **(Jones., 2012)**Impression taking also heightens anxiety and discomfort for patients of all ages, particularly those with sensitive gag reflexes. In vitro studies have shown that full-arch digital scans are as accurate as conventional impressions **(Ender and Mehl., 2011),** without these drawbacks. For the orthodontist, advantages of digital scanning include improved diagnosis and treatment planning, increased case acceptance, faster records submission to laboratories and insurance providers, fewer retakes, reduced chairtime, standardization of office procedures, reduced storage requirements, faster laboratory return, improved appliance accuracy, enhanced workflow, lower inventory expense, and reduced treatment times. Benefits to the patient include an improved case presentation and a better orthodontic experience with more comfort and less anxiety, reduced chairtime, and easier refabrication of lost or broken appliances, as well as potentially reduced treatment time **(Logozzo *et al.*, 2008)**.

1.4 Disadvantages of Intraoral Scanners

1. Difficulty in detecting the sub gingival finish lines of prepared teeth **(Lee *et at.*, 2013).**
2. Difficult to scan with bleeding tissues **(Nedelcu *et al.*, 2018)**.
3. Difficulty in learning the working of IOS and operator related errors **(Nedelcu et al., 2014)**.
4. Purchasing and managing costs- Expensive **(Flugge *et al*., 2013)**.

5. Reflection caused due to saliva, surfaces like enamel crystals or polished surfaces also disrupts the accuracy of the digital impressions **(Cora Abigail coutinho and divya hegde., 2020)**.
6. Powder could be uncomfortable for patients, and additional scanning time is required when powder is contaminated with saliva during impression as this requires cleaning and re-application of powder **(Cora Abigail coutinho and divya hegde., 2020).**

1.5 Scanning Technology

Every scanner has three major components: a wireless mobile workstation to support data entry; a computer monitors to enter prescriptions, approve scans, and review digital files; and a handheld camera wand to collect the scan data in the patient's mouth. To gather surface data points, energy from either laser light or white light is pro- jected from the wand onto an object and reflected back to a sensor or camera within the wand. Based on algorithms, tens or hundreds of thousands of measurements are taken per inch, resulting in a Three-dimensional **(3D)** representation of the object's shape. The technology used by the wand to capture surface data determines the measurement speed, resolution, and accuracy of the scanner.

Three-dimensional **(3D)** in-motion video uses an High-definition video **(HD video)** camera with trinocular imaging—three tiny video cameras at the lens—to capture three precise views of the tooth **(Logozzo *et al*., 2008).**digital impression system can scan through tissue or saliva, proper retraction and isolation are essential for accurate capture of surface data **(Flügge *et al*., 2013).**

1.6 Affecting the accuracy of the intraoral scanner

The intraoral scanner is adevice that senses asperities of an object and captures it as 3D data. In general, the object is irradiated with a laser to acquire three-dimensional data, and the data is then converted into polygon data, which is a set of triangular surfaces. In short, objects that absorb the laser or do not reflect the laser well are considered objects for which it is difficult to acquire data **(Arakida *et al.*, 2018)**.

1.7 Intraoral scanning of neonates and infants with craniofacial disorders

IOS is a fast, safe, and feasible procedure for neonates, small children, and infants with craniofacial malformations. One special challenge for both technician and user was identified in patients with cleft lip and palate **(CLP)**, though implementing this new approach of digital impression taking was otherwise found to be highly successful in everyday clinical routine **(Weise *et al.*, 2021). (Figer 2)**

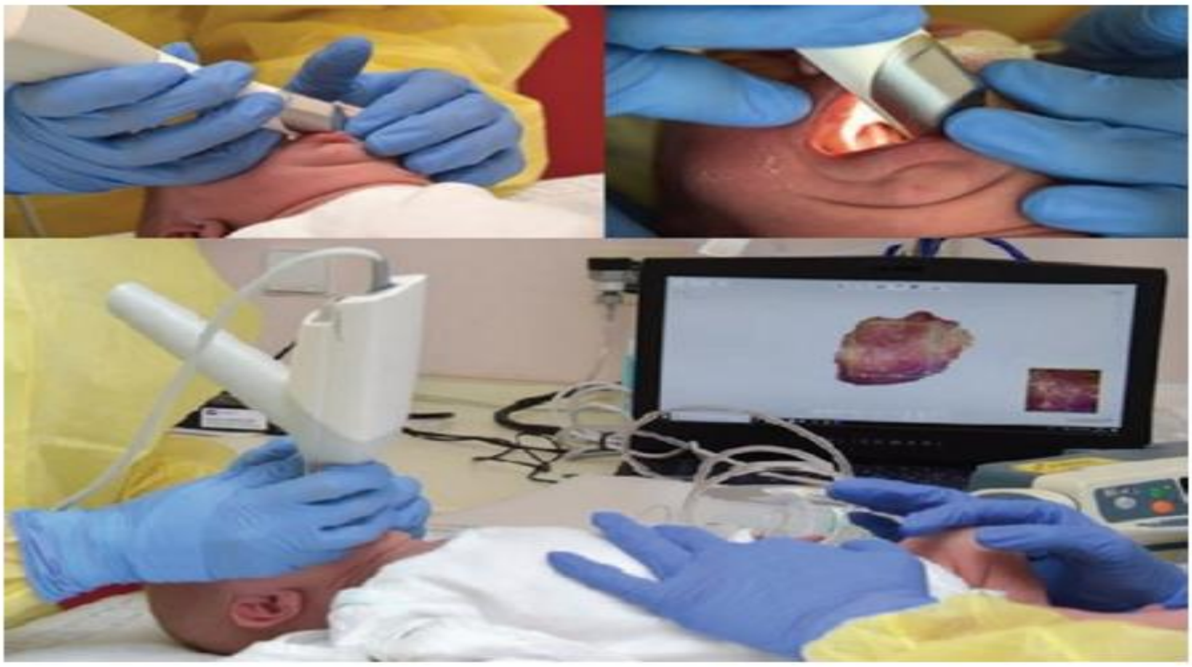

Figure 1.2 Intraoral scanning of neonate patient with the Trios (Weise *et al*., 2021).

For orthodontic treatment of severe craniofacial malformations, an intraoral impression must be taken shortly after birth. This poses a potentially life-threatening risk**(Lipp and Lubit.,1988)**. Patients may become apnoeic while the impression material sets. Therefore, some hospitals perform CI under general anaesthesia, which poses additional risks to the young patients**(Chate., 1995)**. An interdisciplinary team of neonatologists, orthodontists, anaesthetists, and nurses must be present and ready to respond to potential emergencies**(Kravitz *et al*., 2014; Chalmers *et al*., 2016)**. Even after the material has fully set, it can tear and cause an emergency situation. In patients with a cleft lip and palate (CLP), material can remain unnoticed in the cleft and cause local inflammation, or particles may be aspirated leading to airway obstruction**(Datta *et al*., 2017)**. The need for an alternative with fewer and less severe risks to the patients is therefore imperative.

1.7.1 Advantage of the IOS in patients with a cleft lip and palate (CLP)

is that the impression procedure can be interrupted at any time. The patient can then be treated individually, and the healthcare professional can resume the IOS whenever the patient has returned to a stable condition. Interrupting also allows for inspection of the image for missing areas. IOS does not require an interdisciplinary team to be present. Only a few cases have been described in which IOS was used in such young patients, especially only CLP patients **(Xepapadeas *et al*., 2020; Gong *et al*., 2020)**.Scans can be used to manufacture different orthodontic appliances depending on the aetiology of the craniofacial disorder. These appliances, when directly produced using additive or subtractive manufacturing, will have comparable accuracy compared with palatal plates manufactured using conventional materials on a digital model **(Aretxabale *ta et* al., 2021).**

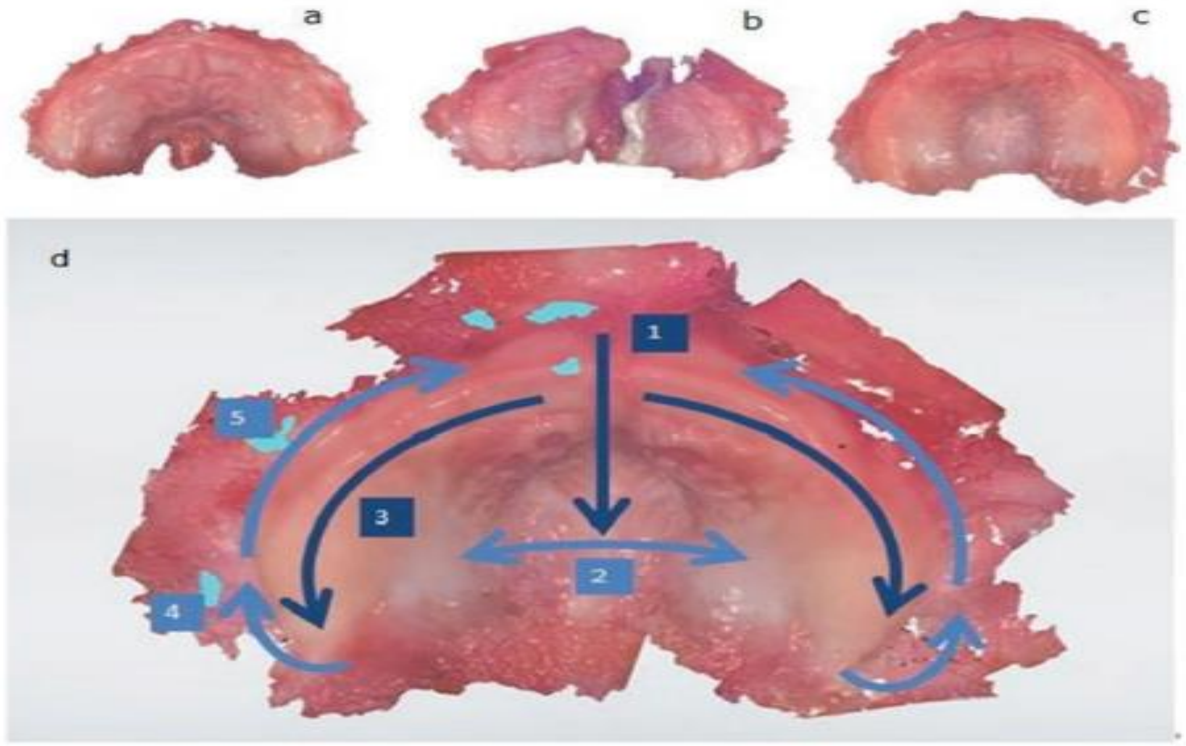

Figure 1.3 Exemplary intraoral scan from an upper jaw of Robin Sequence (a), unilateral cleft lip and palate (b), and Trisomy (c) and the corresponding scanning protocol for neonates and infants. 1: scan of the incisive papilla; 2: registration of palatal area; 3: scan of alveolar arch parallel to occlusal plane; 4: registration of the posterior region; 5: registration of vestibule (Weise *et al*., 2021).

1.7.2 scanning protocol

was used to guarantee high quality and maximize scan efficiency during the introduction of IOS into clinical routine. A standard scan as shown in (Figure 3 d) starts at the incisive papilla (1), which offers a prominent and easily recognizable structure for the scanner. From the incisive papilla, the scanner was moved towards the palate and then to both sides of the alveolar ridge (2). Then the head of the scanner was moved along one side of the alveolar arch parallel to the occlusal plane as far distally as possible (3). To open the patient's mouth and to register the posterior region of the tuberosity the scanner head was tilted caudally (4). The vestibule was registered by laterally tilting the scanner tip and moving it in mesial direction (5). The same procedure was repeated for both quadrants of the jaw (**Weise *et al*., 2021).**

The intraoral scanner was cleaned between patients with disinfection wipes. The removable head of the intraoral scanner was changed after every patient and cleaned in a thermo disinfector. Afterwards this was shrink-wrapped in a sterile way **(Weise *et al*., 2021)**.

1.7.3 Hazards of CI In Neonates With CLP

Cyanotic episodes, remaining impression material during withdrawal causing respiratory obstruction and inflammation **(Chate., 1995)**. Furthermore, neonatal patients are obligatory nasal breathers**(Bluestone *et al*., 1983; Proffit *et al*., 2013)**. For CI it is imperative to secure the respiratory tract, as the impression tray cannot be removed until the material has set, in case of an emergency. This requires the presence of an interdisciplinary team **(Lipp and Lubit.,1988)**. An IOS can be performed by the orthodontist with an assistant. Timing an IOS procedure can be much more flexible. It is both time effective and easy to integrate into daily clinical routine. Furthermore, IOS offers a large safety factor, reducing invasiveness and limiting the burdens for these patients who sometimes must stay in a hospital for weeks after birth. This might decrease the additional psychological and physical

stress factors for patient and parents (**Weise *et al*., 2021).**

1.8 According to the study done by (Weise *et al*., 2021).

This study demonstrates the successful implementation of a new, in -novative approach to IOS for newborns, infants, and small children with craniofacial disorders in everyday clinical practice. Four IOS in only CLP patients had to be repeated and one patient required a CI. Clinically, CLP patients are the most challenging group, which is reflected in the success rate of

94%. Therefore, clinical experience with IOS in CLP patients is specifically shown below. Nonetheless, the following statements are transferable to all young patients with craniofacial anomalies. The individual anatomical cleft formation often has a dislocated, sometimes strongly mobile premaxillary segment, especially in double-sided clefts. Due to this movability, it cannot be recognized by the scanner. Lateral cleft segments are often highly displaced in the vertical plane, with the columella being underdeveloped. Thereis, therefore, a risk that residual impression material may remain in the undercuts of the cleft, shifting into the airways or inflaming the tissue **(Jacobson and Rosenstein., 1984; Lipp and Lubit.,1988; Ting-Shu and Jian., 2015; Patel *et al*., 2019).**

The depth of field of the scanner is a problem when imaging deeper structures and building a ‘virtual bridge’ between the cleft segments. In a successful IOS, a surface must be registered in which all jaw segments are connected because the algorithm that renders the surface deletes all parts that are not connected by the main scan. This causes the software to fail in identifying the entire jaw as contiguous and may delete some parts **(Figure 4a)**. For this procedure in particular, depth of field is a limiting factor, requiring further development of the technology in the future **(Gong *et al*., 2020)**.

When segments are in contact with each other, no special measures are necessary to ensure registration of a sufficient virtual bridge. When the cleft is wider, an intact part of the lip, jaw, palate, or even nose can be used to form a connection **(Figure 4b–4e)**. In the particular case of four scans that had to be repeated, the CLP was too wide and deep. The investigator therefore inserted material such as cotton swabs or the tip of a glove into parts of the cleft to connect the segments **(Figure 4d and 4e).** Important here is that the inserted material was in a stable position for the scanner to recognize it. In one patient with a unilateral CLP, all strategies mentioned above were unsuccessful, as the segments were too far apart with too many undercuts to be connected **(Figure 5)**. An alginate impression was taken. This patient was successfully scanned at a follow-up appointment 7 weeks later. We documented no severe adverse events during IOS in this study, with only minor and superficial injuries to the gingiva occurring during scanning **(Figure 6),** which were caused by patients biting on the scanner head. These superficial injuries healed spontaneously and were of no consequence. A different scanner design with a built-in glass cover might improve patient safety and prevent saliva from staining the mirror or the lens.

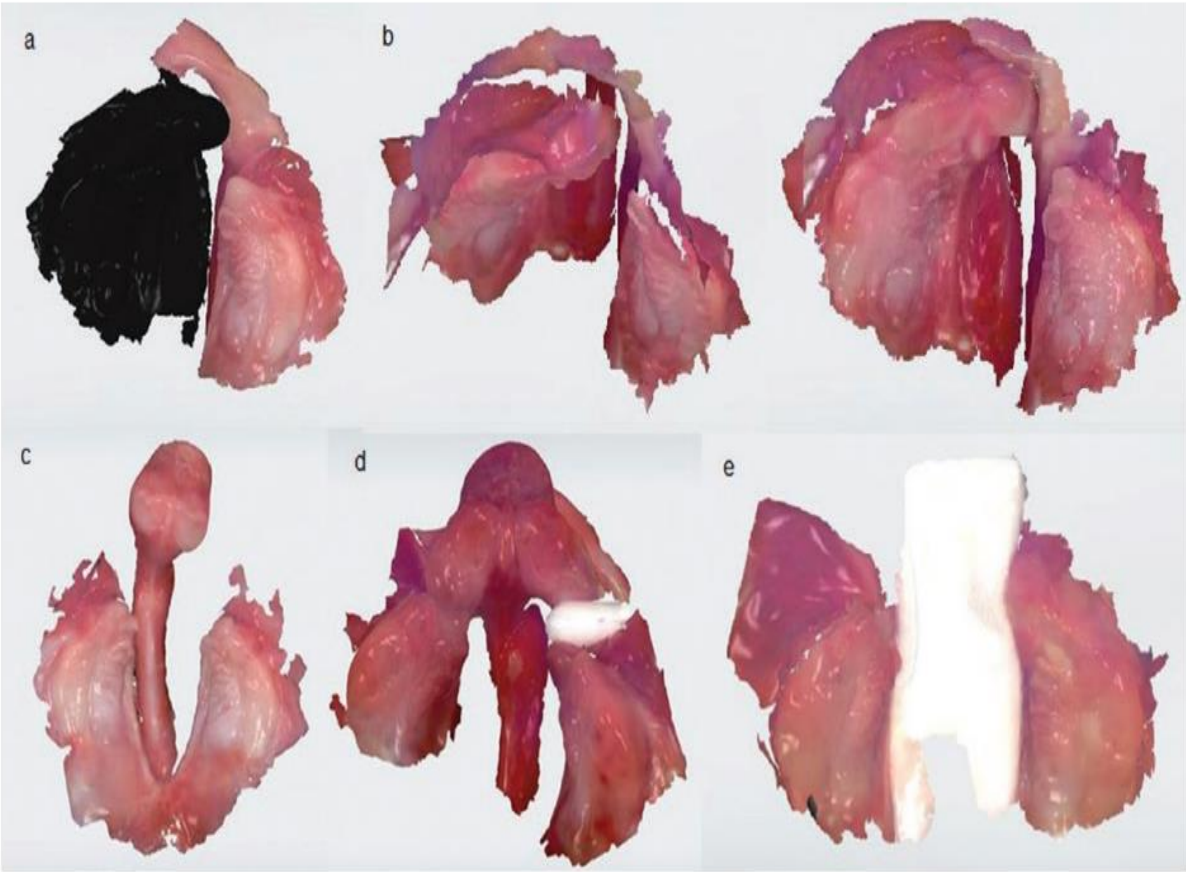

Figure 1.4 (a) Unsuccessful IOS without 'virtual bridge'. Automatically deleted part is depicted in black colour. (b) 'Virtual bridge' built over parts of the nose in a patient with a unilateral cleft. (c) 'Virtual bridge' built over parts in the posterior region of the palate in case of a bilateral cleft. A 'virtual bridge' is built using (d) cotton swab and (e) wound compress. IOS, intraoral scanning. (**Weise *et al.*, 2021).**

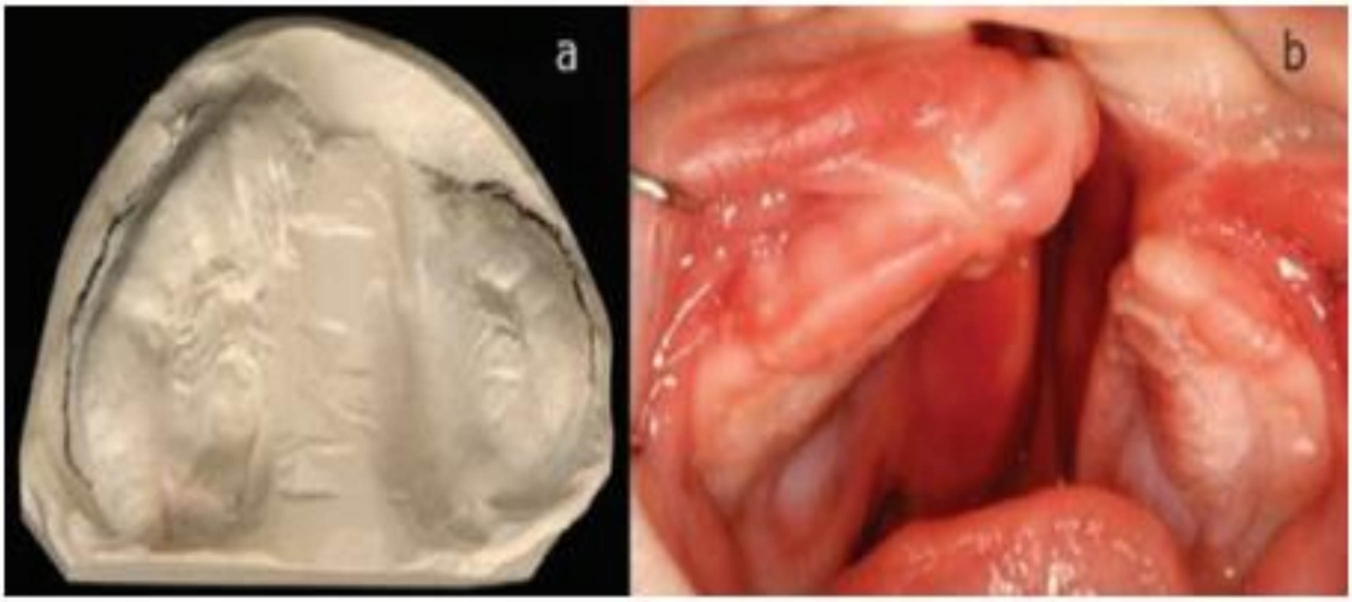

Figure 1.5 (a) Plaster cast model and (b) intraoral photo of the corresponding clinical situation. (Weise *et al.*, 2021).

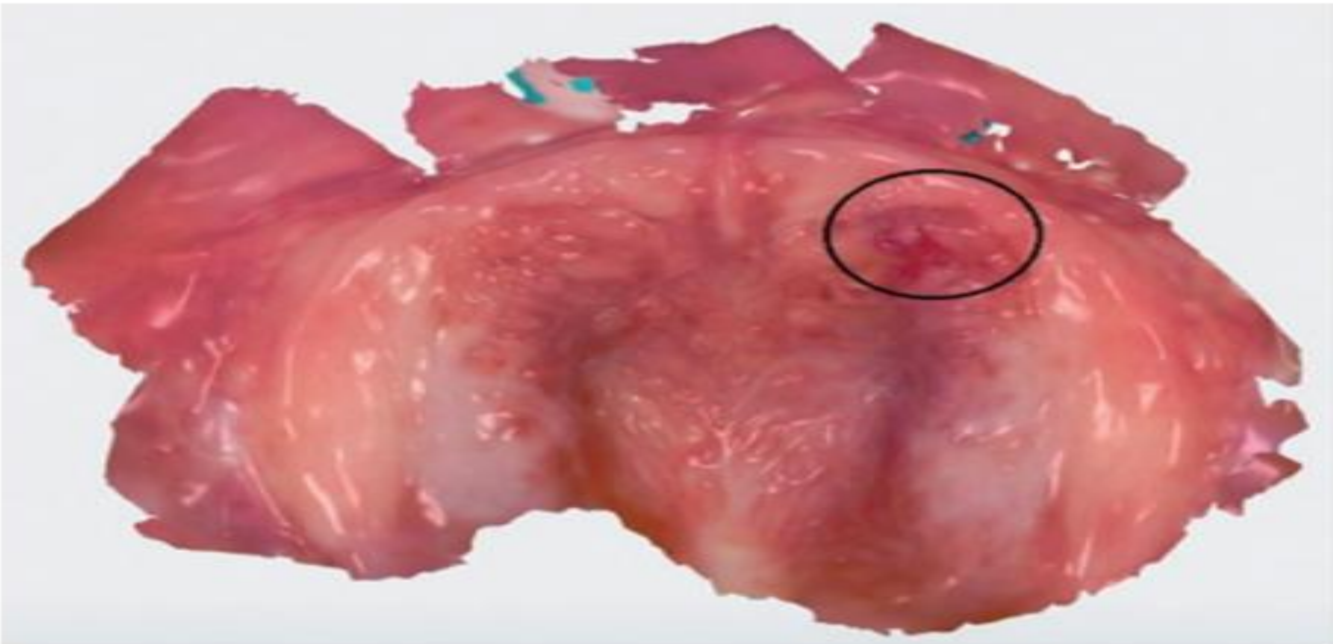

Figure 1.6 Minor gingival injury (Weise *et al.*, 2021).

1.9 Space Maintainers

Vij and Reddy., 2020 described the use of an intraoral scanner to make a digital impression for fabrication of a lower lingual holding arch space maintainer **(figure 8)**. This method reduced chair time with an uncooperative patient, could increase practice efficiency, and enhance patient comfort and compliance. Space maintainer fabrication remains a routine procedure for pediatric and general dentists. Space maintenance is typically recommended as an interceptive treatment to reduce complex orthodontic treatment at a later age **(Brothwell., 1997)**. Further, maintaining arch length becomes a concern with the loss of primary second molars, unilateral loss of primary canines, or the loss of first primary molars before the eruption of the permanent first molars. The most common method of obtaining an impression for a space maintainer, an alginate impression with subsequent dental stone model, has disadvantages offending to distort over time as water evaporates from or absorbs into the impression thereby causing inaccuracies in the impression and subsequent stone casts **(Nicholls., 1977; Powers *et al*., 2013)**. Behavioral issues of an apprehensive or uncooperative patient can be particularly problematic when the clinician is trying to make a conventional intraoral impression for appliance fabrication. In such cases, the use of digital intraoral impressions would eliminate the need for a conventional alginate impression. Since impressions are considered an unpleasant experience by some children, the switch to digital impression procedures may have a long-term positive impact on patient perceptions of dental procedures. In one study, measurements for orthodontic treatment planning were compared between dental stone and 3-dimensionally printed models **(figure 7)** no significant differences were found **(Dalstra and Melsen., 2009).** The current case report describes the use of an intraoral scanner to make a digital impression for fabrication of a lower lingual holding arch space maintainer.

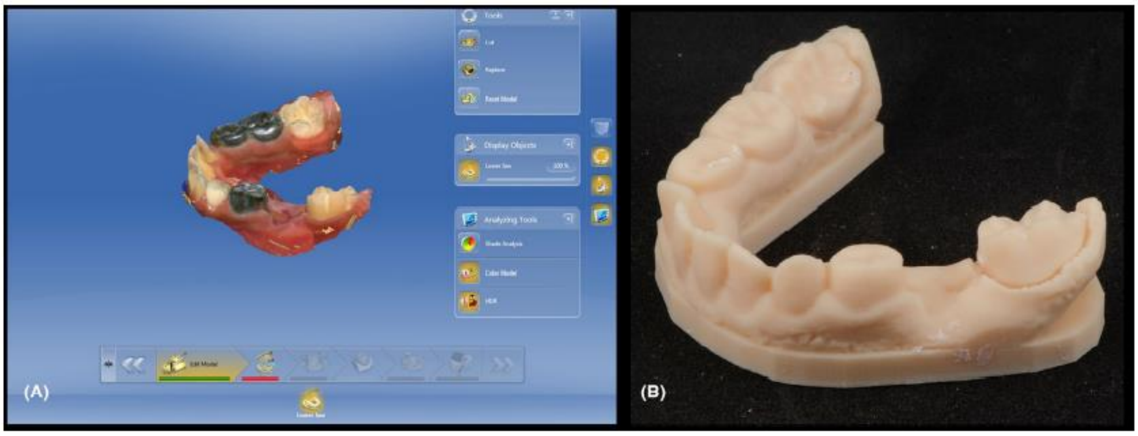

Figure 1.7 A, Lower full arch digital intraoral impression made using the Cerec Omnicam scanner B, 3-Dimensionally printed resin model of the patient's lower arch produced using the digital intraoral impression file (Vij and Reddy., 2020).

Digital impressions have the potential to increase efficiency, be more comfortable for the patient, and reduce long-term costs of the procedure. Digital impressions have been used routinely in other areas of dentistry and expanding their use to pediatric dentistry could be beneficial for both patient and provider. A study by **(Vasudavan *et al.*, 2010).** found that 77% of patients preferred intraoral scans over alginate impressions. Digital impressions were found to be more comfortable for patients, when evaluated by both patients and clinicians **(Yilmaz and Aydin., 2019**).

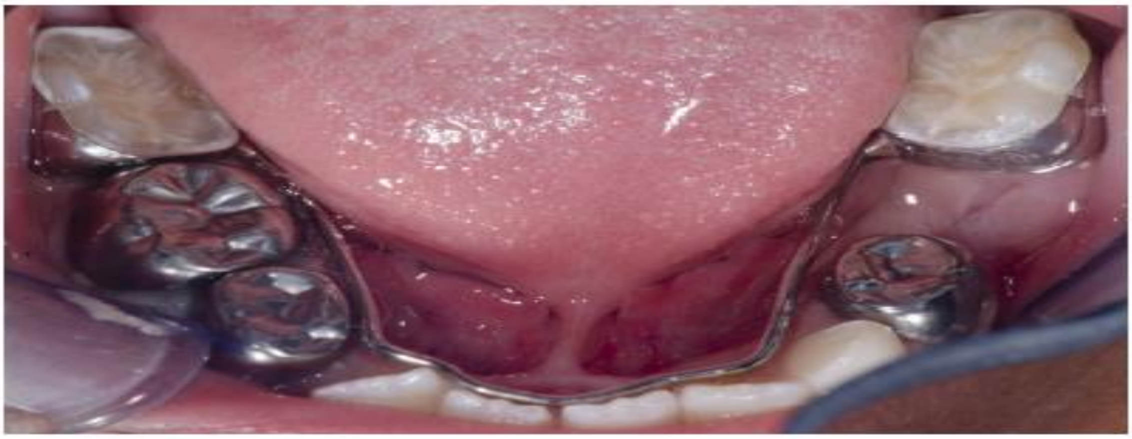

Figure 1.8 Intraoral image taken after the space maintainer appliance (Vij and Reddy., 2020).

The ability to fabricate everything from indirect-bonding setups to retainers and solderedband appliances from digital models may be the most exciting use of intraoral scanning. An acrylic appliance can be directly fabricated on a 3D-printed model as if it were a stone cast (Fig. 9). Banded appliances require no initial separation, although the palate may have to be captured, depending on the appliance design. At present, due to the possibility of melting a 3D-printed model, a soldered appliance requires the printed models to be duplicated in gypsum stone with the bands seated. In the near future, orthodontic labs will use milling machines to produce models out of a gypsum-like material that can be soldered.

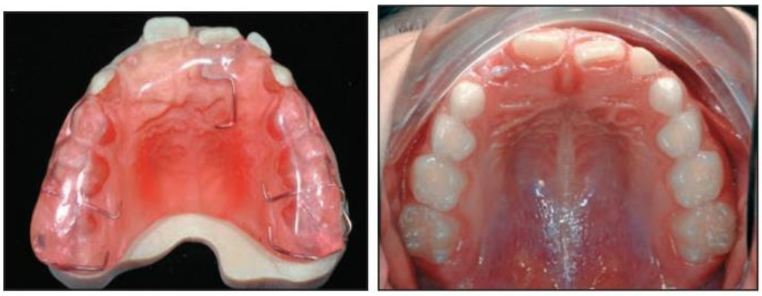

Figure 1.9 Acrylic plate made in office from digital scanner-generated STL file and 3D-printed model (Kravitz *et al.*, 2014).

CHAPTER TWO

Conclusion

CONCLUSION

Intraoral scanner new technology and effective in various fields of dentistry, such as prosthodontics , conservative dentistry and orthodontics . The comfort of impression methods and the time they require are important because it is known that children are more stressed in their encounter with the dentist than the elderly, and their chairside times are shorter.

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