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

Endodontic irrigation techniques

The College of Dentistry, University of Baghdad, Department of Conservative in Partial Fulfillment for the Bachelor of Esthetic and Restorative Dentistry

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2023 **1444**

Certification of the Supervisor

I certify that this project entitled "**Endodontic irrigation techniques** " was prepared by **Nabaa Fadel** under my Supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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May, 2023

Acknowledgment

My faithful thanks and all gratefulness to “Allah”, God of the world, Most

Gracious, Most Merciful for leading and helping me to perform this project.

Firstly, I would like to express my sincere gratitude to my supervisor

Assistant prof.Dr. Samar abdul Hamed for the continuous support and advice. Her guidance

helped me in all the time of research. Besides our supervisor.

My thanks to UOB college of dentistry. I’m feeling proud of being one of its

students. It's helped me to improve my educational level as well as improve my

skills.To the most precious thing in my life, my family ،the source of

inspiration, kindness and happiness. I am so lucky to have them..

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Aims of the study

The aims of this study were to outline the importance of irrigation in endodontics treatment And determine the solutions that were used in this procedure also advanced endodontics irrigation techniques, and the modern methods to manage them.

Introduction

Successful endodontic treatment depends on the complete removal of the remains of vital and necrotic pulp tissue, micro-organism and microbial toxins from the root canal **(Lee SJ,2004)**.The main goal of the endodontist is to remove the infected tissue and bacteria from the root canal which allows the healing of periapical lesion or to prevent the infection from periradicular tissue. So the irrigation of the root canal with antibacterial solution is an important step .The efficacy of irrigation depends on working mechanism of the irrigant and ability to bring the irrigant in contact with the element, material and structure .Sodium hypochlorite is effective disinfectant because it dissolves the organic tissue, it eliminates micro-organism, acts as an lubricant and non-toxic**(Haapasalo M, 2005)**.Root canal irrigation system is divided into two types, manual agitation techniques and machine assisted agitation devices. Manual agitation is positive pressure irrigation which performed by syringe and side vented needle. On the contrary, machine assisted techniques includes sonic and ultrasonic device as well as newer system like apical negative pressure irrigation and plastic rotary files (**Bahcall J,2007,Chopra S,2008)** . Syringe irrigation is commonly used by both the general dentist and endodontics, but this system has its own disadvantage **(Dutner J, 2012)**. We have advanced technology in irrigation to overcome the disadvantage in traditional system which includes the Endovac, Rinsendo . In this article we are going to review the recent advancements in endodontic irrigation system.

1. Endodontics irrigation solutions

1.1. Normal Saline

In endodontics, normal saline is one of the solutions used as an irrigant. It results in root canal debridement and lubrication. Because of its moderate activity, it may be used in conjunction with chemical irrigants . After root canal preparation, it may be used as a last rinse to flush out any leftover chemical irrigant. The most common saline solution is 0.9 percent W/V normal saline(**Nisha Garg, Amit Garg، 2010)**

1.2. Sodium HypoChlorite (NaOCL):

Sodium hypochlorite has been used as an Endodontic irrigant since 1920. NaOCL is the most popular and ideal irrigating solution as it covers most of requirements as endodontic irrigant but it is caustic to tissues and should be used with caution. During World War I, Chemist Henry Drysdale Dakin used 0.5% NaOCL solution to clean infected wounds (**Dakin H. D،1915)**. Various concentrations ranging from 0.5% to 5.25% have been tried out. Best regimen is reported with 5.25% for 40 minutes (**Siqueira, RocasI, Favieri,2000)** 1%-3% is ineffective against e fecalis at the same time (**Retamozo, Johnson N,2010)**. NaOCl is the most commonly used irrigant during endodontic therapy because of its tissue dissolving and antimicrobial properties.

Its germicidal ability is related to the formation of hypochlorous acid when in contact with bacteria and organic debris. It also has minimal "clinical toxicity" when kept within the confines of the canals. However, NaOCl is extremely toxic to the periapical tissues if it is injected beyond the apex of the tooth(**De-Deus G, Zehnder M, Reis C, Fidel RA,2008)** In a study conducted by Clegg et al in 2006, evaluated the effectiveness of 3 different concentrations of Naocl, 2%chx and biopure MTAD on apical dentin biofilms in vitro. He concluded that 6% Naocl was better irrigant compared to chx and MTAD when used alone. **(Ballal NV, KadianS, Mala K,**

Bhat. KS ,2009)In a study done by Zohreh et al in 2009, comparison between efficacies of MTAD, Naocl, chx was done. It was concluded MTAD was far better results comparing remaining irrigants.

The Naocl can be used with few agents like namely, for better efficacy and antibacterial activity:

- Calcium hydroxide,
- EDTAC, or
- Chlorhexidine.

1.3. Hydroxyethylidene Bisphosphonate (HEBP)

Known as etidronic acid or etidronate, is a decalcifying agent that Has little interaction with NaOCl. It has been proposed as an Alternative to EDTA or CA (**Zehnder et al.2005)**. HEBP prevents Bone resorption, and thus is used as a systemic drug in the Treatment of osteoporosis and Paget's disease (. **Russell et**

Al.1999). However, additional studies are needed to determine Whether this solution improves or shortens the duration of Endodontic irrigation. Demineralization with 9% or 18% HEBP is Slower than that with 17% EDTA **(De-Deus et al.2008)**

1.4.Chlorhexidinedigluconate (CHX):

CHX is a powerful antiseptic used commonly for the chemical control of plaque in the oral cavity. Whereas 0.1%–0.2% aqueous solutions are used as mouthwash, a 2% concentration is used for root canal irrigation in endodontic treatment. The antimicrobial activity of CHX depends on the achievement of an optimal pH (5.5–7) **(Siqueria JF,2007)**. CHX is bacteriostatic at lower concentrations and bactericidal at higher concentrations **(Jones C.G, 2000)**.CHX is active against Gram-positive and Gram-negative bacteria, bacterial spores, lipophilic viruses, yeast, fungi, and dermatophytes **(Denton GW,1991)**. As with other endodontic disinfectants, however, these effects are greatly reduced in the presence of organic matter, as the activity of CHX is dependent on pH. Although CHX kills bacteria, it is ineffective in removing biofilm and other organic substances **(Bui TB,2008)**. A 2% solution of CHX is appropriate to achieve the desired maximal antibacterial effect at the end of chemomechanical preparation. This solution is used commonly as an intra canal medicament with calcium hydroxide (Ca(OH)2) **(Russell AD,1993)**.One reason for the widespread use of CHX is its prolonged antibacterial effect; CHX binds to hard tissues and maintains its antimicrobial action. This effect is due to the number of CHX molecules interacting with dentin . White et al. reported that the effect of 2% CHX persisted for 72 h to 12 weeks . The main disadvantage of CHX is the lack of tissue solubility (**Gomes PFA , 2013)**.CHX is a broad-spectrum matrix metalloproteinase (MMP) inhibitor (anticollagenolytic effect). Attachment of CHX to the dentin surface increases resin infiltration into the dentinal tubules, thereby increasing the bond strength **(Gendron R,1999)**. The toxic potency of CHX depends on the size and structure of the region exposed to it. Although CHX does not cause long-term damage to host tissues, it can cause an inflammatory response if it is extruded from root canals or injected inadvertently **(Babich H,1995)**.CHX has several rarely occurring side effects, such as desquamative gingivitis, dental and oral pigmentation, and disgusting (bad-metallic taste in the mouth) (**Zamany A,2003)**. The heating of a low concentration CHX solution increases total antimicrobial efficacy while maintaining low systemic toxicity. CHX can be used in the disinfection of gutta percha. The addition of surface-active agents to a CHX product (CHX-Plus) reduces the surface tension, significantly increasing the activity against bacteria and biofilms. However, no study has examined complications that may arise when an irrigation solution with surfactant overflows from the periapical tissues in clinical practice **(Shen Y, 2009)**.QMix is an irrigation solution developed for use in the final root canal cleaning. A combination of CHX with an added surfactant and EDTA is used to increase penetration to the dentinal tubules (**Torabinejad M,2003)**

1.5. Ethylenediaminetetraacetic Acid (EDTA)

Tissue-dissolving irrigation solutions, both organic and inorganic, are essential for a comprehensive root canal cleanup. To remove the smear layer or other debris from the root canal system, NaOCl, which dissolves only organic tissue, should not be used. A supplementary solution of EDTA and other demineralizing agents should be administered during root canal therapy. Nygaart-Ostby in 1957 recommended the use of chlorinating chemicals for the production of hardened root canals. In the beginning, it was advised to use the 15% EDTA solution with a pH value of 7.3. The most common kind of EDTA solution is a neutralized solution with a concentration of 17%. Dentin calcium ions react with fluid to generate calcium chelates. When the chelator is missing, the process of decalcification halts. Calt and Serper in 2002 The ultrasonic application of 17% EDTA for 1 Min is very effective for removal of the smear layer, Demineralization of dentin was shown to increase with the amount of time spent in contact with it. Especially from The apical third of the root, and the continuous use of liquid EDTA During root canal treatment is recommended **(Kuah HG ET AL 2009**)

1.6. CITRIC ACID:

It can be used alone or in combination with EDTA. Concentrations ranging from 1-50 % have been used in endodontics to remove smear layer after root canal preparation. 10% citric acid removes smear layer and has anti-microbial action (**Yamaguchi M, Yoshida H, Suzuki R, Nakamura H,1996)**. Citric acid should not be used with sodium hypochlorite as it interacts with NaOCl and reduces the available chlorine making it ineffective against microorganisms. Poly acrylic acid and 7% malic acid may also be used to remove smear layer (**Ballal NV, KadianS, Mala K, Bhat. KS,2009)** . HEBP-1- Hydroxyethylidene 1, 1-bisphosphonate also known as Etidronate or etidronicacid has been suggested as an alternative to EDTA and citric acid, as it has short term reaction with NAOCL and is nontoxic to tissues. Studies have found that action of 18% of HEBP is comparatively much slower when compared with 17% EDTA (**De-Deus G, Zehnder M, Reis C, Fidel RA.2008).**

1.7 Mixture of Tetracycline Isomer, Acid, and Detergent (MTAD)

Torabinejad et al. introduced a combination Of 3% doxycycline, 4.25% CA, and detergent (Tween-80) as an alternative to EDTA with the aim Of improving smear layer removal. This mixture acts As a chelator and has antimicrobial activity. As it has No organic tissue-dissolving effect, its use after NaOCl at the end of chemomechanical preparation is Recommended (**Torabinejad M,2003)**

MTAD is a mixture of three substances Expected to affect bacteria synergistically (50). Its Bactericidal effect on E. faecalis biofilm is less than That of NaOCl solution at concentrations of 1%–6%. The CA in the MTAD solution enables smear layer Removal and allows doxycycline to enter the dentinal Tubules and exert antibacterial effects **(Torabinejad M‹2003)**. In a Canal filled with AH Plus and gutta percha, the use Of MTAD as a final irrigation solution significantly Reduces bond strength compared with the use of EDTA (**Hashem AA, 2009)**. When MTAD is used instead of EDTA, Resistance to tetracycline can develop in bacteria Isolated from root canals (**Dahlén G,2000)**.Generally, the use of antibiotics instead of Biocides, such as NaOCl and CHX, is not Recommended because antibiotics have been Developed for systemic use, rather than for local Wound healing, and they have a narrower spectrum Than do biocides (**McDonnell G,1999)**.

1.8 Tetraclean:

Like MTAD, Tetraclean (Ogna Laboratori Farmaceutici, Muggiò (Mi), Italy) is a mixture of CA,Doxycycline (at a lower concentration than MTAD), And detergent. The concentration of antibiotic (doxycycline-50 mg / ml) and the type of detergent (propylene glycol) differ from those in MTAD. Tetraclean does not dissolve organic tissue, and its Use after NaOCl at the end of chemomechanical Preparation is recommended **(Giardino L,2006).**Tetraclean exhibits high activity against Anaerobic and facultative anaerobic bacteria. Compared with MTAD, Tetraclean is more effective Against planktonic cultures of E. faecalis and in vitro Biofilms composed of mixed species (**Pappen FG,2010).**

1.9 Ozonated water:

Even at a low concentration (0.01 ppm) ,Ozone (O_3) can effectively kill bacteria, including Spores . It can be produced easily with an ozone Generator. Ozone dissolves easily and rapidly in Water (**Broadwater WT,1973).** In one study, the researchers compared The microbicidal activities of ozonated water and 2.5% NaOCl under sonic activation. They reported That ozonated water did not neutralize Escherichia Coli or lipopolysaccharides in root canals and that The amount of remaining lipopolysaccharides may Have biological effects, such as the induction of Apical periodontitis (**Huth KC, Quirling M,2009**). Before its routine Clinical use for root canal treatment, ozonated water Needs to be investigated further.

2. Function of irrigation

Irrigation is an important part of root canal treatment because it removes dentin shavings from canals. As a result, they do not become compacted near the root canal's apex. Due to the lack of lubrication in dry canals, instruments are unable to work properly. They become more efficient in wet canals. Devices are less likely to break when canal walls are greased by irrigation. They operate as a necrotic tissue solvent, releasing debris, pulp tissue, and germs from uneven dentinal walls when in contact with the substance. They assist in the clearance of debris from auxiliary and lateral channels where instruments are unable to reach. Although they may be antibacterial, the majority of them are germicidal, having a whitening impact on teeth discoloured by trauma or hefty silver restorations. The use of lubricating agents (RC prep, REDTAC, Glyde, etc.) together with irrigants in the canal makes instrumentation simpler and smoother, but the lubricant alone does not make instrumentation easier or smoother (**Nisha Garg, Amit Garg، 2010)**

3. Factors influencing intracanal irrigant activity

1- The tissue dissolving power of NaOCl is higher at 5.2% than at 2.5% and 0.5%, and therefore, the higher the concentration, the greater the effectiveness(**Nisha Garg, Amit Garg ،2010) .**
2- Touch: To be effective, the irrigant must contact the substrate. The presence of organic tissue must be removed for irrigation to be successful.
3- Quantity of irrigant utilized: The more irrigant is used, the more effective it is.
4- Irrigating needle gauge: 27 or 28 gauge is used for improved canal penetration.
5- Irrigant's surface tension: The lower the surface tension, the better the wettability.
6- Irrigant's temperature: Warming the NaOCl boosts its efficacy.
7- Irrigation frequency: The higher the frequency, the better the outcomes.
8- Canal diameter: The wider the canal, the better the irrigant's effect.
9- Irrigant's age: Newly produced solutions are more efficient than older solutions.

4.needle-tip size and designs

Although 25-gauge needles were common for endodontic irrigation a few years ago, they were replaced by 27-G needles, 30-G and even 31-G needles are taking over for routine use in irrigation .As 27 G corresponds to International Standards Organization size 0.42 and 30 G to size 0.31, smaller needle sizes are preferred. Several studies have shown that the irrigant has only a limited effect beyond the tip of the needle because of the dead-water zone or sometimes air bubbles in the apical root canal, which prevent apical penetration of the solution. However, although the smaller needles allow delivery of the irrigant close to the apex, this is not without safety concerns. Several modifications of the needle design have been introduced to fulfit the ideal properties of needles (should be 1.blunt. 2.allow back-flow. 3.flexible. 4.Longer in length. 5. Easily available. 6. Cost-effective.) **(Haapasalo et al.2010)**

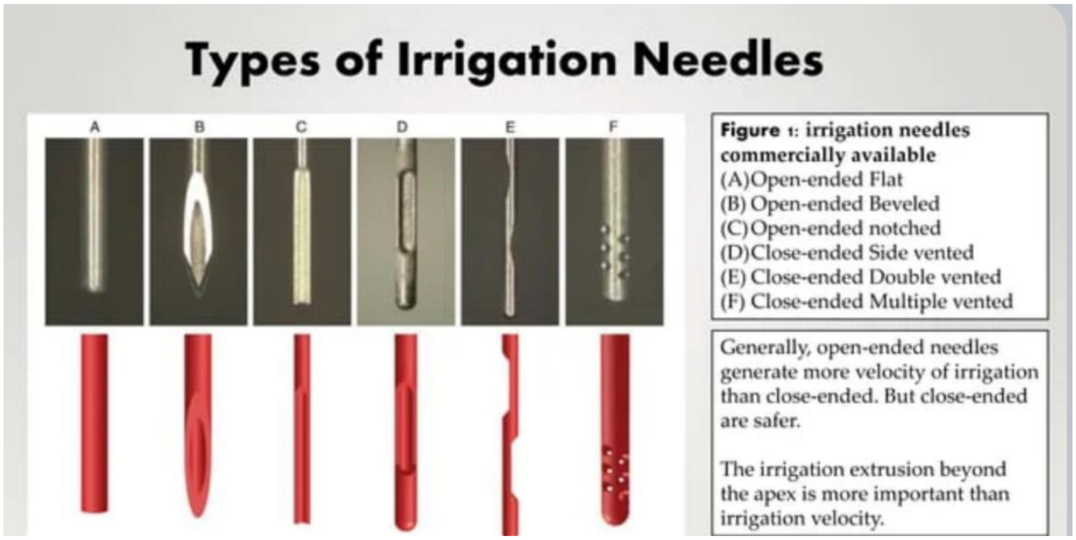


Fig.No.1: Types of irrigation needles

4.1 Management of Separated Irrigating Needle within Root Canal:

The endodontic treatment depends upon the quality of the Cleaning and shaping of the root canals. Syringe irrigation remains A widely used irrigant delivery method. Different irrigation needles With different gauges have been used during root canal treatment. However, the effectiveness varies with the type of the needle. This Is due to the ability of the needles to reach the apical third and Deliver the solution to the full working length (WL) of the root canal.(**Kahn FH, 1995)** Over the years, several types of needles have been used to Deliver irrigants into the root canals.**(Boutsioukis C,2009)**These needles mainly differ In the presence of an open or closed tip and one or more outlets. In the past, large needles (21–25G) were commonly employed for Irrigant delivery.(**Teplitsky PE,1987)** Such needles could hardly penetrate beyond The coronal third of the root canal, even in wide root canals. More Recently, the use of finer diameter needles (28G, 30G, or 31G) has Been advocated, mainly because they can reach farther into the Canal, even to WL.(**Bronnec F,2010)** Periapical extrusion of irrigating solution has been one of the Disadvantages described with the use of needle irrigation.(**Zairi A,2008)** For this Reason, irrigation needles with a side opening have been developed To minimize the risk of extrusion and tissue damage.**(Vinothkumar TS,2007)**Studies have Reported that side-vented closed-end needles were more efficient Than conventional needles in the removal of debris from the root Canal. Extreme pressure during irrigation or binding of the irrigation Needle tip in the root canal may predispose the irrigating needle to Fracture within the canal especially for a side-vented needle. Also, The hollow design of irrigating needles makes them easy to fracture.During irrigation of the root canal, the risk of fracture of the Needle may occur due to the geometrical configuration of the Needle. The presence of a fractured segment can affect the proper Disinfection and obturation of the root canal system (RCS). This can, In turn, affect the long-term prognosis of the tooth. Strindberg Reported a 19% reduction in the rate of healing of apical tissues When separated instruments were present(**Strindberg L, 1956)** **.**

5. Irrigation techniques

RECENT ADVANCES IN IRRIGATION AGITATION TECHNIQUES AND DEVICES

CLASSIFICATION

(Adapted from Li Sha Gu, Review of Contemporary Irrigant Agitation Techniques and Devices. J Endod. 35:791–804,2009.)

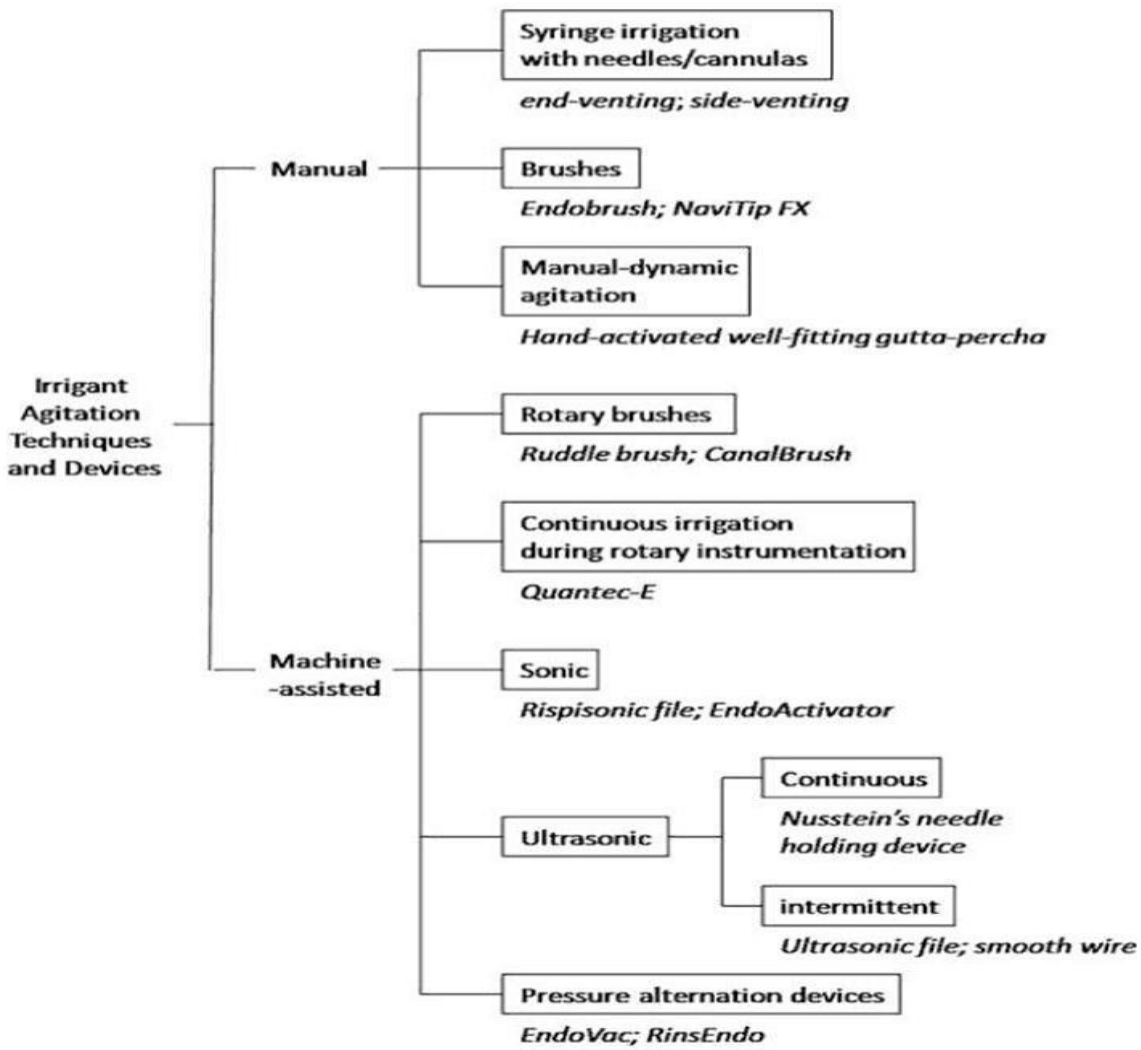


Figure.No.2: irrigation techniques

5.1. MANUAL AGITATION TECHNIQUES

The simplest of all Mechanical activation techniques is the Manual irrigant agitation, which can be Performed with different systems. The Easiest way to achieve this effect is moving Vertically and passively the endodontic file within the root canal. The file promotes the irrigant penetration (**Bronnec F, Bouillaguet S,2010)** and reduces the presence of air bubbles in the canal space(**Vera J, Arias A,2012**),but does not improve the final cleaning.(**Paragliola R, 2010)**

5.1.1.SYRINGE IRRIGATION WITH NEEDLES/CANNULAS:

The technique involves dispensing of an irrigant into a canal through needles/cannulas of variable gauges, either passively or with agitation. The latter is achieved by moving the needle up and down the canal space. Irrigation tip gauge and tip design can have a significant impact on the irrigation flow pattern, flow velocity, depth of penetration, and pressure on the walls and apex of the canal.

Irrigation tip gauge will largely determine how deep an irrigant can penetrate into the canal. A 21-gauge tip can reach the apex of an ISO size 80 canal, a 23-gauge tip can reach a size 50, a 25-gauge tip can reach a size 35 canal, and a 30-gauge tip can reach the apex of a size 25 canal. 27 gauge needle is the preferred needle tip size for routine endodontic procedures (**Boutsioukis C,2010)**,Open-ended tips express irrigant out the end toward the apex and consequently increase the apical pressure within the canal. Closed-ended irrigant tips are side-vented and thus create more pressure on the walls of the root canal and improve the hydrodynamic activation of an irrigant and reduce the chance of apical extrusion**.(Sedgley CM)**

Fig.No.3 Syringe Irrigation (Needles/Cannulas*)*

5.1.2.ROTARY BRUSHES:

Brushes are Not directly used for delivering an irrigant Into the canal spaces. They are adjuncts that Have been designed for debridement of the Canal walls or agitation of root canal Irrigant. They might also be indirectly Involved with the transfer of irrigants Within the canal spaces. Recently, a 30-Gauge irrigation needle covered with a Brush (NaviTip FX; Ultradent Products Inc., South Jordan, UT) was introduced Commercially. NaviTip Fx is a 30-gauge irrigation needle covered with a brush was Introduced commercially by Ultradent LCompany,(**Markus Haapasalo,2010,Migun NP,1996)** The Endobrush could not be Used to full working length because of its size, which might lead to packing of debris Into the apical section of the canal after Brushing (**Keir DM, Senia ES,1990**).

(Fig.No.4 NaviTip FX). (Fig.No.5 NaviTip)

5.1.3.MANUAL DYNAMIC AGITATION:

An irrigant must be In direct contact with the canal walls for Effective action. Its often difficult for the Irrigant to reach the apical portion of the Canal because of the so-called vapor lock Effect (entails the formation of an air or gas bubble inside a close-ended system. The bubbles prevent the action of the irrigants and osmosis. The canal region located beyond the bubble then cannot be reached, usually at the apical third) (**Pesse AV,2005,Schoeffel GJ,2008**). The gently moving well-fitting Gutta-percha master cone up and down in Short 2 to 3 mm strokes (manualdynamic Irrigation) within an instrumented canal can Produce an effective hydrodynamic effect And significantly improve the displacement And exchange of any given reagent(**Ruddle CJ,2001)**.

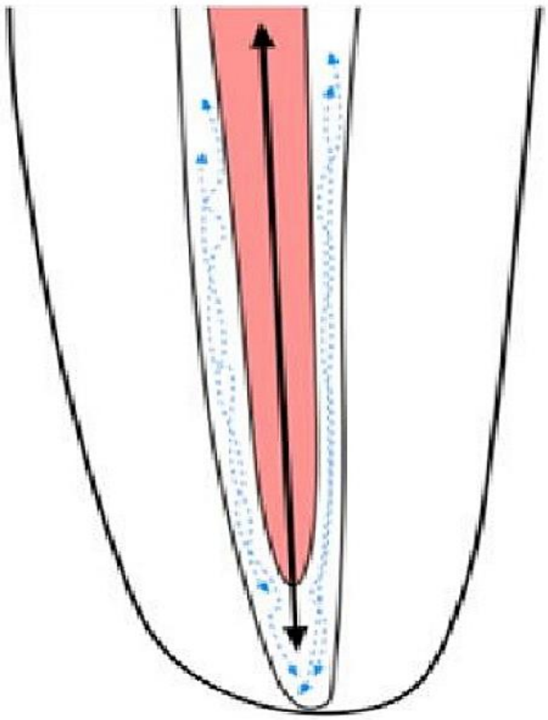
5.1.3.1 Following are the factors affecting manual Dynamic irrigation:

1-The push-pull motion of a well fitting Gutta-percha point in the canal might Generate higher intra canal pressure changes During pushing movements, leading to More effective delivery of irrigant to the "untouched" canal surfaces;

2-The frequency of push-pull motion of The gutta-percha point (3.3 Hz, 100 strokes

Per 30 seconds) is higher than the frequency (1.6 Hz) of positive-negative Hydrodynamic pressure generated by RinsEndo, possibly generating more Turbulence in the canal; and

3-The push-pull motion of the guttapercha point probably acts by physically Displacing, folding, and cutting of fluid Under ‘‘viscouslydominated flow’’ in the Root canal system. The latter probably Allows better mixing of the fresh unreacted



<u>Fig.No. 6:manual dynamic agitation</u>

Solution with the spent, reacted irrigant **(Ruddle CJ,2001)**Many devices used for agitation of root Canal irrigants that are commercially Available.

<u>5.2. MACHINE ASSISTED AGITATION TECHNIQUE</u>:

1-The evolution of th**e** Manual systems led to the introduction of Instruments that may be rotated by Handpieces at low speed inside the canal fill With irrigant. Instruments such as plastic Files can show a smooth surface and Increased taper , or even a surface with Lateral plastic extensions (**Al-Ali M,2012,Garip Y,2010)**

5.2.1.ROTARY BRUSHES:

Ruddle brush and canal brush Come under this. A rotary handpiece-attached microbrush Has been used by ruddle to facilitate debris And smear layer removal from instrumented Root canal.The brush includes a shaft or Shank and a tapered brush section. During Debridement phase, microbrush rotates at About 300 rpm. These brushes are not Straightly used for delivering an irrigant into the canal spaces. They are adjuncts that Has been planned for agitation of root canal Irrigation.

Fig.No.7:Rotary brush

2-Canal Brush is another endodontic Microbrush that has recently been made Commercially available. This highly Flexible microbrush is molded entirely from Polypropylene and might be used manually With a rotary action. Weise et al., showed That debris was effectively removed from Simulated canal extensions and Irregularities with the use of the small and Flexible Canal Brush with an irrigant **(Tronstad L ,1985)**

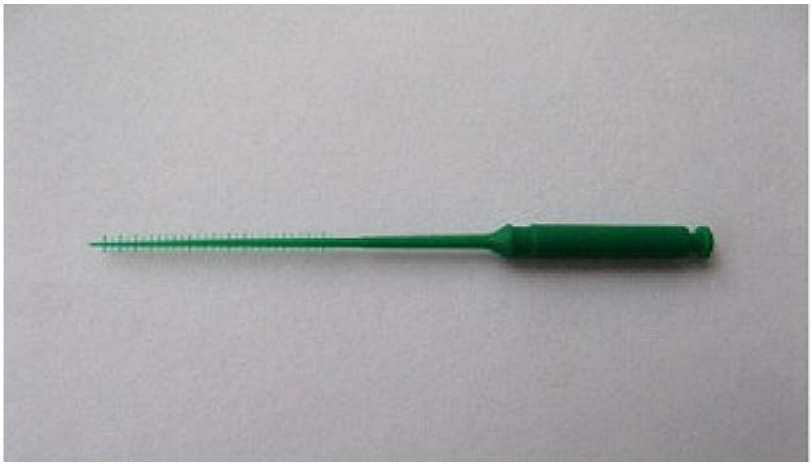


Fig.No.8: endodontic Microbrush

5.2.2.CONTINUOUS IRRIGATION DURING ROTARY IRRIGATION:

***5.2.2.1.The Quantec-E irrigation System*:**

(Sybron Endo, Orange, CA) is a self Contained fluid delivery unit which is Attached to the Quantec-E Endo System . It Consist of a pump console, two irrigation Reservoirs, and tubing which provide

Continuous irrigation during rotary Instrumentation (.**Pasricha SK,2015)**

Continuous irrigant Agitation during active rotary Instrumentation would result in

Fig.No. 9:The Quantec-E irrigation System

generation of an increased volume of irrigant, increase Irrigant contact time, and facilitate greater Depth of irrigant penetration inside the root Canal. This should result in more effective Canal debridement in comparision with Syringe needle irrigation. Studies Conducted by Setlock et al and Walters et al Concluded that Quantec – E irrigation did Result in cleaner canal walls and more Complete debris and smear layer removal in The coronal third of the canal walls (**Walters MJ,2002).**

5.2.2.2.The Self adjusting file(SAF) system:

Is a shaping and cleaning system designed for minimally invasive endodontic Treatment. It is operated with the specific handpiece head (RDT ,ReDent) and an Irrigation pump(VATEA pump) that allows Continuous flow of irrigant through the Hollow file .It is available in two Diameter:1.5-2.0. Both are extremely Compressible. The 0.5mm file compressed To the dimension of 20 K file and 2.0mm

File compressed to the dimension of 35 K File (**Metzger Z,2011).**

<u>Fig.No. 10:The Self adjusting file(SAF)</u> system

<u>5.2.3. SONIC IRRIGATION:</u>

Sonic instruments Was introduced by Tronstad et al in 1985. It Works in lower frequency (1–6 kHz) and Produces smaller shear stresses than Ultrasonic irrigation. with the sonic units, you can hear the actual sounds produced by the unit. There are several Sonic irrigation devices on the market(**Ahmad M, 1987)** Vibringe system is the first endodontic Sonic irrigation system that permits the Delivery and activation of the irrigation Solution in the root canal. The activation of The disinfectant by acoustic streaming Enhances and completes the irrigation Procedure and upgrade the success rate of Endodontic treatments. It improves the Debridement and disrupts the smear Layer (**Walters MJ, 2002)**.It has better irrigation then the Syringe irrigation in removing the debris From the apical two third of the Rootcanal (**Elumalai1 D, 2014)**.

Fig No. 11: Sonic device(Micromega Sonic Air 1500 handpiece)

5.2.3.1.Endo activator

is a mechanical system Which consist of hand piece and various Polymer tips .These tips are strong and Flexible and donot break easily.They are Smooth and they don't cut the dentin. It Removes the smear layer, debride the Uninstrumented portion of the root canal System, and disloge the biofilm within Long, narrow, and highly curved canal of Molar teeth. It provides 10,000 cpm per Minute **(Ruddle CJ,2008 ,Kanter V, 2011 ,Caron 2010)**

Fig.No.12: Endo activator

5.2.4. ULTRASONIC IRRIGATION:

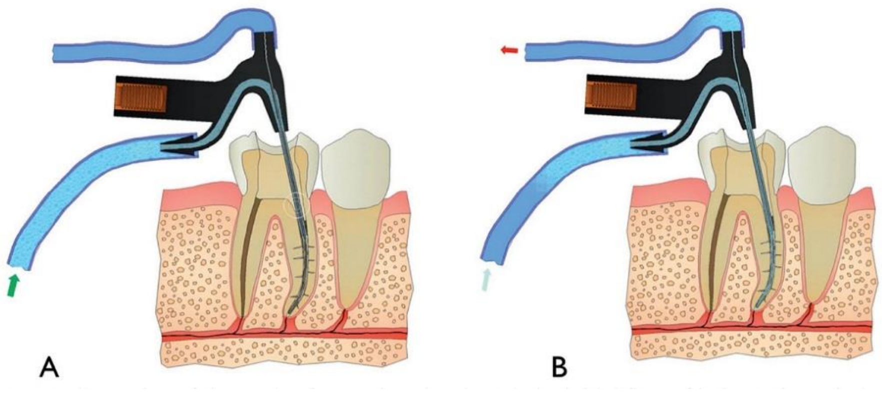
Ultrasonic energy Produces higher frequencies than sonic Energy but has low amplitudes, oscillating At frequencies of 25- 30 kHz (**Gu LS, 2009,Walmsley AD ,1989).** Most of the literature advises that ultrasonic devices are more powerful than sonic ones. Ultrasonic irrigation exhibits better canal debridement efficacy over the use of needle irrigation alone. ultrasonic irrigation presents some drawbacks; when the oscillating tip touches the root canal wall, for example, it dampens the energy and constrains the file movement, and file-to-wall contact occurs approximately 20% of the time. Moreover, ultrasonic files are made of metal alloy, therefore, when they touch the root canal wall, this may cause uncontrolled removal of dentin, deforming the root canal morphology.

Whereas with the ultrasonic units, the sounds are not audible to human hearing**.Two Types** of ultrasonic irrigation are present one Is simultaneous ultrasonic instrumentation And irrigation (UI) and the another one is Passive ultrasonic irrigation (PUI), operates Without simultaneous instrumentation(**Cunningham WT, 1982).**

5.2.4.1.CONTINUOUS ULTRASONIC IRRIGATION:

Nusstein Introduced a needle-holding adapter to an Ultrasonic handpiece. During ultrasonic Activation, a 25-gauge irrigation needle is Used instead of an endosonic file. This Enables ultrasonic activation to be Performed at the maximum power setting Without causing needle breakage . In this Needle is activated simultaneously by the Ultrasonic handpiece, while an irrigant is Carried out from intravenous tubing Connected via a Luer-lok to an irrigation delivering syringe.

Irrigant is delivered in Apical one third by continuous flow(**Gutarts R ,2005, Burleson A,2007).**



<u>Fig No.13:Illustration of the mode of operation showing A) the initial flow of irrigant through the Device, and B) simultaneous flow and aspiration of the irrigant.</u>

<u>5.2.4.2. PASSIVE ULTRASONIC IRRIGATION:</u>

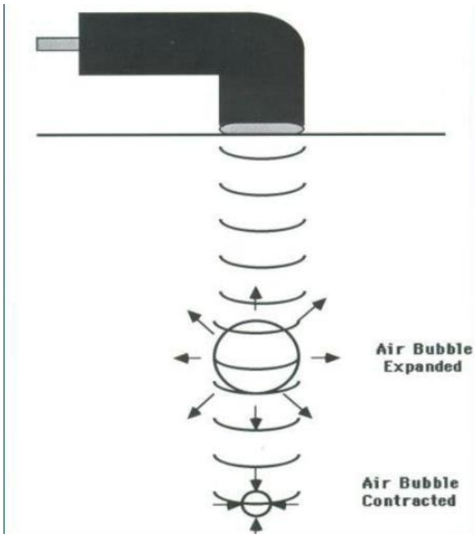
The Term passive ultrasonic irrigation was given By Weller et al in the year 1980**(Weller RN,1980)**. It is a non Cutting technology which reduces creating Abnormal shapes in root canal system. During PUI, energy is transmitted from a file or Smooth oscillating wire to the irrigant by Means of ultrasonic waves that induce two Physical phenomena: stream and cavitation Of the irrigant solution. The acoustic stream Can be defined as a rapid movement of the Fluid in a circular or vortex shape around The vibrating file. Cavitation is defined as The creation of steam bubbles or the Expansion, contraction and/or distortion of pre-existing bubbles in a liquid**(van der Sluis LW,2007)**.The main Goal of this treatment is to remove the pulp Tissues ,dentinal debris,smear layer and Bacteria from the root canal.

Fig.No.14 :Depiction of the waves generated around the vibrating ultrasonic file

5.2.5 Sonic and Ultrasonic Irrigation Devices

The term "sonic" refers to sound waves in the region of 16 Hz up to 20 kHz, whereas ultrasonic waves range from 20 kHz to 1 GHz. Over 50 years ago, Richman (1957) first described the use of ultrasonic technology in endodontic treatment and root tip resection. Almost 20 years elapsed before the use of ultrasonic technology was again pursued **(Martin, 1976)**. Thereafter, numerous scientific publications appeared (**Hülsmann, 2000; Haapasalo et al., 2005)** indicating the possibilities and potential significance of sonic and ultrasonic devices in endodontology. These are based on three mechanisms of action:

- cavitation;
- production of heat;
- acoustic microstreaming.



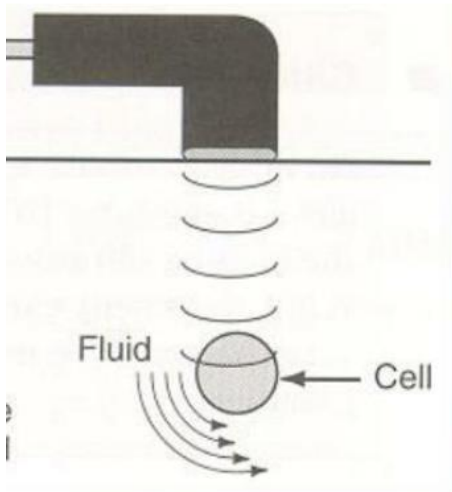


Fig No15: Cavitation.   Fig No 16:Acoustic microstreaming

Most of the research of the past 30 years has been targeted toward the use of sonic and ultrasonic devices as replacements for, or enhancement of, traditional, manual root canal instrumentation, and synergistic action with irrigating solutions. The past decade brought a total paradigm shift: Today, the primary areas of use include disengaging and loosening of intra canal obstructions, endodontic retreatment, and retrograde treatment approaches. The three mechanisms of action of ultrasonic devices have been evaluated time and again with varying results, but in principle they are generally recognized as being effective **(van der Sluis, 2006).**An ultrasonic generator (usually piezoelectric) causes the files to oscillate with an undulating wave pattern with a series of nodes and antinodes along its length. The continuous waves help in the removal of dentin chips and debris; the action is strongest at the tip where the amplitude of the oscillations is the largest **(Ahmad et al., 1992)**. Ultrasonic waves in the presence of liquids results in massive oscillation with regions of high and low pressure. This phenomenon is known as *cavitation*. The result includes bubble formation within the liquid, as well as turbulent fluid currents. The microbubbles created may be empty, or may contain gas or vapor. With the use of sodium hypochlorite, it is possible to achieve a warming effect above the boiling point of 40°C, which leads to the formation of the Na+ cation, the hypochlorite anion ClO, as well as the formation of NaOH, ClOH, C12, O, or NaCl **(van der Sluis et al., 2006)**. These highly reactive elements may be the reason for the observation that the antibacterial effect of ultrasound in the presence of water is relatively weak **(Ahmad et al., 1990)**, but is much stronger with typical endodontic irrigating solutions, providing a large antibacterial effect **(Cameron, 1987; Huque et al., 1998)**. With the application of high acoustic pressure, the microbubbles enlarge until they eventually implode, creating strong local pressure waves as well as a rise in temperature (*heat*). This physical principle is also exploited in devices such as the urolithotripter, which is used for the destruction of gallstones or kidney stones. In comparison, the instruments designed for use in the dental practice are too weak to create large cavitation effects. For this reason, the effect has been considered by numerous authors as too mild and thus ineffective **(Ahmad et al., 1987b, 1988; Walmsley 1987; Lumley et al., 1988)**.Most important and effective is the third mechanism of action: acoustic microstreaming. Within the sonic field, there is an interaction between the sonic file oscillations and the irrigating solution, which leads to motion within the fluid, the so-called "eddy current." This current flows from the coronal end of the root canal toward the apical area and exhibits the typical nodes and antinodes; it is strongest at the tip **(van der Sluis, 2006)**. Due to the higher level of energy, the eddy currents that are created elicit hydrodynamic shear stresses, which have been demonstrated in many studies **(Ahmad et al., 1987a, b, 1992; Lumley et al., 1991; Walmsley et al., 1992, Roy et al., 1994)**. Contact of the sonic or ultrasonic probe with the internal surface of the root canal reduces acoustic microstreaming by interrupting the continuous motion of the wave, but does not eliminate it completely.Sonic devices operate at 1500–6000 Hz. Included in this category, are, for example, Endostar (Syntex, USA), Megasonic 1400 (Mega-sonic, USA), and Sonic Air MM 1500 (MICRO-MEGA, France). Special instruments are required (e.g., heli-, rispi-, shaper-, or triosonic files), some of which resemble traditional rasps. The Shaper-Sonic files in particular permit rapid removal of dentin remnants and debris; this is due to the design of the instruments, but also because sonic devices are much better at removing hard substances than ultrasonic devices **(Miserendino et al., 1988)**.In general, files of smaller diameter are more effective. The higher amplitude of motion at the file tip is advantageous in comparison with ultrasonics, but is counteracted by the fact that the degree of dentin transport is more difficult to control and there is some loss of tactile sensitivity.In addition, instrument fractures and complications such as step formation, loss of working length, etc., occur less frequently with sonic than with ultrasonic devices. There remains some controversy concerning effect on canal shaping and roughness due to the file design **(Loushine et al., 1989)**. For these reasons, sonic systems have not been widely accepted for use in endodontic practice.

***5.2.6. PRESSURE ALTERATION DEVICES*:**

There are apparently dilemmatic phenomena associated with conventional syringe needle delivery of irrigants. It is desirable for the irrigants to be in direct contact with canal walls for effective debris debridement and smear layer removal. Its difficult to reach the apical portion of the canal due to air entrapment (**Senia ES, 1971)** when the needle is placed away from the canal. If the needle is placed so close to the apical formen increased chance of irrigant extrusion from the foramen causes iatrogenic damage to the periapical tissues. Concomitant irrigant delivery and aspiration through the use of pressure alternation devices provide a Plausible solution to this problem (**Hu¨lsmann M , 2000)**

5.2.6.1.ENDOVAC SYSTEM:

Endo Vac apical negative pressure irrigation was given by Discus Dental Company. It uses suction technique which wash out the debris and encourage the flow of irrigation in apical two third of the canal. It has three components: **The Master Delivery Tip, Macro Cannula and Micro Cannula.** The Master Delivery Tip simultaneously delivers and evacuates the irrigant. The is used to suction irrigant from the chamber to the coronal and middle segments of the canal. The MacroCannula or MicroCannula is connected via tubing to the high-speed suction of a dental unit. The Master Delivery Tip is connected to a syringe of irrigant and the evacuation hood is connected via tubing to the highspeed suction of a dental unit .The plastic macrocannula has a size 55 open end with a **.**02 taper and is attached to a titaniumhandle for gross, initial flushing of the coronal part of the root canal. The size 32 stainless steel microcannula has 4 sets of 3 laser-cut, laterally positioned, offset holes adjacent to its closed end. This is attached to a titanium finger-piece for irrigation of the apical part of the canal by positioning it at the working length. The micro-cannula can be used in canals that are enlarged to size 35 or larger. During irrigation, the delivery/evacuation tip delivers irrigant to the pulp chamber and siphons off the excess irrigant to prevent overflow. The cannula in the canal simultaneously exerts negative pressure that pulls irrigan tfrom its fresh supply in the chamber, down the canal to the tip of the cannula, into the cannula, and out through the suction hose. Thus, a constant flow of fresh irrigant is being delivered by negative pressure to working length. Endo vac has the ability to safely deliver the irrigants to working length without causing extrusion into the peri apical region(**Shin SJ, 2010,Nielsen BA,2007)**

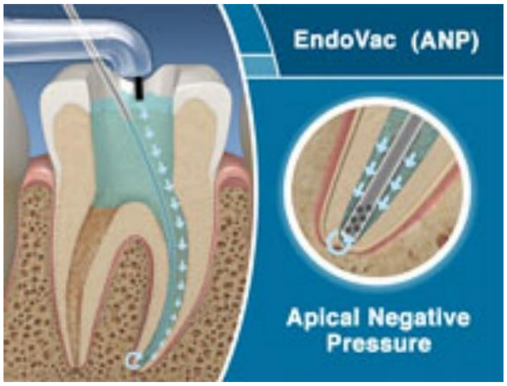


Fig. No.17 :ENDOVAC SYSTEM

5.2.6.2. RINS ENDO SYSTEM:

Rins Endo was introduced by Durr Dental Co.its based on pressure suction technology with aproximately 100 cycles per minute(**Hauser V, 2007)**.Its components are a handpiece, a cannula with a 7 mm exit aperture, and a syringe carrying irrigant. The handpiece is powered by a dental air compressor and has an irrigation speed of 6.2 ml/min. With this system, 65 mL of a rinsing solution oscillating at a frequency of 1.6 Hz is drawn from an attached syringe and transported to the root canal through an adapted cannula. During the suction phase, the used solution and air are extracted from the root canal and automatically merged with a fresh rinsing solution. The pressure-suction cycles change approximately 100 times per minute. The manufacturer of Rins Endo claims that the apical third of the canal might be effectively rinsed, with the cannula restricted to the coronal third of the root canal because of the pulsating nature of the fluid flow. McGill et al. evaluated the effectiveness of Rinse Endo system in a split tooth model. They found to be less effective in removing the stained collagen from root canal walls when compared with manual dynamic irrigation by hand agitation of the instrumented canals with well-fitting gutta percha points(**Wiggins S, Ottino JM.2004).**

Fig.No.18:RINS ENDO SYSTEM

5.2.7.PHOTO ACTIVATED DISINFECTION:

Photo activated disinfection (PAD) in endodontic irrigation has been introduced in order to minimize or eliminate residual bacteria in the root canal. PAD technique employs a non-toxic dye, termed a photosensitizer (PS), and low intensity visible light which, in the presence of oxygen, combine to produce cytotoxic species. The principle on which it operates is that PS molecules attach to the membrane of the bacteria. Irradiation with light at a specific wavelength matched to the peak absorption of the PS leads to the production of singlet oxygen, which causes the bacterial cell wall to rupture, killing the bacteria.PAD is also effective against viruses ,fungi and protozoa(**Burns T,1993, Bonsor SJ, 2006)**. The PS is a watery solution of toluidine blue O (TBO) that attaches to the membranes of microorganisms and binds itself to their surface, absorbs energy from the light and then releases this energy to oxygen (O2), which is transformed into highly reactive oxygen species (ROS), such as oxygen ions and radicals (**Schlafer S, 2010).**

Fig .No 19 :PHOTO ACTIVATED DISINFECTION

5.2.8.OZONE BASED DELIVERY SYSTEM:

Ozone is a triatomic Molecule consisting of three oxygen atoms. It is applied to oral tissues in the forms of Ozonated water, ozonated olive oil and Oxygen/ozone gas. It is unstable and Dissociates readily back into oxygen (O_2), Thus liberating so-called

Fig.No.20 :OZONE BASED DELIVERY SYSTEM

singlet oxygen (O_1), which is a strong oxidizing agent Which further impose the deleterious effect On microorganisms. Various delivery Systems available for endodontic irrigation Like Neo Ozone Water-S unit, HealOzone (Kavo) unit, the OzoTop unit. Nagayoshi et Al.found that ozonated water (0.5–4 mg/L) Was highly effective in killing both gram Positive and negative micro-organisms (**Nagayoshi M, 2004).**

5.2.9.LASER:

Lasers have been Recently proposed to activate irrigation Solutions by the transfer of pulsed Energy(**Blanken J, 2009,Matsumoto H, 2011)**. Laser-activated irrigation by Er:YAG and Er,Cr:YSGG laser light has Been suggested to be more effective in Removing dentin debris and smear layer.The use of laser is to enhance

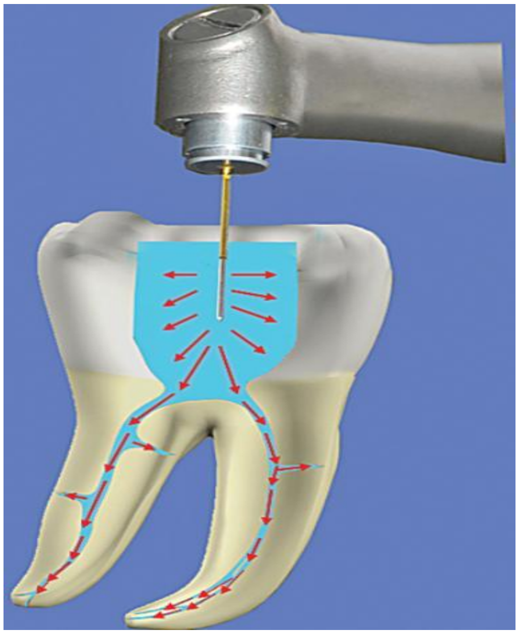


Fig No 21: Laser

the Antimicrobial action of sodium Hypochlorite(**Peters OA, 2011,Jaramillo DE,2012)**. Numerous studies have Found that Er:YAG is the most appropriate Laser for intra canal debris and smear Removal. The laser energy emitted from the Tip of the optical fiber is directed along the Canal and not necessarily lateral to the Walls. To overcome this limitation, a Delivery system that allows lateral emission Of the radiation aimed to improve the Antimicrobial effect(**Stabholz A,2003)** , but a complete Elimination of the biofilm and bacteria was Not yet possible(**Noiri Y, 2008)** . In conclusion, there is Still no strong evidence to support the Application of high-power lasers for direct Disinfection of root canals(**Leonardo MR,2005).**

6.CONCLUSION:

Various irrigating device Has been evolved in order to replace the Previous syringe irrigation. Clinical studies Have described the higher efficacy in Effective microbial count. Though, there is No high level of evidence that correlates the

Clinical efficacy of these devices with better Treatment outcomes. Due to the safety Factors, capacity of the high volume irrigant Delivery and ease of application the newer Irrigation devices may change the insight of Conventional endodontic treatment.

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