The journey of thousand miles begins with a single step, and this step was rightly taken by a visionary & pioneer in the field of endodontics; the ‘Father of Endodontics’ Dr. Louis I. Grossman. Going way back in timeline, when teeth with focal infection and abscess were accused of medical failure and where only extractions & dentures were thought to be the choice of treatment, a ray of hope; Dr. Louis Grossman, changed the scenario. Endodontic therapy was considered as a perspective. The term endodontics which comes from a Greek origin which means ‘inside the tooth’ but with changing times and broaden vision we have reached beyond it.

Particularly aiming towards the endodontic fraternity this poetic prose defined us,

‘This is going to hurt just a bit,
One thing I like less than most things is sitting in a dentist chair with my mouth wide open,
And that I will never have to do it again is a hope that I am against hope hopin’
Because some tortures are physical & some are mental, but the one that has both is dental.’

For more than half a century the dental profession was challenged for painless and efficient care but with the thought of a better tomorrow we could yield the fruits in the present.

Endodontics is a field including not only root canal therapy, but also procedures of apexification, apexogenesis, surgeries, post and core, re-treatments, perforation repairs and possibly all the ways to safeguard the tooth in the oral cavity. But yes, the ways have changed but our goal remains the same.
“Ancient Root Canal Filling Found” the newspaper headlines made history in the field of Endodontics. It was discovered in the skull of a Nabatean warrior, buried 2,200 years ago. Archaeological findings & radiographic examinations revealed the presence of a bronze wire as the obturation material.

From the crude treatment of abscessed teeth with leeches and the pulp being cauterized with hot wires; but at the same time few others thought of root canals being filled from apex to crown with gold foil.

During the mid 19th century with the publication from Dr. Louis I. Grossman on Root Canal Therapy, endodontics witnessed its true rebirth. And since then, the journey of thousand miles had begun with his single step.

The concepts introduced by Dr. Herbert Schilder for cleaning and shaping till obturation techniques have witnessed various advancements. From the conceptuality of cleaning and shaping we have advanced to chemico-mechanical debridement, from silver point obturations to bioactive materials, from macro we have achieved reaching the micro & now the nanotechnology.

As Albert Einstein rightly said, “We cannot solve our problems with the same thinking we used when we created them.”

Endodontic therapy has always aimed at preserving the tooth structure; but during the process we have faced numerous problems; but a problem is only a problem till we don’t know the solution & this quest has led to various inventions.

The management of endodontic problems is reliant on radiographs to assess the anatomy of the tooth and its surrounding anatomy. A correct diagnosis helps in appropriate treatment planning. New self developing X-ray films, radiovisiography (RVG) have been designed for diagnostic purpose but recording patient’s history remains important. Nanodiagnostics can be the future which will use nanodevices for the early disease identification or predisposition at cellular and molecular level. (1)

“It’s not what you look at that matters, it’s what you see”

The horizontal dimension of the root canal system is not only more complicated than the vertical dimension but also more difficult to investigate.
The advent of technology that is the Cone Beam Computed Tomography [CBCT] and Micro CT, we can now view the exact location, extent and precisely measure the surfaces which could not be seen earlier with the two dimensional imaging system. CBCT has proved to be a boon to the field of dentistry. (2)

‘If you change the way you look at things,

Things you look at, change.’ - Wayne Dyer

It is important to visualize and to have knowledge of internal anatomy relationships before undertaking endodontic therapy. The presence of an untreated canal may be a reason for failure. A canal may be left untreated because the dentist fails to recognize its presence. Enhanced magnification and illumination opened the eyes of endodontic surgeons to the intricate and complex root canal system. The use of optical magnification instruments such as endoscopes, orascopes, loupes and microscopes enables the endodontist to magnify a specified treatment field beyond that perceived by the naked eye. (3)

Endoscopes:-

The Modular endoscope system (Sialotechnology Ltd., Ashkelon, Israel) is designed and manufactured based on the experienced gained from other surgical fields of small channels, especially from salivary ductal system. The modular endoscope system includes all in one endoscopic compact system, optical system handpiece with disposable cannulae and accessories. (4) Transillumination and apical root end preparations can also be visualized with the help of endoscope.

Orascopes:-

The recently introduced flexible fiberoptic orascope is recommended for intracanal visualization, has a .8mm tip diameter, 0° lens, and a working portion that is 15mm in length. Orascopic endodontics is the use of orascopy for visualization in conventional and surgical endodontic treatment. An orascope is made of fibre-optics & the 0.8-mm orascope is used to visualize within the canal system. The focus and depth of field of an orascope is zero mm to infinity. (4) This allows the orascope to provide imaging of the apical third of the root without actually having to be positioned within this region of the canal.
Endodontic Visualization System

The recently introduced Endodontic Visualization System (EVS) (JEDMED Instrument Company, St Louis, MO, USA) incorporates both endoscopy and orascopy into one unit. The EVS II System is introduced which combines the fiber optic orascope and a rigid endoscope. It is said to provide optimal illumination and magnification for visualization during endodontic procedures.\(^{(3,4)}\)

Dental Operating Microscopes

An important aid for locating root canals is the dental-operating microscope (DOM) which was introduced into endodontics by Aptheker in 1981 to provide enhanced lighting and visibility. It enhances the dentist’s ability to selectively remove dentin with great precision thereby minimizing procedural errors. Modern endodontic surgical procedures demand a microscopic approach. Use of the smaller retro mirrors allow for a more moderated bevel of the root resection and permit a coaxial ultrasonic preparation into the root.\(^{(5)}\)

Figure 1: Conventional access, Endoguide Burs & Modern Molar Access Preparation

From the past, we have been advocating the conventional straight line access for endodontic procedures, but much did we concern regarding the remaining dentin thickness or so to say, the Pericervical Dentin (PCD). PCD is defined as the dentin near the alveolar crest. This critical zone, roughly 4 mm coronal to the crestal bone and extending 4 mm apical to crestal bone, is crucial to transferring load from the occlusal table to the root, and much of the PCD is irreplaceable.\(^{(6)}\) The modification
in the traditional straight line access helps to preserve the pericervical dentin. With the modern endodontic molar access the coronal third of the crown can be flared to gain access to the canal orifices instead of the straight line access.

As we are moving from conservation to the preservation techniques in dentistry, so as in endodontics the Endoguide Burs (SS White) revolutionaries the traditional access preparation.

Preserving the dentin thickness has become the need of the hour, right from the access preparation to the procedures of root canal instrumentation. The introduction of nickel-titanium (NiTi) rotary files to endodontics has changed the way root canal preparations are performed, enabling more complicated root canal systems to be shaped with fewer procedural errors. (7)

Figure 2: NeoNiTi File & Wizard Navigator

Various systems like the Self-Adjusting File System (ReDent NOVA), V-Taper (SS White), Safe Siders, Hyflex Files (Coltene Whaldent), NeoNiTi (Neolix, France), Protaper Next (Dentsply), Single File Systems like WaveOne, One Shape, Komet F360, Unicone have changed the sequence in endodontic instrumentation. Wizard Navigator is a newer file system to promise meeting the endodontic canal challenges.

Technologies and file design like the M-wire technology, controlled shape memory, hollow tube designs have great and direct impact on the chemico-mechanical debridement. With the advent in technology, new devices are designed that incorporate the apex locator along with the torque controlled gear reduction hand-piece device. (7,8)
Irrigation has been one of the core areas of interest in endodontics for a very long time. It has been universally accepted that success of endodontic treatment is based on successful eradication of bacteria from the root canal system. With various newer formulations such as BioPure MTAD, ozone, hypochlorous acid, etidronate solution (HEBP) have been recently studied for their effects as endodontic irrigants. There are two schools of thought in comparing the irrigants in terms of their disinfecting and cleaning qualities. In one, more emphasis is placed on the chemical properties of the irrigant such as Sodium hypochlorite, whereas in the other the overriding consideration is the mechanical action of the solution as a flushing agent. As the irrigant delivery system and its activation both play a major in disinfection various systems like the Self Adjusting File System incorporates dual action. \(^9\) Other types of delivery systems are Monoject endodontic needles; ProRinse probes Micromega 1500 and CaviEndo systems, the Max-I-Probe, The Endo-Eze system and Irrivac, Quantac E, Multiflex. Rinse Endo, Stropko NiTi FlexiTip. \(^{11}\) Recently new technologies have been developed that deliver various types of irrigants from in office air pressurized bottles (Vista Dental Products, Racine). \(^{10}\) New irrigation technology allow clinicians to conveniently choose, dispense, and more effectively irrigate root canal systems.

![Figure 3: PIPS & X Pulse Laser disinfection Tips](image)

Few other devices such as Endoactivator, V Clean, ultrasonic K File, Photon Induced Photo Acoustic Streaming (PIPS) tip, X- Pulse tip (Fig:-3) are used to
activate these irrigants. PIPS & X-Pulse laser tips create photoacoustic streaming and thus the wave and the heat generated help in deeper penetration of the irrigants to upto 1000µm. The PIPS tip is unsheathed 14mm while the X-Pulse tip is unsheathed 3mm apically. The V clean is used manually to activate the irrigants. It helps in effect removal of smear layer and dislodges the debris.

Root canal morphology is a critically important part of conventional and surgical endodontics. Ideal root canal treatment should seal all “portals of exit” to prevent any sort of communication between the root canal system and periodontium. This can be achieved by cleaning and shaping of entire root canal system and its three dimensional obturation. Currently 2 types of flowable gutta-percha obturating systems are popular in endodontics that Injectable obturating systems and Carrier Based obturation Systems. Injectable obturating systems include Obtura III, Ultrafil (Hygienic-Coltene-Whaledent, Akron, OH), Calamus obtrurating system (Dentsply-Tulsa Dental, Tulsa), Elements obtrurating unit (SybronEndo). Carrier based gutta percha systems include Thermafil (Dentsply-Tulsa Dental, Tulsa, OK), Successfil (Coltene-Whaledent, Inc., Akron, OH), SimpliFill (Discus Dental, Culver City, CA), GuttaFusion(VDW). Recently self adhesives Gutta Percha(Bio-Gutta) has been developed. This material comprises of bio-active glass particles which aid in the adhesion to the root canal dentin wall.

A new bioactive cement, also called as smart dentin replacement and popularly known as Biodentine (Septodont, France), was recently launched as a dentin substitute. It shares both its indications and mode of action with calcium hydroxide, but does not have its drawbacks. On the biological level, it is perfectly biocompatible and capable of inducing the apposition of reactionary dentin by stimulating odontoblast activity and reparative dentin, by induction of cell differentiation. Bioaggregate is a recently developed fine white hydraulic powder cement mixture for dental applications. It utilizes the advanced science of nano-technology to produce ceramic particles that, upon reaction with water produce biocompatible and aluminum-free ceramic biomaterials.

The BioAggregate Powder reacts upon mixing with BioA Liquid (deionized water), which leads to the formation of a nano-composite network of gel-like calcium
silicate hydrate intimately mixed with hydroxyapatite bioceramic, and forms a good seal.\(^{(16)}\)

Bioceramics are ceramic materials specifically designed for use in medicine and dentistry. They include alumina and zirconia, bioactive glass, glass ceramics coatings and composites, hydroxyapatite and resorbale calcium phosphates and radiotherapy glasses. Bioceramic sealers EndoSequence BC sealer have been developed. This material is highly biocompatible, non-toxic and chemically stable. Moreover the material itself has the ability to form hydroxyapatite and to create a bond between dentin and the root canal filling materials. \(^{(17)}\)

Recently developed Activa BioActive is a liner/base and composite material for pulpal protection and restoration.

During the past few decades, endodontic treatment has benefited from the development of new techniques and equipments, which have improved the outcome and predictability of the treatment. Important attributes such as operating microscope and ultrasonic instruments have found indispensable applications in a number of dental procedures. The use of ultrasonic along with the dental operating microscopes is termed as Microsonics.\(^{(18)}\)

The use of ultrasonic instruments has revolutionized the art of endodontic re-treatment. These instruments have multiple uses and have become an integral part in endodontics.
A new paradigm shift is the Gentle Wave system (Fig. 5) which utilizes the patented multisonic ultracleaning technology that is designed to quickly, easily and safely loosen and remove pulp tissue, debris, decay within minutes. The system is designed to clean the entire canal system automatically. (19)

With introduction of lasers to the field of dentistry, various treatment modalities changed. Laser Doppler flowmetry (LDF), which is a noninvasive, painless, semi-quantitative method, has been shown to be reliable for measuring pulpal blood flow. (20) With developing technology, new lasers tips have been designed for endodontic disinfection namely PIPS & X-PULSE.

We can experiment the technology such that it incorporates all the above mentioned tools, as a single component.

These all are treatment modes but the main goal is to restore the original physiologic structures and functions of the pulp-dentin complex. However, treating necrotic immature teeth has always been a clinical challenge for several reasons. It is difficult to achieve an appropriate apical seal with an open apex by using conventional root canal treatment. In addition, the discontinued development of dentinal walls after pulp necrosis can cause thin dentinal walls that make the tooth more prone to fracture. Regenerative endodontics can be defined as biologically
based procedures designed to replace damaged structures, including dentin and root structures, as well as cells of the pulp-dentin complex.\(^{(21)}\)

Regenerative approaches in endodontics comprise two clinical concepts. One concept involves a revitalization approach to achieve tissue regeneration. The other concept is the active pursuit of pulp and dentin regeneration via tissue engineering technology to implant or re-grow pulp tissue. Procedures attempting to preserve the remaining dental pulp stem cells and the mesenchymal stem cells of the apical papilla (SCAPs) can result in root canal revascularization and the completion of root maturation.\(^{(22)}\)

The future of endodontics is definitely bright with these these technologies and equipments as powerful tools. But maybe we can go a step ahead and think at a molecular level that is the nanotechnology.

**Nanotechnology**

*Figure 5:- Nanorobots*

Every field is advancing, so is endodontics. We are refining the old concepts with new technology, we have reached a stage to regenerate the pulp-dentin complex but can we think of regaining the vitality of the tooth. How about actually being at site of treatment, reaching the unseen apical third? Tiny machines, known as nanoassemblers, could be controlled by computer to perform specialized jobs.\(^{(23)}\) Nanorobots could be the next big thing in dentistry, where possibly we can reach and visualize even inside each dentinal tubule and treat the same. Replacement of the
whole tooth, including the cellular and mineral components, is referred to as complete dentition replacement. (24,25) This therapy is possible through a combination of nanotechnology, genetic engineering, and tissue engineering. Researchers suggest use of nanosponges introduces in blood stream could reduce toxicity; this could be applied in dental pulp revitalization.

Necessity is the mother of all inventions. Assessing our needs will help us develop new techniques to overcome our problems. Future research needs to be done in the field of regenerative endodontics, tissue engineering. We are yet to achieve the prediction with perfection in endodontics, but we shall definitely strive hard to conquer the dental world and promise our patients to retain every tooth in the oral cavity.

We are the cardiologist for the tooth but we are trying to replace the heart (Pulp) but not revitalize the same. If our dream mission to reach Mars has become a successful giant leap for mankind, we can definitely dream to reach at that cellular level endodontics where we can detect & treat the cause.

The role of endodontics is not only to preserve the tooth but also its vitality. You are never too old to set another goal or to dream a new dream. Your dreams of today will be the future of tomorrow. So let’s ask ourselves if what we’re doing today is getting us closer to where we want to be tomorrow…..

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