The root canal system has the capacity to harbor several species of microorganisms as well as their toxins and by products. Egress of such irritants from the root canal system into the periradicular tissues results in the formation of periradicular lesions. Removal of these irritants and three dimensional obturation of the root canal system are the main goals of non surgical root canal therapy.

Endodontic surgery is indicated in the following situations where there is strong possibility of failure from non surgical treatment, if failure has resulted following non surgical endodontic treatment and when retreatment is impossible or would not achieve a better result.

Endodontic surgery consists of exposure of the involved apex, root resection, root end preparation and root end filling. Root end filling material should improve the seal of existing root canal fillings, there by impeding both the traffic of tissue fluids into the root canal and the egress of micro organisms from the root canal system toward the periradicular tissues. Many materials have been used as root end fillings. Recently Mineral Trioxide Aggregate (MTA) and Portland cement have been strongly suggested as root end filling

materials providing adequate sealing ability together with their high biocompatibility.

Leakage of root end filling materials has been measured by different methods including penetration of dyes, isotopes, micro organisms, or electrochemical means. All of these techniques have been shown to have a variety of short comings. The fluid filtration method provides an accurate quantitative mean for leakage measurements in addition to long term testing of sealing ability.

The main objective of root end filling is to provide an apical seal that prevents the movement of bacteria and the diffusion of bacterial products from the root canal system into the periapical tissues.

An ideal root end filling material should be easy to manipulate, radioopaque, dimensionally stable, non absorbable, insensitive to moisture, adhesive to dentin, nontoxic and biocompatible. Many materials have been suggested among which are; gutta percha reinforced Zinc oxide-eugenol, Cavit, composite resin, gold foil, glass ionomer and Amalgam.

Amalgam. As root end filling material

Barry et al.[1] evaluated the seal provided by gutta-percha root canal filling, heat-sealed gutta-percha, retrograde amalgam filling and retrograde Durelon filling by observation of apical dye penetration in extracted teeth. No significant difference was found between gutta-percha, heat-sealed gutta-percha and retrograde amalgam. On the other hand, Durelon filling showed significantly poor seal in comparison to gutta percha and retrograde amalgam.

Delivanis and Tabibi[2] compared the sealing properties of Cavit, zinc polycarboxylate cement and

silver amalgam when used as retrofilling materials. The retrofilling materials were placed at the apices of dog's teeth and were left there for 6-month period. Teeth were then extracted and the marginal leakage was evaluated by C14 labeled urea. Under the conditions of this study the results showed that amalgam afforded a better seal than polycarboxylate cement or Cavit.

Tanzilli et al[3] compared the marginal adaptation of amalgam, heat sealed gutta percha and cold burnished gutta percha when used to seal resected root ends. The samples were examined using the scanning electron microscope after one month of storage in 100% humidity. The results showed the superiority of the cold burnished gutta percha over the other techniques with an average marginal defect of 1.8um, while amalgam showed uniform defects that reached 3.1um.

Abdal and Retief[4] studied in vitro the apical seal of sixteen retrofilling materials Evaluation was done quantitatively using a dye penetration method and qualitatively using the scanning electron microscope. The root canals were biomechanically prepared and obturated with laterally condensed gutta percha, Root end resection was done and retropreparations of 3 mm depth were performed at the root apices. The results showed that adaptic and glass ionomer cement provided

the best apical seal. Concerning the tested amalgam brands the results demonstrated that the cupralloy and spheralloy provided the best adaptation and the least leakage.

Abdal et al[5] conducted the second part for their preliminary study to compare the apical seal obtained by adaptic, ASPA, cupralloy and spheralloy with and without varnish. Seventy maxillary central incisors with class I canal anatomy were used in this study. The canals were biomechanically prepared and the apical 2-3 mm of the roots were resected and 3mm retropreps were done and filled with the experimental materials. The apical seal was evaluated quantitatively using a flourescent dye technique with standardized photomicro-graphs. The results showed that the least dye pene-tration was seen in the adaptic and ASPA groups. It was also proven that the use of varnish under amalgam retrofillings, significantly reduces microleakage.

Kaplan et al[6] compared invitro the retroseal of amalgam, heat sealed gutta percha, cold burnished gutta percha and apicoectomy alone using methylene blue dye as an indicator for apical microleakage. The root canals of ninety maxillary central incisors were mechanically prepared to size # 60 K-file and obturated with laterally condensed gutta percha and sealer. The apical 2 mm

were beveled and the root ends were manipulated according to each test group. The results showed the least leakage with the cold burnished gutta percha with an average of 1.5mm, followed by amalgam with an average of 3.1mm, then heat sealed gutta percha with an average of 4.0mm. The apicoectomy group showed the highest leakage values with an average of 4.6mm.

Tronstad et al[7] studied the sealability of amalgam as retrofilling in vitro. The root canals of two hundred and seventy human, single rooted teeth were instrumented and filled with gutta percha and Kloroperka N-O sealer. The apical 2mm were cut off and cavities for retrograde fillings were prepared in the resected surfaces. The samples were divided according to the experimental materials as follows: zinc containing silver amalgam, zinc free silver amalgam, dispersed phase alloy 19% Cu and spheralloy with 27% Cu. The roots were sterilized using gamma-radiation and implanted subcutaneously in rabbits, for periods of 7, 30 and 90 days. After every observation period, the roots were retrieved and examined for leakage using radioactive Ca^{++} and autoradiographed using ultra speed x-ray films. The results showed the superiority of high copper spherical alloys in preventing apical

leakage. Also, the application of cavity varnish under amalgam significantly minimized microleakage.

Mattison et al.[8] compared in vitro the micro-leakage pattern of zinc containing and zinc free amalgam with and without cavity varnish when used as a retrograde filling material at different depth of retro cavities. They found a significant difference in leakage between depth 1 to 3mm and no significant difference between zinc containing and zinc free amalgam, also they found that the cavity varnish decreased the leakage pattern. The authors recommended the use of cavity varnish and the depth of the cavity should not be less than 3mm.

Szerementa Browar et al[9] compared invitro the sealing properties of different root end manipulation using radioactive Ca^{++} with standardized autoradio-graphs. Sixty two freshly extracted single rooted human teeth had their crowns decapitated and the root canals were mechanically prepared and obturated with laterally condensed gutta percha and sealer. Samles were divided into six groups in which gutta percha of two groups were either heat or cold burnished. Amalgam and super EBA were used as retro filings in another two groups while the last two groups had their root apices either left intact or resected without any further manipulation. The results

showed that the least microleakage was in the group in which no resection was done which was followed by the super EBA group, while the maximum leakage was found in the amalgam group. The results also proved that heat sealed gutta percha afforded a better seal than cold burnished gutta percha.

Stabholz et al[10] studied invitro the marginal adaptation and sealability of amalgam, restodent, zinc phosphate, duralon and cavit. Fifty single rooted human teeth were used in the study where the apical 4mm were beveled and the root canals were instrumented 1mm beyond the apices. Retropreparations of 2mm depth were made in the resected surfaces and the samples were equally divided into five groups that were retrofilled with one of the experimental materials. All the samples were examined in cross-sections using the scanning electron microscope. The results showed that the five tested materials demonstrated various degrees of marginal imperfection, inconsistency and gaps. Amalgam showed the worst adaptation with the largest gaps and imperfections.

Abdel Aziz and Fahim[11] compared, the sealability of amalgam and polycarboxylate cement when used as retrofilling materials, in forty eight extracted human single rooted teeth. The root canals were instrumented

and obturated with laterally condensed gutta percha and sealer. The apices were resected with a 45° bevel and 2mm deep rctrocavities were prepared. The samples were equally divided into 4 groups where groups one and two were retrofilled with zinc-free amalgam and non gamma II amalgam while group three and four were retrofilled with either poly F or lumican cement. The samples were stored in methylene blue dye for seven days and sectioned horizontally to examine the dye penetration. The results showed the superiority of the tested amalgams over the polycarboxylate cement. It also proved that zinc-free amalgam offered a better seal than non-gamma II amalgam.

Escobar et al[12] compared the apical seal provi-ded by amalgam and low temperature thermoplasticized injectable gutta percha in an in vitro dye study. Single rooted human, mandibular and maxillary teeth were used in this study. The samples were divided into two equal groups according to the experimental materials. For the amalgam group, the root canals were instrumented and obturated with laterally condensed gutta percha and sealer. After root end resection, retrocavities of 2mm depth were prepared and filled with amalgam. For the injectable, low-temperature thermoplasticized gutta percha group, the root canals

were prepared then injected with gutta percha The apices were resected and 2 mm deep rctrocavitics were prepared and sealed with injcctablc gutta pcrcha. All the samples were then immersed in methylene blue dye for seven days, vertically sectioned and examined under the dissecting microscope. The results showed no significant difference in the sealability of the two materials.

Vertucci and Beatty[13] compared microscopically the sealing ability of cold burnished gutta-percha, amalgam filling material with and without varnish, in normal retrograde cavity preparation and amalgam filling in retrograde cavity preparation with bevel. All roots were immersed in 1% methylene blue dye for 2 weeks and the depth of linear dye penetration was measured by the use of illuminated microscope with millimeter scale. Results showed that cold burnished gutta-percha demonstrated more dye penetration than did amalgam without varnish. Low grade dye penetration was observed when varnish was used in both cavity preparation and beveled root surface, and there were no differences between the group of amalgam with cavity varnish and that without cavity varnish.

Smee et al[14] compared invitro the apical seal afforded by P-30 resin, teflon, zinc-free amalgam and IRM when used as retrofilling materials. The root canals

of all samples were instrumented and obturated with laterally condensed gutta percha and sealer. Retrocavities were prepared in the resected surfaces and filled with the experimental materials. The samples were vertically suspended in India ink for 48 hours, then vertically sectioned for detection of linear dye penetration The results showed that IRM, teflon and P-30 demonstrated significantly less leakage than zinc-free amalgam.

Barkhordar et al[15] evaluated invitro cyano-acrylate as a retrograde filling material using a methylene blue dye tracer. The material was compared to amalgam with and without varnish, heat sealed gutta percha and cold burnished gutta percha All samples were subjected to standardized root end resection then divided into five groups: three of which were retrosealed with amalgam with and without varnish and cyanoacrylate in standard retropreparations, In the other two groups the apical gutta percha was heat sealed and cold burnished respectively. All samples were examined under the dissecting microscope for linear leakage measurement. The results showed that cyanoacrylate afforded the best seal, followed by amalgam with varnish, amalgam without varnish and heat sealed gutta percha. The worst seal was afforded by the cold burnished gutta percha.

Schwartz and Alexander[16] Compared apical micro leakage following reverse filling with zinc free amalgam and silver glass ionomer cement with and without cavity varnish After retrofilling, specimens were suspended in 2% methylene blue dye, sectioned longitudinally, and the depth of linear dye penetration was measured. Results showed that penetration of dye was significantly less in the specimens filled with zn free amalgam and cavity varnish.

Negm[17] studied the effect of pit and fissure sealants on the sealing capacity of retrofilling techniques in vitro. Four hundred and eighty human anterior teeth were used in this study. The root canals were instrumented and filled with laterally condensed gutta percha and sealer. The samples were equally divided into three groups where group A were retrosealed with amalgam, group B were only root end resected while samples of group C received no additional treatment. Each of the three groups was further subdivided into four subgroups where subgroups : I,II were coated with 2 different types of pit and fissure sealants subgroup III were coated with a layer of varnish while sub group IV received no additional treatment. The results showed the superiority of the amalgam and laterally condensed gutta percha which

improved by further application of the helioseal. The heat sealed gutta percha afforded the worst seal and varnish application did not improve the condition.

Tuggle et al[18] evaluated in vitro the apical sealing ability of amalgam with or without varnish, super EBA and cold burnished gutta percha. The samples were stored in methylene blue dye, vertically sectioned and examined for linear dye penetration under the dissecting microscope. The results demonstrated significantly less leakage in the amalgam with varnish group, with no statistically significant differences in the results of the other groups.

Bondra et al[19] evaluated invitro the leakage of IRM, high copper amalgam and EBA cement retrofillings using a dye technique. Single rooted human teeth were used in this study where the crowns were sectioned, the root canals prepared using a step-back technique and the canals obturated by a single cone to duplicate a poor apical seal. The apical 3mm were sectioned and 2mm deep retrocavities were prepared in the resected surfaces and retrofilled with the tested material. The results showed the superiority of both EBA and IRM over amalgam with varnish as retrosealing materials.

MacPherson et al[20] studied the apical seal afforded by injectable high temperature thermo-plasticized gutta percha, high copper amalgam and warm gutta percha when used as retrofilling materials. The root canals were biomechanically prepared by a step-back technique, then obturated using a single gutta percha cone to duplicate a poor apical seal. The apical 3 mm were horizontally resected and 2 mm deep class I retropreparations were performed at the resected apices. The samples were placed in India ink as an indicator for apical leakage and examined under the stereo-microscope. The results showed that high temperature thermoplasticized gutta pcrcha provided significantly less leakage than the amalgam or the warm softened gutta percha.

Barkhordar et al[21] compared the apical seal of glass ionomer and amalgam when used as retrofillings materials. The root canals of seventy human extracted single rooted teeth were prepared and obturated with vertically condensed gutta percha and sealer. The apical 2mm was horizontally resected and standardized retrocavities were prepared in the resected surfaces. Tested materials were placed in the retro cavities either with or without varnish. After immersion in 1% methylene blue dye for 24 hours as a leakage tracer, the samples were vertically

sectioned and examined under a dissecting microscope. The results showed that the sealability of glass ionomer was superior to that of amalgam and that the application of a varnish significantly improved the sealability of both materials.

Becker and Von Fraunhofer[22] compared the leakage behaviour of thermoplasticized gutta percha with and without sealer to that of amalgam with varnish when used as retrofilling materials. The root canals of extracted human single rooted teeth were instrumented and obturated with laterally condensed gutta percha and sealer. The apical 2-3mm were bevelled, and 2mm deep class I retropreparations were performed in the resected surfaces. The samples were divided into three groups that were retrosealed with thermoplasticized gulta percha without sealer, thermoplasticized gutta percha with sealer, and amalgam with varnish. After 10 days of storage in methylene blue dye, the roots were vertically sectioned and observed with a magnifying lens with a built in scale for linear dye penetration measurement. The results showed no significant difference between the leakage of injected gutta percha with sealer and that of amalgam with varnish.