

A New Look at the Endo- Restorative Interface

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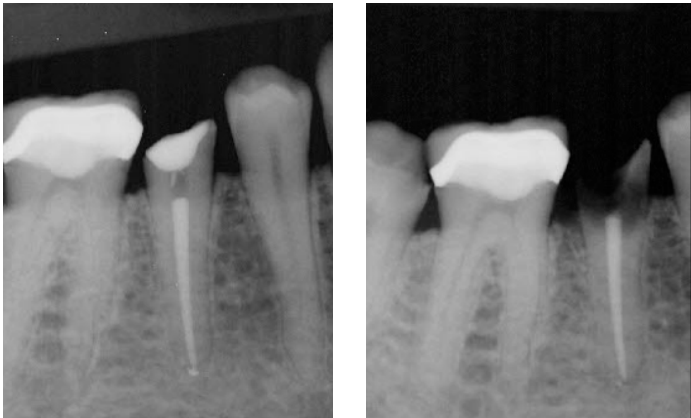


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When looking at long-term outcomes, endodontic and restorative treatments are inseparable. Endodontic procedures, and how they are performed have considerable effect on the success and failure of the restorative treatment. Similarly, the restorative treatment affects the long-term outcome of the endodontics. I provided the content for a 2004 issue of Colleagues for Excellence titled “Restoration of endodontically treated teeth: The endodontist’s perspective.” Much of that material still applies 16 years later, such as the importance of proper isolation, performing bonding procedures properly and the importance of a ferrule. There is new evidence in some areas and some perspectives have changed. These will be the focus of this issue.

An important advancement in “endo-restorative” has been the use of assistant side oculars with the dental operating microscope, which allows the assistant to see what the clinician sees. The assistant oculars are helpful for most dental procedures, but are particularly helpful for restorative treatment. In teeth with substantial loss of tooth structure and/or deep finish lines, assistant side oculars make it easy for the assistant to help: maintain isolation, help with decay removal, place a matrix, shape and finish a restoration, and place finish lines. Figure 1 shows Dr. Carlos Portoles and his assistants working on a patient. Note how both are sitting in a comfortable upright position, supported by arm rests, and are focused on the same clinical field through the microscope.



Figures 2a and 2b: This image shows a tooth that was temporized after completion of the endodontics. The patient never had it restored, ultimately resulting in extraction. When this sort of thing happens, the quality of the endodontics is irrelevant.

that was temporized after completion of the endodontics. The patient never had it restored, ultimately resulting in extraction. When this outcome occurs, the quality of the endodontics becomes irrelevant.

One of the impacts of implants has been increased emphasis on predictability and longevity. This has led to less emphasis on “dental heroics” to try to save every tooth, which, in turn, has led to an emphasis on the preservation of tooth structure during endodontic and restorative procedures. If you look at extraction data for endodontically treated teeth over the longer term, only a small percentage were extracted due to failure of the endodontics. Six studies are shown in Table 1, with long term recalls. The percentage of teeth extracted due to endodontic failure is very low compared to the total number extracted. The great majority were extracted due to structural failure, decay or other factors related to the restorative dentistry. There is considerable evidence linking the strength of a tooth to the amount of remaining tooth structure (4-9). When you look at endodontically treated teeth in your practice that were treated 20 or 30 years ago, one common characteristic tends to be considerable remaining tooth structure. Often the endodontic treatment doesn’t look so good. The root canal and restorative



Figure 1: Dr. Carlos Portoles and his assistants work on a patient.

Excellence in endodontics is all about providing consistent results. There are many aspects of endodontic outcomes over which the clinician has little control such as the patient’s biology, physiology, microbiology and compliance. One important factor we can control is the quality of the initial restorative treatment. Even teeth with poorly fitting crowns are likely to last a long time with high-quality endodontics and foundational restorative treatment. Following completion of the endodontics, immediate restoration by a clinician knowledgeable and skilled in restorative dentistry, is an important factor in longevity. Nothing good happens when restoration is delayed (1-3). Figure 2 shows a tooth

Table 1. Extractions due to failure of the endodontic treatment/total extractions (%)

Sjogren (26)	2/68 (3%)	8-10 years
Fonzar (27)	8/68 (12%) Retreatments 3/25 (12%)	> 10 years
Lee (28)	19/162 (12%)	Up to 21 years
Landys Boren (29)	5/69 (7%)	> 10 years
Prati (30)	2/41 (5%)	20 years
Olcay (31)	15/281 (5%)	Up to 10 years

Table 1: Six studies are shown, with long term recalls.



Figure 3: The root canal and restorative treatment shown here was more than 30 years old, according to the patient.

treatment shown in figure 3 was more than 30 years old according to the patient.

In the past 10 years or so there has been a movement in endodontics that is sometimes referred to as “minimally invasive endodontics,” or MIE. Perhaps a better term would be “minimally destructive endodontics,” since all the procedures we do are destructive to the tooth to some extent (10). The exact definition varies, but there are three aspects to MIE: 1) The access preparation 2) The taper of the canal preparation and 3) The apical size. The idea is to remove only enough tooth structure in all three areas to accomplish the endodontic treatment. Advocates of MIE say the natural apical size and location should be preserved, taper should be kept to a minimum to preserve cervical dentin, a key component in the strength of the tooth, and access should be only large enough to allow the endodontic procedures to be completed successfully. The

initial size and shape of the canal should determine the final preparation, rather than the traditional ideas of a large access for visibility, .04 or .06 canal taper and a predetermined minimal apical size such as 40. The combination of CBCT and excellent microscope skills allow a clinician to maintain more tooth structure than in the past. It appears that new technologies will bring additional advances in our ability to preserve tooth structure during endodontic procedures. More on new technologies later.



Figures 4a and 4b: An example of a tooth treated following the concepts of MIE, resulting in minimal weakening of the tooth.

There is not very much literature to date on the topic of MIE. Most of the studies evaluated the strength of the teeth with small or large access preparations. The majority of laboratory studies show that teeth are stronger with smaller access cavities (4, 6, 9, 11-13). Several studies showed no difference (14-16). If there is a strengthening effect, it is not known if it is clinically relevant. This would be difficult to study, so we probably will never know the answer for certain. Advocates of MIE suggest that our default position should be to preserve tooth structure when possible, a concept that is hard to dispute. Figure 4 shows an example of a tooth treated following the concepts of MIE, resulting in minimal weakening of the tooth.

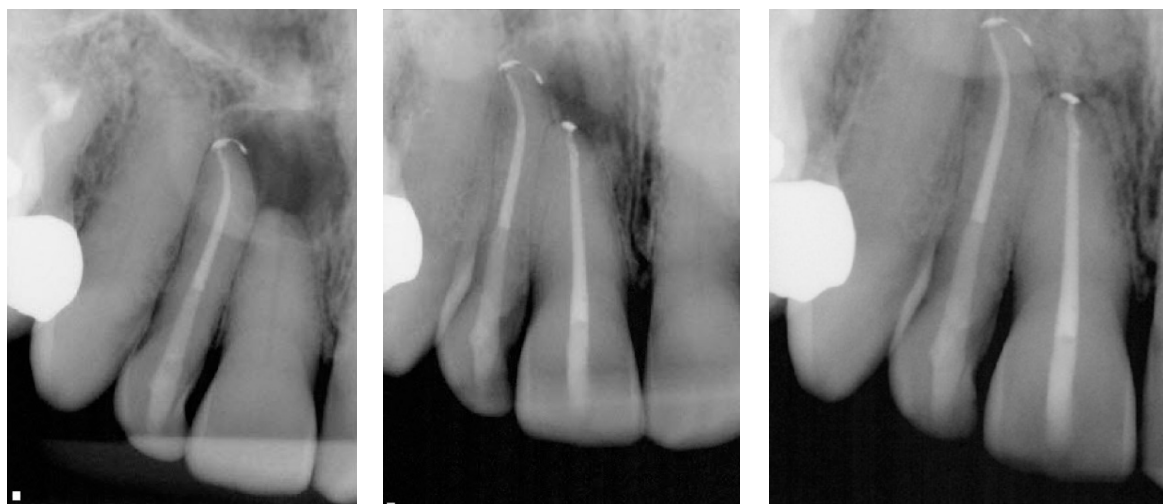
Conservative endodontics means different things to different clinicians. The controversial

“Ninja” access is not for everyone and is a moot point most of the time because most premolars and molars are broken down or heavily restored long before they need endodontic treatment. Nonetheless, when the opportunity presents, highly skilled clinicians can do excellent endodontic treatment through a very small access cavity, even in molars. Figure 5 shows an example of what is possible, in a tooth treated by an endodontist. Again, our default position should be to remove only enough tooth structure to get the job done.

One of the concerns about smaller access cavities and shapes is whether there is adequate irrigation in the apical 1/3. We assume more irrigation is better, but unfortunately, we don’t know how much is enough or whether the smaller shapes affect success and failure rates compared to conventional treatment in the short or long term. Those who have been doing conservative shaping for some time report that the healing rates remain quite high. Note how



Figure 5: An example of what is possible, in a tooth treated by Dr. Steve Baerg. The final radiograph is a six-year recall.



Figures 6a, 6b, and 6c: Note how complete healing was accomplished in figures 5 and 6, with minimal weakening of the tooth.

complete healing was accomplished in figures 5 and 6, with minimal weakening of the tooth. A number of new technologies purport to provide more effective irrigation, including for smaller canal sizes and shapes. There has been a lot of interest in recent years in adjuncts to irrigation particularly for lasers such as

the Waterlase, and newer irrigating devices such as GentleWave. These have been shown to clean and disinfect the canals effectively (17-20), but thus far it is not known if they improve outcomes.

Additive rather than subtractive restorative dentistry has been around for many years in Europe, but has just recently started gaining traction in the U.S. It is a long tradition in the U.S. to place cuspal coverage restorations on most or all teeth after endodontic treatment. Crowns make sense for teeth with considerable loss of tooth structure, but for teeth that are largely intact, particularly for those with considerable enamel available for bonding, more conservative replacement of tooth structure with additive bonded restorations may result in stronger, more durable teeth. Depending on the design, a crown preparation may remove up to 70% of the coronal tooth structure (21, 22). Even with a conservative access cavity, there is not much tooth



Figure 7: If an indirect, cuspal coverage restoration is not planned, tight contacts and excellent contours can be obtained with composite or amalgam with one of the matrix systems that incorporates the Bitine Ring, as shown here.

structure left after traditional shoulder type preparations, particularly for anterior teeth and premolars. If an indirect, cuspal coverage restoration is not planned, tight contacts and excellent contours can be obtained with composite or amalgam with one of the matrix systems that incorporates the Bitine Ring, as shown in figure 7. A fairly recent addition to the concept of additive dentistry called the Bioclear system was developed. It incorporates a clear matrix, special wedges and a Bitine ring, and provides consistently tight, well contoured contacts. The concept includes minimal removal of tooth structure, partial cuspal coverage and “injection molding” of heated composite. Figure 8 shows a tooth restored with the Bioclear system. Note the conservation of tooth structure in both the endodontic and restorative procedures, partial cuspal coverage, and excellent mesial contact and interproximal contours. This is endo-restorative treatment performed at a very high level.

For those restorative dentists who feel strongly that full cuspal coverage is necessary after endodontic treatment, conservative, indirect restorations may be placed that minimize removal

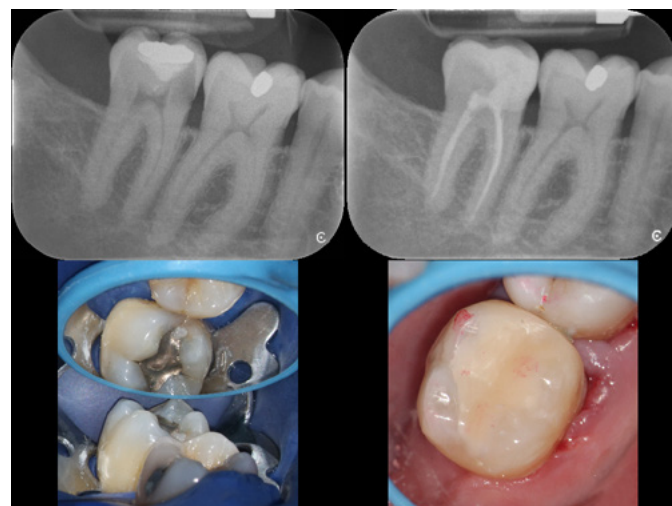


Figure 8: A tooth restored by Dr. Dale Jung with the Bioclear system – which was developed by Dr. David Clark – is shown here. Note the conservation of tooth structure in both the endodontic and restorative procedures, partial cuspal coverage, and excellent mesial contact and interproximal contours. This is endo-restorative treatment performed at a very high level.

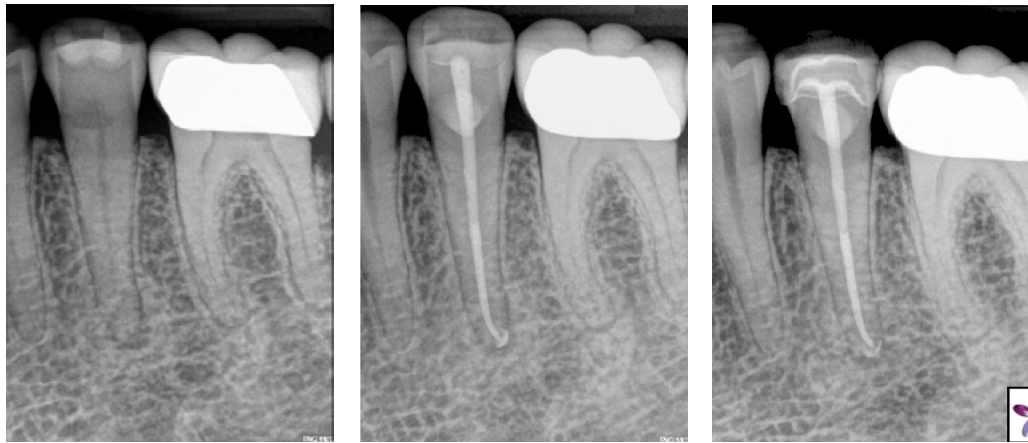


Figure 9: Whenever possible conservative endodontics and conservative restorative treatment should be encouraged, as shown here.

of tooth structure, avoiding the cervical area of the tooth if possible. A heavy shoulder in the cervical area of a small premolar or incisor sets it up for a snap-off failure in the future. Whenever possible conservative endodontics and conservative restorative treatment should be encouraged, as shown in figure 9.

One of the big changes from 2004 involves fiber posts. Most of us were taught that the purpose of a post is to retain the core and that posts don't make teeth stronger. The first part of the statement remains true, but the second part is highly doubtful based on

the fiber post literature starting in 2003. There are at least 36 studies that show fiber posts make teeth more resistant to fracture. Three of them are referenced here (23-25). There is possibly no other assertion so well supported in the dental literature. A caveat is that once the endodontic treatment is complete, a post is fit to the existing canal space rather than enlarging the canal to fit the post. Because of the strengthening effect, fiber posts are indicated in many anterior teeth and premolars. This is particularly true when completing the endodontic treatment through an existing crown since the amount of remaining coronal tooth structure is unknown. Placement of a fiber post doesn't guarantee long-term success, but it improves the odds.

According to the literature, fiber posts fail most commonly in two ways: they pull out or snap off. Pull out should not be much of an issue, however, if there is adequate post length, the dentin was cleaned thoroughly, and proper bonding procedures are followed. The author places more

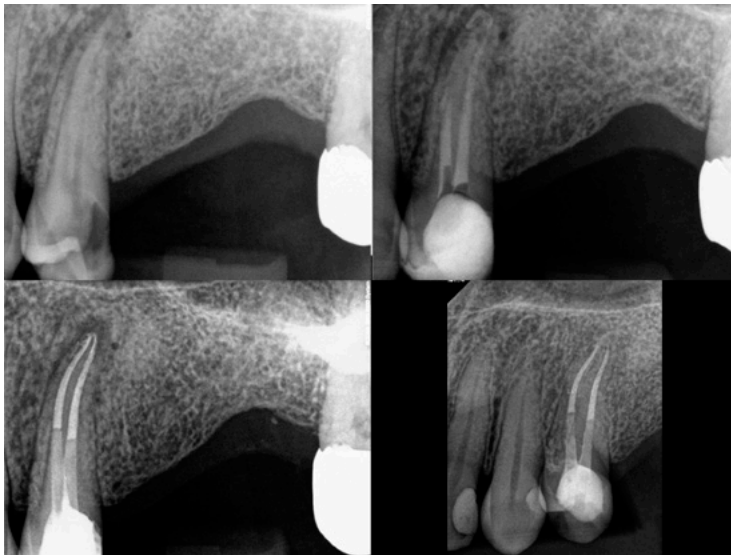


Figure 10: The author places more than one post whenever possible, which reduces the probability of pull out and snap off failures. This is a change from 2004.

than one post whenever possible, which reduces the probability of both types of failures, as shown in figure 10. This is a change from 2004.

Another development which has enhanced the principles of MIE has been the use of CBCT imaging for image-guided treatment (IGT). CBCT imaging can be used to help guide access location, angulation and depth. New technologies have taken this a step farther by physically guiding the access preparation. This is particularly useful for teeth where the canal is not visible on radiographs in the cervical area of the tooth, but can be used with any tooth. One method utilizes a solid drill guide, similar to those used for implants. This is sometimes referred to as "static guidance." An example of a static drill guide is shown in figure 11. More recently "dynamic guidance" has been developed. CBCT data is inputted into a device that provides visual, real

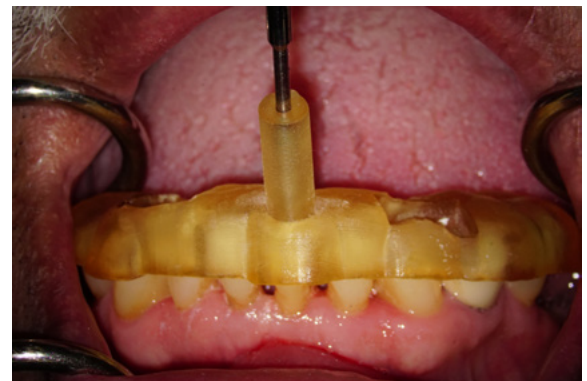


Figure 11: An example of a static drill guide is shown here courtesy of Dr. Gary Benjamin.



Figure 12: The X-Nav system, operated by Dr. Charles Maupin, is shown here.

more efficient irrigation methods may take us into in a new era of conservation of tooth structure, and greater longevity of the teeth we treat.

In our endodontic practice, we do a few things for our referring doctors that readers might consider. After completion of the buildup we often “rough prep” the teeth, so all the restorative dentist has to do is refine the preparation and place finish lines. In figure 15 we removed the bridge and decay, endodontic treatment was completed, a buildup was placed and the tooth was rough prepped in preparation for a new bridge. For areas with deep restorations we sometimes place a finish line on tooth structure for the referring doctor. An example is shown in figure 16. With the microscope, you can usually see these areas very clearly because of the high magnification and illumination. With a little practice, a clinician can learn to place beautiful smooth finish lines under the microscope. For endodontists: anything you can do to help your restorative dentists will be appreciated. For restorative dentists: your specialists should be doing things to make your life easier and helping you to be successful.

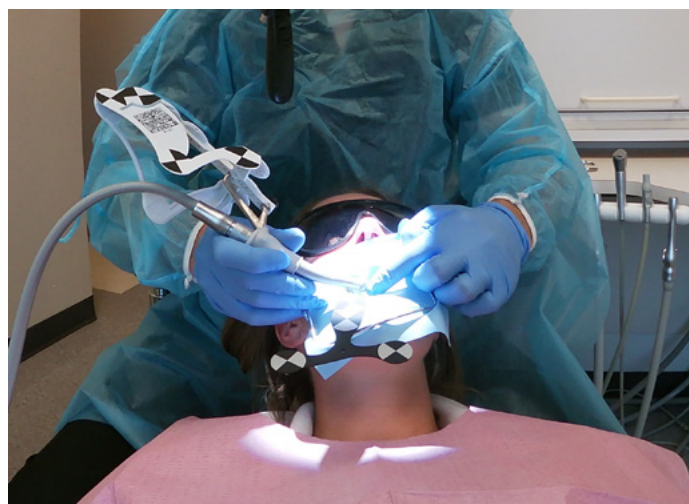
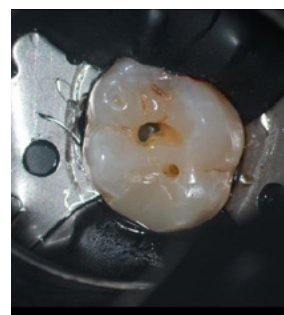


Figure 13: The Navident system, courtesy of Dr. Bobby Nadeau, is shown here.



Figures 14a, 14b, and 14c: An example of multiple access points made with X-Nav is shown here, courtesy of Dr. Charles Maupin.

we placed cotton and Cavit, like the other endodontists in town. Soon we started seeing problems coming back like unrestored teeth with decay as shown in figure 2, fractures, perforations, and sometimes a tooth restored with the cotton pellet still in the chamber. We invited our top 50 referrers to dinner, showed them some of the literature on the benefits of immediate restoration and the problem cases we were seeing resulting from cotton and Cavit temporization. We

time guidance on a computer screen, somewhat like a computer game. One example is the X-Nav system, shown in figure 12. Another example is the Navident system shown in figure 13. An advantage of dynamic guidance is that it doesn't require impressions or laboratory procedures so the clinical procedure can be performed the same day as the CBCT imaging is obtained. The new guided access technologies allow more conservative root canal treatment than traditional methods and some very creative solutions. An example of multiple access points made with X-Nav is shown in figure 14. IGT, in combination with

How does an endodontist get started doing restorative dentistry, particularly if that is not the local custom? In our case, we asked permission. In the early years of our practice,



Figure 15: The bridge and decay were removed, endodontic treatment was completed, a buildup was placed and the tooth was rough-prepped in preparation for a new bridge.

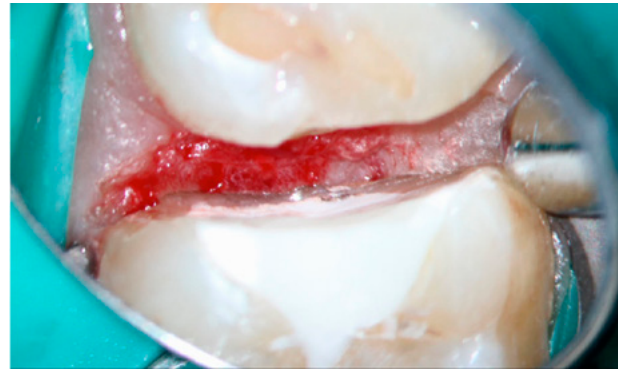


Figure 16: For areas with deep restorations, we sometimes place a finish line on tooth structure for the referring doctor.

asked their permission to start restoring access cavities and doing the foundational restorative treatment. We said, “Restorative dentistry is a money loser for us, but we would like to start doing it because we believe this is the best thing for your patients. Let us start with difficult buildups on upper second molars, the ones you don’t want to do anyway, and see what you think.” Initially, 35/50 gave us permission and we eventually won over the rest, so that we now restore close to 100% of the teeth we treat. We feel, and were able to convince our referring doctors, that it was the best thing for their patients. If endodontists are going to do restorative dentistry, they must be able to do it very well. The quality of their restorative work, just like their endodontics, should speak for itself.

References

1. Willershausen B, Tekyatan H, Krummenauer F, Briseno Marroquin B. Survival rate of endodontically treated teeth in relation to conservative vs post insertion techniques -- a retrospective study. *Eur J Med Res.* 2005 May 20;10(5):204-8.
2. Pratt I, Aminoshariae A, Montagnese TA, Williams KA, Khalighinejad N, Mickel A. Eight-Year Retrospective Study of the Critical Time Lapse between Root Canal Completion and Crown Placement: Its Influence on the Survival of Endodontically Treated Teeth. *J Endod.* 2016 Nov;42(11):1598-1603.
3. Yee K, Bhagavatula P, Stover S, Eichmiller F, Hashimoto L, MacDonald S, Barkley G 3rd. Survival Rates of Teeth with Primary Endodontic Treatment after Core/Post and Crown Placement. *J Endod.* 2018 Feb;44(2):220-225.
4. Abou-Elnaga MY, Alkhawariz MAM, Kim HC. Effect of Truss Access and Artificial Truss Restoration on the Fracture Resistance of Endodontically Treated Mandibular First Molars. *J Endod.* 2019;45(6):813-817.
5. Corsentino G, Pedullà E, Castelli L, Liguori M, Spicciarelli V, Martignoni M, Ferrari M, Grandini S. Influence of Access Cavity Preparation and Remaining Tooth Substance on Fracture Strength of Endodontically Treated Teeth. *J Endod.* 2018;44(9):1416-1421.
6. Plotino G, Grande NM, Isufi A, Ioppolo P, Pedullà E, Bedini R, Gambarini G, Testarelli L. Fracture Strength of Endodontically Treated Teeth with Different Access Cavity Designs. *J Endod.* 2017 Jun;43(6):995-1000.
7. Balkaya H, Topcuoğlu HS, Demirbuga S. The Effect of Different Cavity Designs and Temporary Filling Materials on the Fracture Resistance of Upper Premolars. *J Endod.* 2019 May;45(5):628-633.
8. Fokkinga WA, Kreulen CM, Bronkhorst EM, Creugers NH. Up to 17-year controlled clinical study on post-and-cores and covering crowns. *J Dent.* 2007 Oct;35(10):778-86.
9. Yuan K, Niu C, Xie Q, Jiang W, Gao L, Huang Z, Ma R. Comparative evaluation of the impact of minimally invasive preparation vs. conventional straight-line preparation on tooth biomechanics: a finite element analysis. *Eur J Oral Sci* 2016; Dec;124(6):591-596.
10. Sela K.F, Hussain SKF, McDonald A, Moles DR. In vitro study investigating the mass of tooth structure removed following endodontic and restorative procedures. *J Prosthet Dent* 2007;98:260-269.
11. Zhang Y, Liu Y, She Y, Liang Y, Xu F, Fang C. The Effect of Endodontic Access Cavities on Fracture Resistance of First Maxillary Molar Using the Extended Finite Element Method. *J Endod.* 2019 Mar;45(3):316-321.
12. Jiang Q, Huang Y, Tu X, Li Z, He Y, Yang X. Biomechanical Properties of First Maxillary Molars with Different Endodontic Cavities: A Finite Element Analysis. *J Endod.* 2018 Aug;44(8):1283-1288.
13. Krishan R, Paqué F, Ossareh A, Kishen A, Dao T, Friedman S. Impacts of conservative endodontic cavity on root canal instrumentation efficacy and resistance to fracture assessed in incisors, premolars, and molars. *J Endod.* 2014 Aug;40(8):1160-6.
14. Özyürek T, Ülker Ö, Demiryürek EÖ, Yılmaz F. The Effects of Endodontic Access Cavity Preparation Design on the Fracture Strength of Endodontically Treated Teeth:

Traditional Versus Conservative Preparation. J Endod. 2018 May;44(5):800-805.

15. Silva EJNL, Rover G, Belladonna FG, De-Deus G, da Silveira Teixeira C, da Silva Fidalgo TK. Impact of contracted endodontic cavities on fracture resistance of endodontically treated teeth: a systematic review of in vitro studies. Clin Oral Investig. 2018 Jan;22(1):109-118.

16. Rover G, Belladonna FG, Bortoluzzi EA, De-Deus G, Silva EJNL, Teixeira CS. Influence of Access Cavity Design on Root Canal Detection, Instrumentation Efficacy, and Fracture Resistance Assessed in Maxillary Molars. J Endod. 2017 Oct;43(10):1657-1662.

17. Wang Z, Shen Y, Haapasalo M. Root Canal Wall Dentin Structure in Uninstrumented but Cleaned Human Premolars: A Scanning Electron Microscopic Study. J Endod. 2018 May;44(5):842-848.

18. Molina B, Glickman G, Vandrangi P, Khakpour M. Evaluation of Root Canal Debridement of Human Molars Using the GentleWave System. J Endod. 2015 Oct;41(10):1701-5.

19. Saydjari Y, Kuypers T, Gutknecht N. Laser Application in Dentistry: Irradiation Effects of Nd:YAG 1064 nm and Diode 810 nm and 980 nm in Infected Root Canals-A Literature Overview. Biomed Res Int. 2016;2016:8421656.

20. Asnaashari M, Safavi N. Disinfection of Contaminated Canals by Different Laser Wavelengths, while Performing Root Canal Therapy. J Lasers Med Sci. 2013 Winter;4(1):8-16.

21. Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for anterior teeth. J Prosthet Dent. 2002 May;87(5):503-9.

22. Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for posterior teeth. Int J Periodontics Restorative Dent. 2002 Jun;22(3):241-9.

23. Bitter K, Meyer-Lueckel H, Fotiadis N, et al. Influence of endodontic treatment, post insertion, and ceramic restoration on the fracture resistance of maxillary premolars. Int Endod J. 2010 Jun, 43(6):469-77.

24. Tanalp J, Dikbas I, Malkonu O, Ersev H, Güngör T, Bayırlı G. Comparison of the fracture resistance of simulated immature permanent teeth using various canal filling materials and fiber posts. Dent Traumatol. 2012 Dec;28(6):457-64.

25. Torres-Sánchez C, Montoya-Salazar V, Córdoba P, Vélez C, Guzmán-Duran A, Gutierrez-Pérez JL, Torres-Lagares D. Fracture resistance of endodontically treated teeth restored with glass fiber reinforced posts and cast gold post and cores cemented with three cements. J Prosthet Dent. 2013 Aug;110(2):127-33.

26. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10):498-504.

27. Fonzar F, Fonzar A, Buttolo P, Worthington HV, Esposito M. The prognosis of root canal therapy: a 10-year retrospective cohort study on 411 patients with 1175 endodontically treated teeth. Eur J Oral Implantol. 2009 Autumn;2(3):201-8.

28. Lee AH, Cheung GS, Wong MC. Long-term outcome of primary non-surgical root canal treatment. Clin Oral Investig. 2012 Dec;16(6):1607-17.

29. Landys Borén D, Jonasson P, Kvist T. Long-term survival of endodontically treated teeth at a public dental specialist clinic. J Endod. 2015 Feb;41(2):176-81.

30. Prati C, Pirani C, Zamparini F, Gatto MR, Gandolfi MG. A 20-year historical prospective cohort study of root canal treatments. A Multilevel analysis. Int Endod J. 2018 Sep;51(9):955-968.

31. Olcay K, Ataoglu H, Belli S. Evaluation of Related Factors in the Failure of Endodontically Treated Teeth: A Cross-sectional Study. J Endod. 2018 Jan;44(1):38-45.

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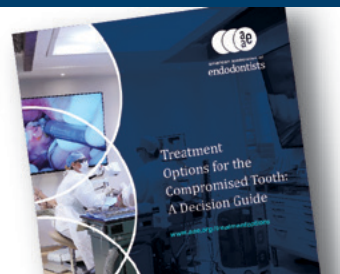


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