

**A new concept in conservatism Adult tooth pulpotomy: The promising success A nine years' study  
An evidence based study**

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**Abstract:** Adult tooth pulpotomy is continuously proving to be a more reliable pulpal therapy. The aim of this study was to assess the clinical success rates of adult tooth pulpotomy. Thirty permanent molars belonging to thirty healthy adults were included in this study. The treated teeth were re-evaluated after six weeks, six months, two, four, six and nine years; clinically and radiographically. For 28 teeth, clinical and radiographic examination revealed appropriate function, absence of any signs and symptoms and normal periodontium apparatus. This has been the clinical condition of all the examined cases until today. Further basic research should be carried out with larger samples and at, comparatively, longer evaluation time periods.

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**Key words:** pulpal therapy, adult pulpotomy.

### 1. Introduction

Concepts in restorative dentistry have been continually changing during the last decades. The process was, certainly, heading towards providing maximum function and esthetics with minimal removal of sound tooth structure<sup>(1,2)</sup>.

Historically, traditional endodontia has been reported to be a more reliable treatment than pulpotomy techniques<sup>(3-22)</sup>.

However, new researches are changing this view<sup>(3, 23, 24, 8-12)</sup>.

In light of conservative dentistry; endodontic treatment is a rather invasive procedure in comparison to pulpotomy. Also an endodontic treatment is a relatively expensive procedure, requiring several visits; mean while pulpotomy is a rather in-expensive single visit procedure.

Traditional endo has been described to have other additional drawbacks, e.g. the discomfort related to the anesthesia, rubber dams, especially with long periods with the mouth open, retreatments, post-op sensitivity, blowups, blocked canals, separated files, apicoectomies, hypochorite leaks, ledges, excessive biofilms, lateral canals, anastomoses, deltas, over fills, under fills, cracks, perforations and micro surgery<sup>(3, 5-7)</sup>.

A typical pulpotomy procedure is to open the tooth's pulp chamber, remove the decay and as much of the pulp tissue as practical, place the medication in the form of a cotton pellet or cement paste and then close the tooth with a restoration (e.g. composite). There are numerous types of

pulpotomies such as, partial pulpectomy, shallow pulpotomy and radicular pulpotomy<sup>(3)</sup>.

Several reports show adult tooth pulpotomies can have a success record approaching, if not surpassing, that of traditional endodontics<sup>(3, 13, 15)</sup>.

Our study of adult tooth pulpotomy with a nine years follow-up, clinically and radiographically; which is, relatively, a long evaluation time period; was conducted to evaluate the clinical success rate of adult tooth pulpotomy.

### 2. Method and materials

Thirty permanent molars belonging to thirty healthy adult males and females (fifteen males and fifteen females), were included in this study. Regarding all subjects, there were no medical contraindications for dental treatment. The patients aged fourteen to forty. By thorough clinical examination, all patients had good oral hygiene. The caries risk assessment (Table 1) measured the caries balance of a patient at a point in time, and the collected information led to an appropriate decision – making procedure in clinical treatment. Our treatment was evidence – based and the decision to perform adult pulpotomy for the individual patients was set according to their oral environment rather than treating all patients similarly. Moreover, our treatment included strategies that put the patients into a healthy balance, for example the patients did not only receive restorative treatment but also simple interventions with a remineralizing agent (CpP-Acp) (Recaldent) was used.

All patients had moderate-to-severe pain as a result of irreversible pulpitis. Teeth were examined to ensure pulp vitality and complete apical closure. Also an informed consent from each study participant was obtained. The patients included in this study were family members and close friends so as to facilitate recall and follow up along such a relatively long term study.

The first step, routinely, was anesthesia and isolation with a rubber dam. Caries was then removed using high speed burs with thorough irrigation. That was followed by pulpotomy. The pulp chamber was opened, further decay, in addition to, the inflamed pulp tissue were removed to orifice level using a large high speed round bur and appropriate water cooling. Sterile normal saline

irrigation along with sterile dry cotton pellets were used to stop any possible bleeding. A cotton pellet soaked with dilute formcresol (1:5 concentration of Buckley's formcresol) was placed on the exposed clot-free pulpal wound in order to destroy any infective organisms, mummify or fix any remaining tissue and render the infected tooth, aseptic (Table 2). All cavity walls were, then, conditioned and bonding performed in order to strengthen the remaining tooth structure. Afterwards a composite restoration was placed, light cured and finished. For all patients, the bonding system used was Single Bond (3M ESPE) which was applied in two consecutive coats. The resin composite restorative material used was filtek Z250 (3M ESPE). (Table 2).

Table 1:

**CariFree**  **CARIES RISK ASSESSMENT**

www.carifree.com 866.928.4445

Adults/Children Age 6 and Over

Patient Name: \_\_\_\_\_ Date: \_\_\_\_\_

Instructions: Check all answers that apply.

If **1 or more Disease Indicators** or **2 or more Risk Factors** are circled, then this patient is at risk and therapeutic intervention is recommended.

**1 ASSESS**

DISEASE INDICATORS	AT RISK	LOW RISK
Visible Cavitations	yes	no
Radiographic Lesions	yes	no
White Spot Lesions	yes	no
Cavity in Last 3 Years	yes	no

**RISK FACTORS**

Visible Plaque	yes	no
Inadequate Saliva Flow	yes	no
Hyposalivary Medications	yes	no
Acidic Beverages	yes	no
Frequent Snacking (1-3 times daily)	yes	no
Appliances Present	yes	no
Deep Pits and Fissures	yes	no
Other	yes	no

**TESTING**

CariScreen	9,999 – 1,501	1,500 – 0
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**2 DIAGNOSE**

Risk Assessment	AT RISK	LOW RISK
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**3 PRESCRIBE**

Treatment Kit                       Maintenance Kit

I understand my risk for caries based on this assessment, as well as the benefits of the recommendations for therapeutic intervention.

Release Signature: \_\_\_\_\_

\* Based on clinically proven Caries Risk Assessment Form in the Featherstone 2003-2005 study.  
 \* Caries risk criteria as defined by the American Dental Association Council on Scientific Affairs, JADA August 2006.

The treated teeth were re-evaluated after six weeks, six months two, four, six and nine years for clinical signs and symptoms (pain, swelling, tenderness, tooth mobility, fistula); using percussion tests, soft tissue examination, and palpation of teeth and alveolar areas; and radiographic changes.

### Statistical analysis

Qualitative data were presented as frequencies (n) and percentages (%). Friedman's test was used to study the changes by time. The significance level was set at  $P \leq 0.05$ . Statistical analysis was performed with IBM SPSS Statistics Version 20 for Windows.

**Table 2: Materials, batch number, type, composition and manufacturer**

Material	Type	Components	Manufacturer
Recaldent	Topical cream	<ul style="list-style-type: none"> <li>GC MI paste plus with flavors</li> </ul>	GC corporation Japan
Formcresol (Asept)	Disinfecting	<ul style="list-style-type: none"> <li>1.5 concentration of Buckley's formcresol (19% aqueous formaldehyde, 35% creosol in a solution of 15% glycerine and water)</li> </ul>	Product of Young Dental, 2418 Northline of industrial Blvd., Maryland Heights, U.S.A
3M™ ESPE™ Single Bond 20030609	Dental adhesive system	<ul style="list-style-type: none"> <li>Phosphoric acid etchant</li> <li>A vial of adhesive</li> </ul>	3M ESPE Dental Products St Paul, MN, USA
3M Filtek™ Z 250 2MT	Microhybrid composite	In organic filler: Zirconia/Silica (60% by volume) Matrix: BIS-GMA, UDMA and BIS-EMA resins	3M ESPE Dental Products St Paul, MN, USA

### 3. Results

#### Clinical examination

At all time periods (six weeks, six months, two, four, six and nine years), twenty eight of the treated teeth revealed appropriate function and absence of any signs and symptoms (e.g. pain, swelling tenderness, tooth mobility and fistula).

However, two of the treated teeth failed over fifteen months and two years periods; and needed traditional endodontic treatment.

#### Radiographic examination

At all time periods (six weeks, six months, two, four, six and nine years), twenty eight of the treated teeth appeared in function with normal periapical tissues and, generally, normal periodontium apparatus and absence of overt radiographic, intercanal or periapical pathology (Figs., 1-9). The very same above mentioned two teeth that showed signs of clinical failure also demonstrated radiographic changes indicating failure.

#### Statistical analysis:

Qualitative data were presented as frequencies (n) and percentages (%). Friedman's test was used to study the changes by time. The significance level was set at  $P \leq 0.05$ . Statistical analysis was performed with IBM ® SPSS ® Statistics Version 20 for Windows.

### 3. Results

As shown in table (3) & figure 10:

After 6 weeks as well as 6 months, all cases showed clinical success (100%).

After 2 years, 2 cases showed failure making a success rate of 93.3%. There was no

change in success rate through the rest of follow up period (4, 6 as well as 9 years).

The change in success rate over time was not statistically significant ( $P$ -value = 0.075).

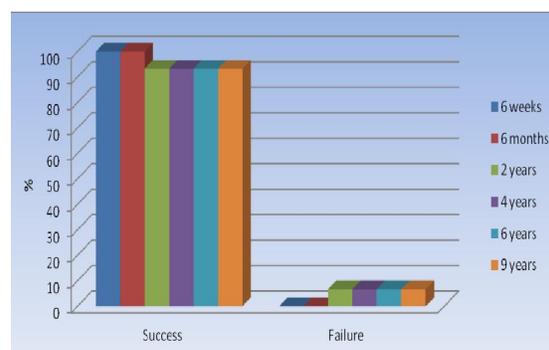
**Table (3): Frequencies (n), percentages (%) and results of Friedman's test for comparison between success rate at different follow up periods.**

Time	Success	Failure
6 weeks (n, %)	30 (100)	0 (0)
6 months (n, %)	30 (100)	0 (0)
2 years (n, %)	28 (93.3)	2 (6.7)
4 years (n, %)	28 (93.3)	2 (6.7)
6 years (n, %)	28 (93.3)	2 (6.7)
9 years (n, %)	28 (93.3)	2 (6.7)
<i>P</i> -value	0.075	

\*: Significant at  $P \leq 0.05$

® IBM Corporation, NY, USA.

® SPSS, Inc., an IBM Company.



**Figure (10): Bar chart representing changes in success rate.**

This success record approaches or even, surpasses, that of traditional endodontics. The condition of all successful cases in this study is still

maintained until the day of publishing of this paper which points out the way for further research.

**Radiographic Examination**



**Fig(1):** A radiograph of a maxillary first molar with an irreversible pulpitis (male, 31 yrs. old).



**Fig(2):** A radiograph of the same tooth four years after performing adult pulpotomy.



**Fig(3):** A radiograph of the same pulpotted tooth after nine years.



**Fig(4):** A radiograph of a mandibular first molar with an irreversible pulpitis (female, 38 yrs. old).



**Fig(5):** A radiograph of the same tooth two years after performing adult pulpotomy.



**Fig(6):** A radiograph of the same pulpotted tooth after nine years.



**Fig(7):** A radiograph of a mandibular first molar with an irreversible pulpitis (male, 15 yrs. old).



**Fig(8):** A radiograph of the same tooth two years after performing adult pulpotomy.



**Fig(9):** A radiograph of the same pulpotted tooth after nine years.

#### 4. Discussion

We are living in a world of increasing tendency towards conservative approaches. The concept of conservatism is currently expanding to include, almost, all medical fields particularly, the field of surgery.

In light of conservative dentistry, endodontic treatment is a rather invasive procedure in comparison to pulpotomy. Also an endodontic treatment is a relatively expensive procedure, requiring several visits; meanwhile pulpotomy is a rather inexpensive single visit procedure.

Historically, traditional endodontia has been reported to be a more reliable treatment than pulpotomy techniques<sup>(3, 4 - 22)</sup>. However new researches are changing this view,<sup>(3,23,24, 8-12)</sup>. This goes in accordance with our study.

Traditional endo has been described to have other additional drawbacks, e.g. the discomfort related to the anesthesia, rubber dams, especially with long periods with the mouth open, retreatments, post-op sensitivity, blowups, blocked canals, separated files, apicoectomies, hypochlorite leaks, ledges, excessive biofilms, lateral canals, anastomoses, deltas, over fills, under fills, cracks, perforations and micro surgery<sup>(3, 5-7)</sup>.

The selected subjects of this study were males and females to rule out any factors related to gender. Also, all of them happened to be family members and close friends in order to facilitate recall and follow up along such a relatively long term study.

For all patients, a preliminary medical examination was required to rule out any medical contraindications for dental treatment, and a preliminary dental examination was conducted to ensure pulp vitality and complete apical closure of the selected teeth for treatment. Our treatment was evidence – based and the decision to perform adult pulpotomy for the individual patients was set according to their oral environment rather than treating all patients similarly. Moreover, our treatment included strategies that put the patients into a healthy balance, for example the patients did not only receive restorative treatment but also simple interventions with a remineralizing agent (CpP-Acp) (Recaldent) was used.

In this study dilute formocresol was used in order to destroy any infective organisms, mummify or fix any remaining tissues and render the infected tooth aseptic. Although formocresol has been reported to be theoretically mutagenic, yet in the real world, no related cancer cases have been reported<sup>(25,26)</sup>. Also, the material was found, not to be associated with any overt neoplastic changes,

because, so little is used in pulp therapy<sup>(23,24,26)</sup>. Nevertheless, the material proved to be very efficient in rendering the infected tooth aseptic and, it allowed the tooth to remain comfortably for years.

On the other hand, other pulpotomy materials had clinical drawbacks. Some studies demonstrated the presence of tunnel defects in the dentinal barrier formed after calcium hydroxide pulp capping<sup>(27, 28, 29)</sup>; these could serve as pathways for micro leakage and pulp inflammation<sup>(27)</sup>. Eugenol pulpotomy, prevented pain for six months, however a long-term success was reported questionable<sup>(27, 30)</sup>. In recent years, mineral trioxide aggregate (MTA) has been introduced for pulpotomy, the material demonstrated good biocompatibility<sup>(27, 31)</sup>; excellent sealing ability<sup>(28)</sup>; and stimulation of healing in the pulpal tissue<sup>(27, 28, 32)</sup>. However despite its excellent properties, it has been reported that MTA showed disadvantages including a nonpredictable antimicrobial activity<sup>(27, 33)</sup>; difficult management, expanded setting time, and a high price<sup>(27, 34, 35)</sup>.

In this study, bonded resin composite restorations were used. It was thought appropriate to make use of the strengthening effect of bonding systems and the bonding procedure to strengthen the remaining tooth structure which would, certainly, impart to the longevity of the restoration. On the other hand, regarding micro leakage; it was postulated that one of the most important causes of failure in vital pulp therapy was the presence of leakage during the healing process because of the material used for pulpotomy or the restorative material used<sup>(27-29, 36-39)</sup>.

Therefore, in our study, a bonded resin composite restoration was used to reduce microleakage along the restoration tooth interface which, in turn, would impart to the longevity of the restoration.

It has to be noticed that conditioning of all cavity walls was performed directly after pulpal fixation, without resorting to the use of liners or bases, as it has been reported by several recent studies that the use of bonding systems could totally replace liner and bases<sup>(2)</sup>.

Except for two of the tested cases; at all testing time periods, clinical and radiographic evaluation of the rest of the cases; revealed appropriate function, absence of any signs and symptoms and normal periodontium apparatus. The success rate, in our opinion, was attributed to the different meticulous set up parameters of the test, e.g. selection of patients with good oral hygiene, appropriate clinical and radiographic inspection

through all evaluation time periods, skillful procedural management of the cases and proper selection of the materials as the use of bonded resin composite restorations. Nevertheless two cases were reported as failure cases which, in our opinion, could be attributed to individual variation as the general health including immunity of those subjects, in addition to factors related to home hygiene care, certain sleeping disorders and some bad habits.

The evaluation time in this study lasted for nine years, which is supposed to provide more reliable, evidenced and consistent results in comparison to several previous studies.

Regarding the success rates of adult pulpotomies, Derosa has shown 65 percent success rate of pulpotomies after eight years' follow up<sup>(16)</sup>.

Aguilar did a metaanalysis of PubMed adult pulpotomy studies, finding a 73 to 99 percent success range over three years<sup>(9)</sup>. Witherspoon described a 95 percent success rate for pulpotomies after 1.5 years<sup>(17)</sup>. Barrieshi-Nusair reported a 90 percent success rate of pulpotomies after two years<sup>(18)</sup>. Noorollahian demonstrated a 94 percent success rate after two years<sup>(19)</sup>. Honegger reported in a study of 123 teeth an 83 percent success rate after seven years<sup>(20)</sup>. These recent reports show adult tooth pulpotomies can have a success record approaching, if not surpassing, that of traditional endodontics.

Statistically, using Friedman's test this study demonstrated the following: After 6 weeks as well as 6 months, all cases showed clinical success (100%).

After 2 years, 2 cases showed failure making a success rate of 93.3%. There was no change in success rate through the rest of follow up period (4, 6 as well as 9 years).

The change in success rate over time was not statistically significant (P-value = 0.075). Moreover, the condition of all successful cases in this study is still maintained until the day of publishing of this paper which points out the way for further research.

### Conclusion

Pulpotomy can be used as an alternative therapy for adult teeth with irreversible pulpitis, providing a degree of success that is comparable to, if not surpassing, traditional endodontics.

### Recommendation

Further basic research should be carried out with larger samples and at comparatively longer evaluation time periods.

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