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# Apical Disposition of Isthmus in Maxillary Premolars: A Surgical Endodontic Problem

SUMMARY

*The isthmus is a narrow, ribbon shaped communication between 2 root canals that contains pulp tissue, which must be removed during the surgical endodontic treatment. The aim of the study was to assess apical canal morphology of maxillary premolars in vitro, as well as to locate and define the type of the isthmus. To achieve that task, 60 maxillary premolars (MP) were extracted, 30 for each premolar group. The apical samples were obtained by resection of the apical third of the root. The resected surfaces of each apical fragment were exposed to different methods of visual inspection, regarding the set aims.*

*Isthmus presence was detected in 90% of the examined samples, and 80% of MP with 2 canals on the resected root surface. Detected isthmuses were type II, III, IV, V. We detected a unique type of isthmus which consisted of 2 main, and numerous accessory canals. The isthmus incidence was higher as the resections were more distant from the apex.*

**Keywords:** isthmus, premolars, surgical endodontic

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## Introduction

The basic prerequisite for successful surgical endodontics is a thorough debridement of the root canal system and surrounding periapical area, and biological seal with inert material. Despite respecting this basic prerequisite failure can occur, especially when posterior teeth are in question (premolars and molars). Long-term studies of surgical-endodontic procedures confirm a less favourable prognosis after surgery of posterior teeth. Friedman et al[4] reported the success rate of 44.1% for 136 surgically treated roots of molars and premolars.

According to Carr[1] and Carr[2], most surgical failures were due to a lack of seal of the resected root, which Tam et al[8] explained by failure to detect and properly prepare the isthmus area of posterior teeth. A canal isthmus is defined as a narrow, ribbon shaped communication between 2 root canals, which contains pulp tissue[10]. The recognition and management of the isthmus is an important factor that could improve the success rate of peri-radicular surgery of posterior teeth[7].

Hsu et al[3] described 5 types of isthmus, depending on the number of the canals included in the isthmus formation, and what is of foremost importance for oral surgeons, in teeth with 2 canals, the 4 mm sections contain an isthmus in 100% of the time.

Premolars can vary widely in root canal anatomy, so it would be reasonable to expect some type of an isthmus in this teeth. Therefore, we established the **aims** of the study: (1) to determine the canal morphology of the apical third of the maxillary premolars; and (2) to evaluate the location and type of isthmus, as it plays a key roll in the success of surgical endodontics of posterior teeth.

## Material and Methods

To realize the set task, 60 MP were extracted, 30 for each premolar group (Fig. 1). The apical samples were obtained by resection of the apical third of the radix (Fig. 2).

The resected root surfaces of each apical fragment were exposed to direct visual inspection, then painted in methylen blue dye, and examined under focused light and x2 magnification (Figs. 3 and 4). At the Institute of Pathology, the samples were de-calcinated in 7.5% trichloracetate acid, exposed in a series of transversal sections 1mm each, starting from the apex, and numerated

from I to VI, each individually fixed upon 10% formalin, and painted in HE. Finally, the material was viewed with a Light microscope at x40 magnification.



*Figure 1. Extracted maxillary premolars*

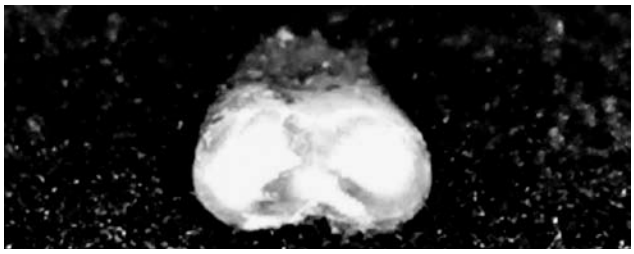


*Figure 2. Apical sample*

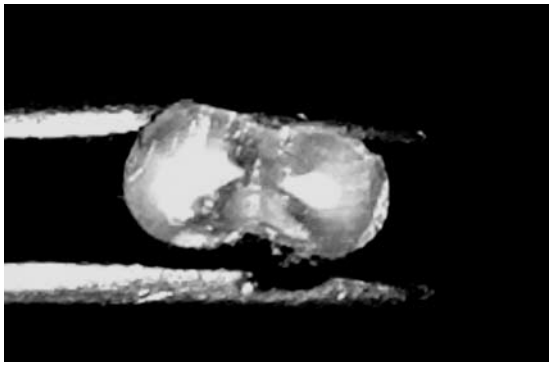


*Figure 3. Resected root surface viewed by naked eye*



*Figure 4. Resected root surface painted with methylen-blue*

## Results

We identified isthmus in 90% of the examined first MP, and 80% of second MP with 2 canals on the resected root surface, 6 mm from the apex. (Tabs. 1 and 2). Detected isthmus connections in the apical samples were of type II, III, IV and V, at different level of sections (Figs. 5-8).

*Table 1. Canal morphology of the resected root surface of the examined first MP*

| Number of canals | Samples of first MP | Isthmus incidence |
|---|---|---|
| 2 canals | 10 (33%) | 9 (90%) |
| 3 canals | 1 (3.1%) | / |
| 1 canal | 19 (63%) | / |
| Total | 30 (100%) | / |

*Table 2. Canal morphology of the resected root surface of the examined second MP*

| Number of canals | Samples of MSP | Isthmus incidence |
|---|---|---|
| 2 canals | 16 (53.3%) | 14 (80%) |
| 3 canals | 1 (3.4%) | / |
| 1 canal | 13 (43.3%) | / |
| Total | 30 (100%) | / |

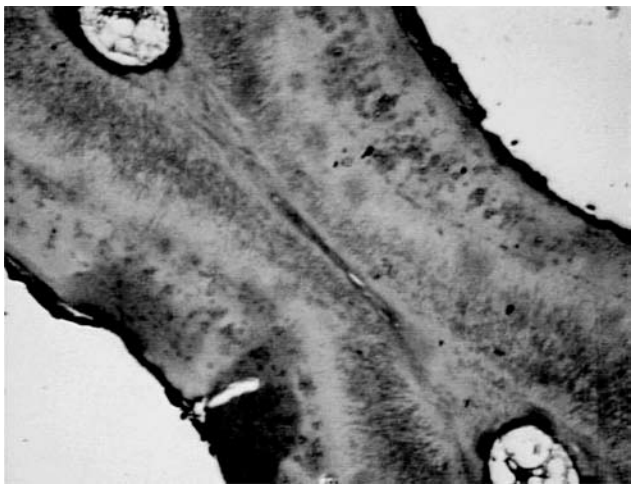


*Figure 5. Isthmus type II, Light microscopy x40 (HE)*

Hsu et al[3] defined Isthmus type II as 2 canals that possess a definitive connection. Type III differs from the latter only with the presence of 3 canals instead of 2. Incomplete C-shaped canals extended into the isthmus area were deemed type IV. Type V was recognized as a true connection.

Our data concerning the isthmus incidence at a different level of section confirmed high statistical significance for examined first and second MP (Diagrams

1 and 2). We discovered a unique type of isthmus which consisted of 2 main canals and numerous accessory canals (Fig. 9).



*Figure 6. Isthmus type III, Light microscopy x40 (HE)*

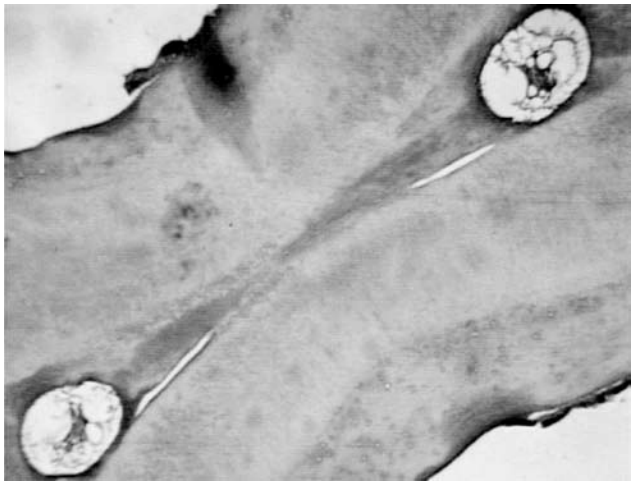


*Figure 7. Isthmus type IV, Light microscopy x40 (HE)*

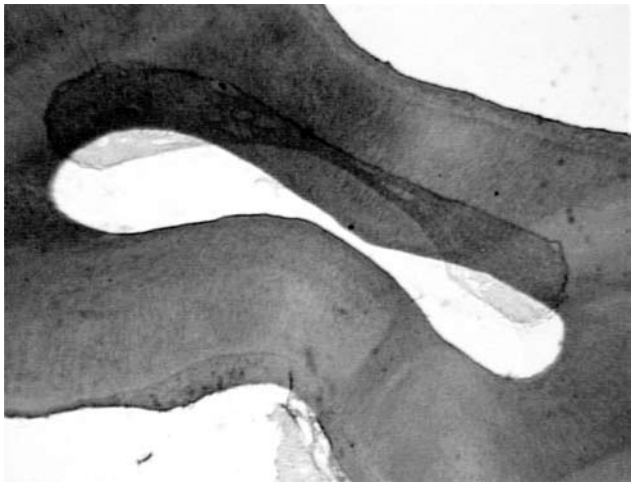
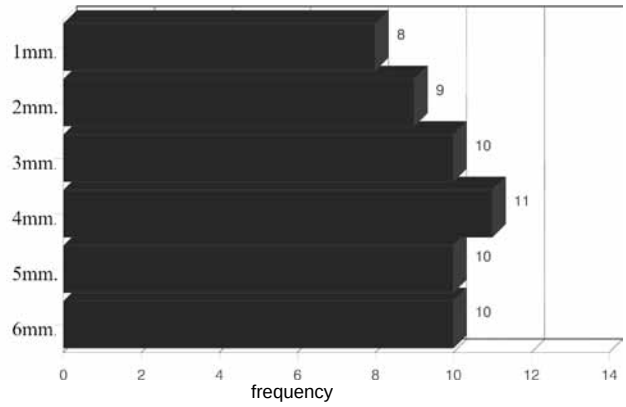


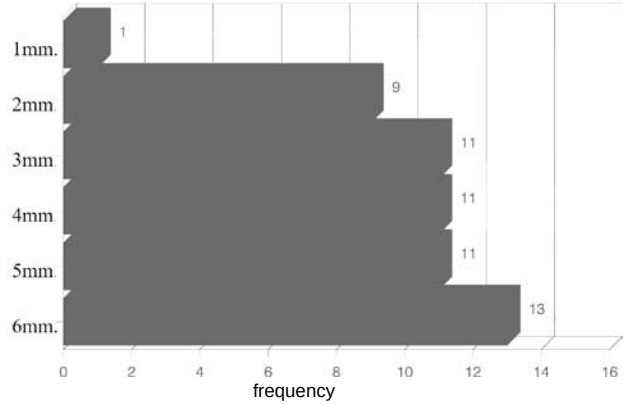
*Figure 8. Isthmus type V, Light microscopy x40 (HE)*

*Diagram 1. Isthmus incidence on different level of section for maxillary first premolars*




F = 2.32 ; DF = 5 ; P < 0.05 *

*Diagram.2. Isthmus incidence on different level of section for maxillary second premolars*




F = 2.98; DF = 5 ; P < 0.05 *

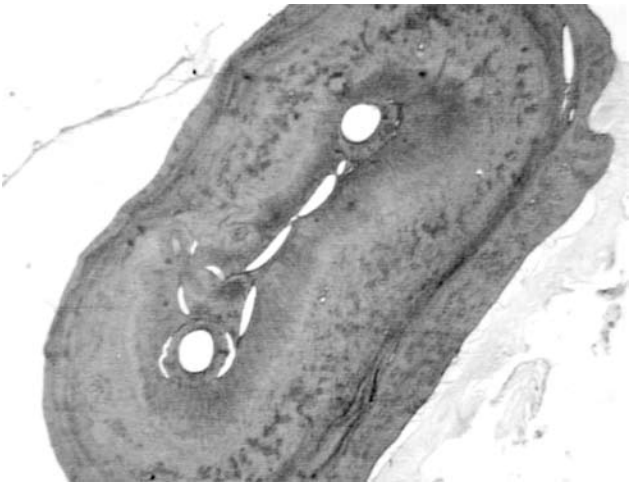


*Figure 9. Unique type of Isthmus*

## Discussion

When performing surgical endodontics on posterior teeth, oral surgeon must routinely look for isthmus connections. But traditional surgical techniques do not obtain good visualization of the entire resected root surface. This is partially due to an inadequate light source, and also, because during the surgical procedures oral surgeon doesn't use visual aid.

In our study, we implemented different methods of visualization (naked eye, blue dye and magnifying loupe x2), and finally, as a check up method, light microscopy. The blue dye enhances the visualization of the entire resected root surface by deposition on the soft tissue and empty spaces. Thus, isthmuses, missed canals, leaking fillings, and fractures can be accurately stained and enhanced with this dye. In our study, engaged methods of visualization showed no statistical significance on the meter of gained results. This could be explained by the *in vitro* nature of our study (we could adapt the light source and our objects of interest, to gain best view of the target area).

The literature is insufficient with data concerning the isthmus incidence in apical portion of MP. Our data concerning incidence of isthmus at a different level of section confirmed high statistical significance for the examined first and second MP, and this is in accordance with data reported by Hsu[3] (Diagrams 1 and 2). In other words, the further we go from the apex more isthmus we can expect.

As Tam et al[8] reported, any opening on the resected root surface acts as a portal of exit, or foramen. Endodontic surgery should seal all portals of exit of the root canals system and the isthmuses, to eliminate bacteria and their by-products from contaminating the peri-radicular tissues Mc Donald et al[5].

Enhanced visualization is an integrative part of contemporary surgical endodontics. Surgical binoculars providing 2-3.5 times magnification, operative head lamps and fibre optics illumination, have been a part of the practitioner's armamentarium for many years. Operating microscope and endoscope are the latest addition to this armamentarium[9]. Retro preparations performed by piezoelectric ultrasound handpiece and specially designed retro tips, must include isthmus formations.

## Conclusions

The isthmus connection can be observed between any 2 root canal systems that occur within one root.

Our study confirmed that almost all apical samples of MP with 3 canals had isthmus connections.

The isthmus incidence is higher as the resection is more distant from the apex.

The preparation of the root surface must incorporate the isthmus area.

Present-day surgical techniques that provide better visualization, retro preparations performed by piezoelectric ultrasound handpiece and specially designed retro tips, are the best tool that will improve the outcome of surgical endodontics of posterior teeth (Figs. 10 and 11).

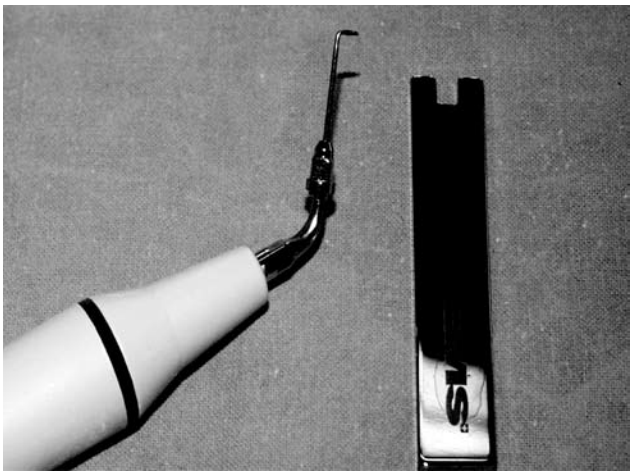


*Figure 10. EMS Retro Berruti*



*Figure 11. Retro-preparation of second MP performed by EMS piezo handpiece and Retro Berruti*

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