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An in vitro study of the Sealing Ability of Materials Used for Furcation Perforation Treatment

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SUMMARY

The aim of the study was to determine the sealing ability in vitro of the materials used for furcation perforation (FP) treatment, using Methylen blue dye. Thirty extracted human molar multi-rooted teeth and a synthetic bone substance (Bioplant HTH), amalgam, and MTA (mineral trioxide aggregate) were used in this study. The access openings to all teeth canals were made, and 1.5 mm diameter FPs were drilled. A sponge and wax were used to surround FP , and the teeth were plastered. The teeth were randomly divided into three groups: A (filled with amalgam), B (amalgam and HTR as internal matrix), C (filled with MTA). The whole surface of the teeth was covered in nail varnish, except for the site of the perforation. The teeth were immersed in Methylen blue dye for 4 days, in temperature +37°C. Vertical incisions were made and excess of the amalgam were measured in Groups A and B, dye penetration(mm) in all groups. The dye leakage was observed in all teeth groups, however, in Group C (filled with MTA) it was significantly less($p<0,001$). Synthetic bone substance, using it as an internal matrix, reduced the penetration of filling material into the periodontium to the minimum.

Key words: Furcation perforation, MTA (mineral trioxide aggregate), sealing ability, internal matrix.

Furcation perforation (FP) is one of the procedural accidents that can occur in dental practice. According to other authors, perforations constitute about 9.5% of all endodontic complications [1]. Data on the number of perforations vary, as different authors have different classifications of complications and criteria of failure during their research. The goal of FP repair is to maintain intact periodontium and to prevent bacterial infection. Perforation repair may be achieved either through a conservative, non-surgical technique, or by employing surgical intervention. The choice of the treatment depends on the size of the perforation, the damage to the periodontal tissue, the time between the perforation was done and it repair, the tooth canal condition, and the visibility of the defect. The main principle of conservative FP treatment is to seal the defect with filling material as soon as possible [2]. Various materials can be utilized for non-surgical FP repair: amalgam, glass ionomer cements, IRM, composits, compomers, MTA (mineral trioxide aggregate). Various researches are being carried out to evaluate the advantages and disadvantages of these materials. The important properties of these materials include: good retention, minimal leakage, biocompatibility, moisture resistance, and insolubility in oral fluids. The problem with the conservative approach is the difficulty to control the exact depth of FP filling. If the filling material gets into periodontium, it can not ensure the exact filling of the perforation cavity, what will result in more marginal leakage of the filling material and the risk of infection spreading into periodontium. Furthermore, the filling material will have an irritant effect on the periodontal tissues, what may result in inflammation (the injury will depend on the properties of the material) [2]. In order to prevent the repair material from getting into the periodontal tissue, a conservative repair approach based on internal matrix theory has been suggested [3]. According to this theory, the barrier is formed preventing the repair material from getting into the periodontal tissue. Materials that can be used in the role of internal matrix are the following: tricalcium phosphate, hydroxylapatite, dentin chips, liophylised bone, HTR (synthetic bone substance). Perforation repair technique using the internal matrix: the chosen material is entered through FP cavity in order to form a filling material barrier and to restore the bone defect. The material is being condensed till end of FP(or depth of FP), which length measured using electronic apex locator. Using the barrier material, the bleeding is controlled, which ensures a better adaptation of repair material to FP margins. The aim of the study was to determine the sealing ability in vitro of the materials used for furcation perforation (FP) treatment, using Methylen blue dye.

MATERIAL AND METHODS

Thirty extracted human molar multi-rooted teeth were used in the study. The materials chosen for FP repair were the following: amalgam and MTA (mineral trioxide aggregate). Amalgam is the oldest and most widely used material, whose disadvantages include marginal leakage due to contraction, moisture sensitivity, and complex retention. In order to prevent amalgam from getting into the periodontal tissue, we used a synthetic bone substance, Bioplant HTR, as an internal matrix. MTA is a root repair material composed of tricalcium silicate, tricalcium aluminate, tricalcium oxide, silicate oxide, and other mineral oxides.The material consists of hydrophilic particles which set in about 4 hours in the presence of moisture, and has pH of 12,5 [4]. According to other authors, this material is biocompactible and has an inductive effect on cementoblasts. Therefore, even if it does get into the periodontal ligament, the tooth cement continuity on its surface is formed [1,5,6]. In the teeth used for the study, the endodontic cavities were prepared, canal access openings found, and 1.5 mm FP drilled. The thickness(or depth) of FP (i.e. the length clinically determined by electronic apex locator)measured. Shaping the firmness of periodontal tissue, root furcation was filled with sponge piece and wax, and the teeth were plastered.All teeth were randomly divided into 3 groups: A, B and C. The root perforations of Group A were filled with amalgam, and those of

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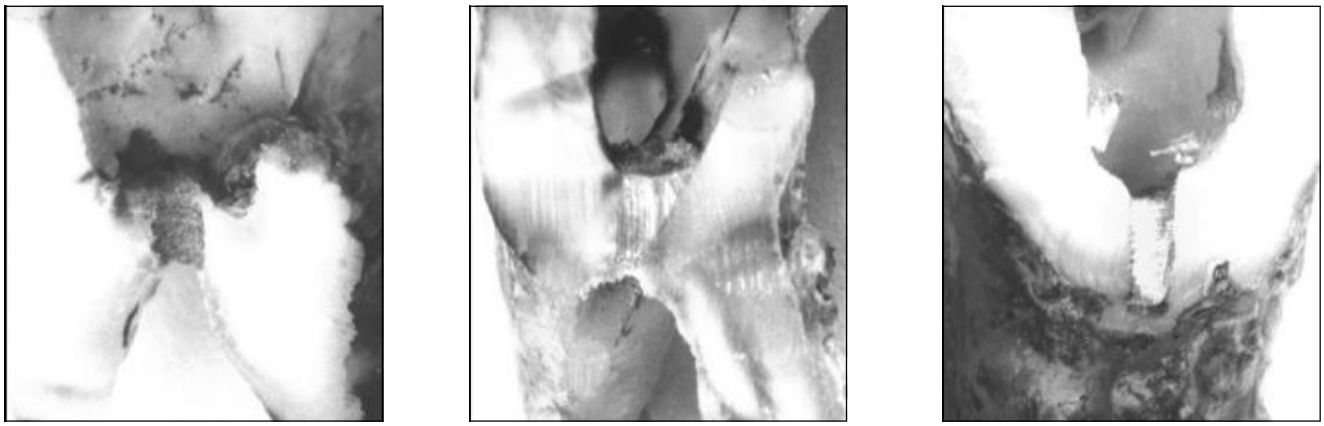


Figure 1. *Furcation perforation(FP) filled with different repair materials. A. FP filled with amalgam; B. FP filled with amalgam and HTR(as internal matrix); C. FP filled with MTA.*

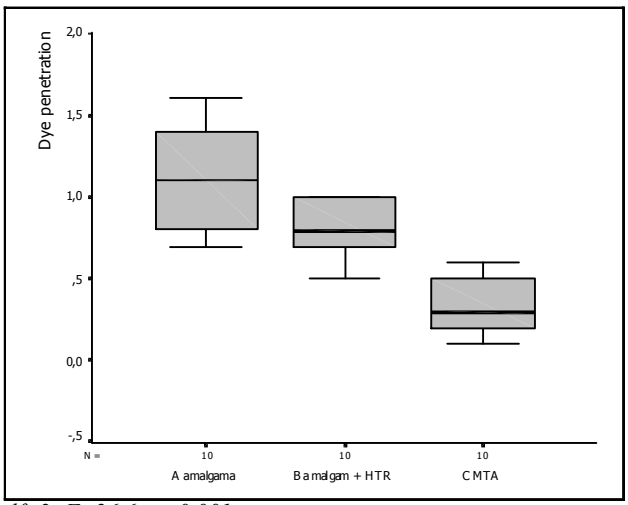
Group B – with amalgam and HTR using it as an internal matrix. Grains of synthetic bone substance were entered into the plastered teeth of this group until the instrument reached the fixed depth of the perforation. Then, the perforations were filled with amalgam. The furcation perforations of Group C were filled with MTA. The whole surface of the teeth was covered in nail varnish, except for FP site. The teeth were immersed in Methylen blue dye for 4 days, in temperature +37°C. Then, vertical incisions were made (fig.1) and the dye leakage(mm)(fig.2), excess of the amalgam(mm)(table1) measured.

Table 1. *Overfill of amalgam (mm) after repair of furcal parforations with use of internal matrix (B) and without it (A).*

Group	n	Overfill of amalgam			
		< 0.3	<0.5	<1.0	>1.0
A	10	-	3	3	4
B	10	4	3	-	-

Table 2. *Relation between excess and leakage of amalgam.*

Group	n	Overfill of amalgam	Leakage (mm) of amalgam
A	10	0,86 ± 0,14	1,09 ±
B	10	0,17 ±	0,82 ±



df=2; F=26,6; p<0,001

Figure2. *Results of dye penetration(mm) after repair of furcal perforation*

RESULTS

The results of the study are presented in fig.2 and tables 1 and 2.All cases of our research have demonstrated a leakage of the repair material, although in the teeth of Group C (filled by MTA) it was significantly lower than in Groups A and B(filled with amalgam)($p<0,001$).Statistical data analysis was performed by using SPSS data analysis package. Quantitative value comparison was performed by using T.Student and F.Fisher criterion. The study has also exhibited a higher leakage in the teeth filled only with amalgam than in those filled both with amalgam and HTR (internal matrix) . In the group of teeth, where the internal matrix was not used, the excess of amalgam ranged from 0.5 mm to 1 mm, and in four cases exceeded 1 mm. However, with the use of internal matrix, the excess of amalgam did not exceed 0.5 mm, and in some cases no excess was observed at all

DISCUSSION

Prior to discussing the results, it should be pointed out that the numbers are valid only in vitro conditions. In vivo, the results may be different due to additional conditions, such as bleeding and defect visibility. These conditions aggravate technical possibilities of perforation repair. Similar studies of different authors show different results [1,5,6,7,8]. A number of factors can account for these differences: different methodologies used in the research (dye material leakage, bacteria leakage, fluid filtration, etc.), different dye materials and different techniques employed by the researcher. Higher leakage in the teeth filled only with amalgam than in those filled both with amalgam and HTR is related tothe excess of amalgam in the periodontal tissue. The excess of amalgam and the leakage in Group A were higher than in Group B, where the excess and leakage were respectively lower($p<0,05$)(table 2).This can be explained by the fact that the higher the excess, the worse the retention of the material, and therefore the higher marginal leakage. The results of our study strongly suggest that the root FP treated using MTA has a more favourable prognosis because a better sealing ability of this material. The better prognosis of root furcation treatment using MTA is also related to the properties of this material: setting in the presence of moisture (which makes the procedure easier even in the presence of bleeding), biological compatibility and inducement of cementoblasts (therefore it is suitable for repairing perforations larger than 2 mm in diameter without the use of internal matrix) [7]). As these properties are absent in amalgam, its use for FP treatment is more technically complicated and has a poorer long-term prognosis than using MTA. However, the prognosis of FP treatment will depend not only on repair material, but also on the conditions, which must be evaluated prior to the choice of treatment approach (mentioned in the introduction).

CONCLUSIONS

1. Under the conditions of this research, the sealing ability of MTA has been proven to be superior to that of amalgam.

2. The results of this study demonstrate that the use of a synthetic bone substitute(HTR) in FP treatment prevents the repair material from getting into the periodontal tissue.

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