Influence of access cavity designs, root canal enlargement and short-term calcium hydroxide intracanal medicament on fracture susceptibility of root-filled teeth

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Introduction

Tooth fracture is a common cause of tooth loss. Endodontic treatment is associated with loss of tooth structure when an access cavity is cut and the root canals are enlarged. Intracanal medicaments can change the structure and quality of dentine which also affects the tooth's mechanical properties.

Fracture susceptibility is routinely assessed *in-vitro* with the Instron Universal Test Machine. The effects of access cavity preparation, root canal preparation and calcium hydroxide on the force required to fracture teeth have been assessed with this method. Unfortunately, the effect of mastication has been overlooked and the models lack clinical relevance when dentine specimens or roots without coronal tooth structure and/or restorations have been used, root canal treatment was not or was only partially performed, the load was applied from an angle or vertically via D11 spreaders in the canals, and periodontal ligament and alveolar bone simulation were not considered. The use of simulated chewing prior to testing for fracture may provide more precise information about the clinical performance of root-filled teeth.

Aims

The aims were to investigate whether the force required to fracture root-filled and restored mandibular molars is affected by:

(1) simulated chewing,

(2) access cavity designs,

(3) degree of root canal enlargement, and

(4) short-term exposure to calcium hydroxide.

Methods

An *in-vitro* controlled trial was conducted using human mandibular molars without previous restoration. Quantitative methods were used to measure the forces required to fracture the teeth after root-filling and access cavity restoration. Generally, all samples had standardised endodontic treatment (except the variable being tested) and an amalgam restoration. Teeth were mounted in acrylic with a simulated periodontal ligament. Forces required to fracture the teeth were determined with an Instron Universal Test Machine and results were statistically analysed.

Experiment (1): Thirty-one samples were used - one group had the equivalent of three years' mastication with a chewing simulator while the others did not.

Experiment (2): Consisted of 10 intact control teeth (NT) and 31 experimental teeth in each group. Two access cavity designs (CONS and SLA) were tested with and without simulated chewing groups.

Experiment (3): Consisted of four groups (n = 15). Controls had no mechanical root canal preparation. Hedström files (HF), ProTaper Ni-Ti rotary files (PT), and ProTaper plus SystemGT Ni-Ti rotary files (GT) were used to prepare canals. All samples were subjected to simulated chewing prior to testing.

Experiment (4): Thirty-two samples were used. $Ca(OH)_2$ paste was placed in the canals of the experimental group for four weeks prior to root canal filling and amalgam restoration. Controls received similar treatment without $Ca(OH)_2$. The samples were exposed to simulated chewing prior to testing.

Results

Experiment (1): Mean forces were 2708 ± 711N and 2757 ± 783N in experimental and control groups, respectively, without significant difference.

Experiment (2): Mean forces were 2708 ± 711N, 2931 ± 685N, 3360 ± 309N, 2757 ± 783N, 2715 ± 740N, 3224 ± 650N in $CONS_c$, SLA_c, NT_c, $CONS_{nc}$, SLA_{nc} and NT_{nc}, respectively. Differences were not significant between CONS, SLA, NT groups, and between groups with and without simulated chewing. The influence of access cavity design was not dependent on simulated chewing and vice versa.

Experiment (3): Mean forces were 2972 ± 793N, 2931 ± 685N, 2883 ± 958N, 2884 ± 661N in the control, HF, PT and GT groups, respectively. These differences were not significant.

Experiment (4): Mean forces were 2949 ± 904N and 2708 ± 711N in experimental and control groups, respectively. The differences were not significant.

Conclusions

In mandibular molars with intact marginal ridges and amalgam restorations in the access cavity:

(1) Simulated chewing had no effect on the force required to fracture the teeth.
(2) Extent of access cavity preparations and simulated chewing did not affect the force required to fracture teeth.
(3) Mechanical preparation of the root canals had no influence on the force required to fracture the teeth, regardless of the degree of root canal enlargement.
(4) The use of calcium hydroxide as a short-term intracanal medicament had no effect on the force required to fracture the teeth.

These results suggest that the increased fracture risk of teeth is mainly associated with loss of coronal tooth structure

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