

LUIZA CRUZ GUIMARÃES

**TRATAMENTOS ENDODÔNTICOS REALIZADOS EM UMA
CLÍNICA DE GRADUAÇÃO: *CARACTERÍSTICAS DOS CASOS,
PREVALÊNCIA DE FRATURAS DE INSTRUMENTOS E
PERCEPÇÃO DOS ALUNOS***

Faculdade de Odontologia
Universidade Federal de Minas Gerais
Belo Horizonte
2020

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PERCEPÇÃO DOS ALUNOS***

Tese apresentada ao Programa de Pós-Graduação em Odontologia da Faculdade de Odontologia da Universidade Federal de Minas Gerais como requisito parcial à obtenção do título de Doutor em Odontologia – área de concentração: Endodontia.

Orientadora: Prof.^a Dr.^a Ana Cecília Diniz Viana

Co-Orientadora: Prof.^a Dr.^a Renata de Castro Martins

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FOLHA DE APROVAÇÃO

TRATAMENTOS ENDODÔNTICOS REALIZADOS EM UMA CLÍNICA DE GRADUAÇÃO: CARACTERÍSTICAS DOS CASOS, PREVALÊNCIA DE FRATURAS DE INSTRUMENTOS E PERCEPÇÃO DOS ALUNOS

LUIZA CRUZ GUIMARÃES

Tese submetida à Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em Odontologia, como requisito para obtenção do grau de Doutor, área de concentração Endodontia.

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Desde a defesa da dissertação do Mestrado, há quatro anos atrás, percebo em mim um enorme amadurecimento pessoal e evolução profissional.

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“É muito melhor arriscar coisas grandiosas, alcançar triunfos e glórias, mesmo expondo-se à derrota, do que formar fila com os pobres de espírito que nem gozam muito nem sofrem muito, porque vivem nessa penumbra cinzenta que não conhecer a vitória nem a derrota”.

(Theodore Roosevelt)

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RESUMO

O estudo avaliou os tratamentos endodônticos realizados nas clínicas de Endodontia da Faculdade de Odontologia da UFMG. Trata-se de um estudo transversal que analisou os procedimentos de urgência prévios e finalização dos casos, à prevalência de fraturas de instrumentos endodônticos e às percepções dos alunos frente a essa ocorrência e a prática endodôntica. Os dados foram obtidos nos prontuários clínicos e no acompanhamento dos atendimentos, durante dezoito meses, entre os anos de 2017 e 2018. As percepções dos estudantes foram levantadas através da aplicação de um questionário. Os dados foram analisados descritivamente por meio de frequência absoluta e relativa e análise bivariada realizada utilizando o teste Qui-Quadrado de Pearson com correção de Bonferroni considerando um nível de confiança de 95%, e probabilidade de significância de 5% ($p \leq 0,05$) no SPSS v. 22. Os molares ($p > 0,0001$) e os dentes diagnosticados com necrose pulpar ($p < 0,0001$) foram os mais relacionados a procedimentos de urgência prévios. A maioria dos tratamentos endodônticos foram finalizados (85,9%). A taxa de finalização foi menor entre adolescentes comparados com jovens ($p = 0,006$) e adultos mais velhos ($p = 0,003$), em dentes molares comparados com dentes anteriores ($p = 0,005$) e pré-molares ($p = 0,003$), em dentes que passaram por urgência prévia ($p = 0,002$) e em pacientes que faltaram às consultas ($p = 0,014$). Ocorreram fraturas de limas rotatórias em 3,9% dos casos em canais curvos de molares (66,7%). Fragmentos localizados no terço coronário/médio (61,3%), medindo mais de três milímetros (72,2%) e foram removidos ou ultrapassados em metade das ocorrências. A maioria dos estudantes relatou controlar o número de usos (88,9%) e em 66,7% dos casos a fratura ocorreu até o terceiro uso. Os alunos relataram dificuldades (98,0%), a maioria relacionada à procedimentos técnicos (54,1%) e a morfologia e localização dos dentes (26,8%). Para os estudantes que não relataram a ocorrência de fraturas, a maioria relatou que seu interesse (88,2%) e confiança (83,9%) não seriam influenciados caso esse incidente ocorresse. Já os alunos que de fato tiveram a experiência de fratura, observou-se uma diminuição desse percentual para 44,5% e 33,3%, respectivamente. O estudo evidenciou um número satisfatório de tratamentos concluídos demandando poucas sessões. A não finalização foi associada à complexidade anatômica dos molares, à baixa idade dos pacientes e ao absenteísmo. A prevalência de fraturas de instrumentos endodônticos foi baixa. Os aspectos relacionados a elas sugerem sobrecarga torcional como a causa mais provável. As dificuldades mais relatadas estão relacionadas a falta de habilidades técnicas ou a complexidade anatômica dos molares. A percepção sobre a própria confiança e interesse na especialidade parece ser diretamente afetada pela ocorrência de fratura de instrumentos.

Palavras-chave: Epidemiologia. Endodontia. Ensino. Odontologia. Percepção.

ABSTRACT

Endodontic Treatments Performed in a Graduation Clinic: Characteristics of the cases, Prevalence of Instrument Fracture and Student's Perceptions

The study evaluated the endodontic treatments performed in the Endodontic clinics of UFMG School of Dentistry. This is a cross-sectional study that analyzed the previous urgent procedures, the completion of the cases, the prevalence of fractures of endodontic instruments and the perceptions of students regarding such occurrence and endodontic practice. Data were obtained through clinical records and during clinical practice during eighteen months between the years of 2017 and 2018. Students' perceptions were raised through the application of a questionnaire. Data were analyzed in a descriptive way by absolute and relative frequency and bivariate analysis performed using the Pearson's Chi-Square test with Bonferroni correction considering a 95% confidence level and 5% significance probability ($p \leq 0,05$) in SPSS v. 22. The molars ($p > 0.0001$) and the teeth diagnosed with pulp necrosis ($p < 0.0001$) were the most related to previous emergency procedures. 85.9% of endodontic treatments were completed. Treatments were less finalized in adolescents compared with young people ($p = 0.006$) and older adults ($p = 0.003$), in molar teeth compared with anterior teeth ($p = 0.005$) and premolars ($p = 0.003$), in teeth that had previous emergency treatments ($p = 0.002$) and in patients who missed appointments ($p = 0.014$). Instrument fractures occurred in 3.9% of cases in curved canals of molar teeth (66.7%). Fragments were located in the coronal/middle third (61.3%), measuring more than three millimeters (72.2%) and removed or exceeded in half of the occurrences. Most students reported controlling the number of uses (88.9%) and in 66.7% of fractured occurred in up to the third use. Students reported difficulties (98.0%), most technical procedures (54.1%) and to the morphology and location of teeth (26.8%). For students who did not report the occurrence of fractures, the majority reported that their interest (88.2%) and confidence (83.9%) would not be influenced in case of a fracture. Among the students who had the fracture experience, a decrease in this percentage was observed, 44.5% and 33.3% respectively. The study showed a satisfactory number of completed treatments requiring few sessions. The conclusion was associated with the anatomical complexity of the molars, the low age of the patients and absenteeism. The prevalence of fractures of endodontic instruments was low. The aspects related to them suggest torsional overload as the most likely cause. The most related difficulties are the lack of technical skills or the anatomical complexity of the molars. The perception of their own confidence and interest in the specialty seems to be directly affected by the occurrence of instrument fractures.

Keywords: Dentistry. Epidemiology. Endodontics. Perception. Teaching.

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LISTA DE ABREVIATURAS

AI	Aço inoxidável
COEP/UFMG	Comitê em Ética em Pesquisa da Universidade Federal de Minas Gerais
FAO UFMG	Faculdade de Odontologia da Universidade Federal de Minas Gerais
NiTi	Níquel-Titânio
SCR	Sistema de Canais Radiculares
SPSS	Statistical Package for the Social Sciences
SUS	Sistema Único de Saúde

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CONSIDERAÇÕES INICIAIS

1 CONSIDERAÇÕES INICIAIS

O Sistema Único de Saúde (SUS) é um dos maiores sistemas de saúde pública do mundo e observando os princípios estabelecidos de universalização, descentralização, equidade, integralidade e participação social, assegura à população brasileira acesso às ações e serviços de saúde, incluindo atenção à saúde bucal pela política nacional de saúde bucal, intitulada Brasil Sorridente. Tal política trouxe transformações e melhorias de vida de grupos populacionais, muitas vezes de baixa renda, que dependem dos serviços públicos de saúde (JUNQUEIRA *et al.*, 2008; PUCCA *et al.*, 2009; PEDRAZZI *et al.*, 2011; PAIM *et al.*, 2011; BRASIL, 2018).

Tornou-se assim, cada vez mais importante a integração entre os serviços do SUS e o ensino odontológico, capaz de inserir o aluno de graduação no cotidiano do serviço público e possibilitar o desenvolvimento de competências e habilidades para atuar na prestação de serviços à população, seja durante ou após sua graduação (CARRER *et al.*, 2019). Desta forma, a Faculdade de Odontologia da Universidade Federal de Minas Gerais (FAO UFMG) faz parte da rede hierarquizada de atenção à saúde do SUS e recebe diariamente pacientes encaminhados de centros de saúde da prefeitura de Belo Horizonte, por meio do sistema de regulação desses serviços. Neste contexto, os pacientes têm acesso à tratamentos endodônticos por meio das disciplinas práticas e teórico-práticas do curso.

O curso de graduação da FAO UFMG tem um currículo que consiste em 10 semestres. As disciplinas de endodontia fazem parte da grade curricular do quinto e sétimo semestres. Durante o quinto semestre, os alunos cursam a disciplina de Endodontia I e têm seu primeiro contato com a área (através de aulas teóricas, pré-clínicas e clínicas) e suas primeiras oportunidades de realizar tratamentos endodônticos simples (incisivos, caninos e pré-molares; superiores e inferiores). Durante o sétimo semestre, os alunos cursam a disciplina de Endodontia II e realizam tratamentos endodônticos mais complexos (molares superiores e inferiores). A experiência com a prática clínica endodôntica continua ao longo dos semestres subsequentes, nas disciplinas de Clínica Integrada e em alguns Projetos de Extensão.

O tratamento endodôntico consiste no preparo mecânico-químico do Sistema de Canais Radiculares (SCR) e envolve técnicas de limpeza, formatação e desinfecção,

propiciando uma obturação tridimensional e conseqüentemente o sucesso da terapia endodôntica (RUDDLE, 2005). As limas endodônticas são utilizadas como agentes mecânicos durante estes procedimentos e podem ser fabricadas com ligas de aço inoxidável (AI) ou níquel-titânio (NiTi) (CHEUNG *et al.*, 2007; UNGERCHTS *et al.*, 2014). Nos últimos anos, a instrumentação mecanizada utilizando as limas rotatórias de NiTi tornou-se popular, pois permite a realização da limpeza e formatação dos canais radiculares com mais facilidade, rapidez e previsibilidade (BAUMANN, 2004).

O ensino da instrumentação mecanizada com a utilização de instrumentos de NiTi é realizado em diversas universidades ao redor do mundo. Muitos autores já reportaram em seus estudos as vantagens dessa técnica na aprendizagem dos estudantes, e salientam a importância de um treinamento pré-clínico antes da utilização em pacientes (YARED *et al.*, 2001; HANNI *et al.*, 2003; SONNTAG *et al.*, 2003). Embora as técnicas de instrumentação mecanizada ainda não sejam o procedimento básico de ensino na totalidade das Faculdades de Odontologia do Brasil, muitos serviços odontológicos particulares e públicos utilizam essa tecnologia. Por isso, parece sensato que os cursos de odontologia abordem pelo menos uma técnica rotatória na graduação (HANNI *et al.*, 2003; SPANGBERG, 2011).

Na FAO UFMG a instrumentação mecanizada do SCR utilizando instrumentos rotatórios de NiTi tem sido ensinada desde 2012 (MARTINS *et al.*, 2012; SEIJO *et al.*, 2013) empregando o sistema ProTaper Universal (Dentsply Sirona, Ballaigues, Suíça), utilizado até o final do segundo semestre de 2017, e seu sucessor, o sistema ProTaper Next (Dentsply Sirona, Ballaigues, Suíça), introduzido a partir do início do primeiro semestre de 2018. O Sistema ProTaper Universal é confeccionado com a liga Níquel-Titânio superelástica convencional e possui uma secção transversal triangular convexa. É composto por uma seqüência de 6 limas, sendo as três primeiras de formatação (S1, S2 e SX) e as outras de acabamento (F1, F2 e F3) (RUDDLE, 2005). O sistema ProTaper Next é a evolução do sistema ProTaper Universal. Além de ser fabricado com a liga NiTi M-Wire que lhe confere maior resistência e flexibilidade, ele possui secção transversal retangular descentralizada, destinada a diminuir a tensão sobre os instrumentos. A seqüência técnica básica é composta por apenas 2 limas a serem utilizadas na maioria dos casos (X1 e X2) e uma terceira lima (X3) específica para casos em que se deseja preparos

mais dilatados. Por ser uma técnica mais simples, requer uma menor curva de aprendizagem (ELNAGHY & ELSAKA, 2014; ALMEIDA *et al.*, 2018).

Na prática clínica, durante a formatação dos canais, os instrumentos endodônticos sofrem tensões de tração, compressão e torção que podem levá-los à fratura. As fraturas são resultado da associação de uma série de fatores como anatomia do canal radicular, dimensões e design do instrumento, propriedades mecânicas do material, o número de usos dos instrumentos e as habilidades do operador (GAMBARINI, 2001; PARASHOS & MESSER, 2006; HAAPASALO & SHEN, 2013). O mecanismo de fratura dos instrumentos endodônticos pode se dar por fadiga flexural ou por sobrecarga torcional (PRUETT *et al.*, 1997; SATTAPAN *et al.*, 2000; CHEUNG *et al.*, 2007; PARASHOS & MESSER, 2006; SHEN *et al.*, 2009). A fratura por sobrecarga torcional ocorre quando parte do instrumento se prende no interior do canal, enquanto sua haste continua a girar. Se o limite elástico do instrumento é excedido, ele sofre deformação plástica e em seguida, a fratura (SATTAPAN *et al.*, 2000; PETERS *et al.*, 2003; BAHIA & BUONO, 2005; CÂMARA *et al.*, 2009; SHEN *et al.*, 2013; CAMPBELL *et al.*, 2014). Esse tipo de fratura tem sido associado à aplicação de força apical excessiva durante a instrumentação. A fratura por fadiga flexural, por sua vez, ocorre quando um instrumento gira no interior de canais curvos. No ponto de curvatura máxima ele sofre tensões de tração e compressão alternadas e repetitivas, levando à nucleação de trincas que crescem, coalescem e se propagam em direção ao centro, reduzindo a área da seção transversal do instrumento, que se torna cada vez mais incapaz de suportar a força aplicada, até sua fratura final (COURTNEY, 1990; SERENE *et al.*, 1995; PRUETT *et al.*, 1997; SATTAPAN *et al.*, 2000; BAHIA & BUONO, 2005; PLOTINO *et al.*, 2012).

Alguns estudos já mostram que as taxas de fratura de instrumentos endodônticos na prática clínica de alunos da graduação podem variar entre 0,9% a 3,3% (IQBAL *et al.*, 2006, GARCÍA-FONT *et al.*, 2012; UNGERECHTS *et al.*, 2014; CABALLERO-FLORES *et al.*, 2019). A literatura também relata a ocorrência de ansiedade e falta de confiança nos estudantes durante a prática endodôntica (MARTINS *et al.*, 2012, SEIJO *et al.*, 2013, TANALP *et al.*, 2013, DAVEY *et al.*, 2014, MURRAY & CHANDLER 2014, PURYER *et al.*, 2017, LUZ *et al.*, 2018, GROCK *et al.*, 2018, TAVARES *et al.*, 2018, BAAJI *et al.*, 2020). Entretanto, são escassos os estudos sobre a prevalência de

fraturas de instrumentos de NiTi associada a percepção dos estudantes em relação à essa primeira experiência em sua prática clínica.

É importante ressaltar também que a introdução da técnica de instrumentação mecanizada na graduação, além de melhorar a experiência educacional e clínica dos alunos, possibilitou a finalização de maior número de casos e a redução do tempo de espera pelo tratamento endodôntico (MARTINS *et al.*, 2012; SEIJO *et al.*, 2013). De fato, as infecções e inflamações agudas de origem endodôntica quando não tratadas em tempo adequado, podem ganhar proporções extensas e provocar dores fortes, que levam os pacientes a buscar por atendimentos de urgência recorrentes na atenção primária no sistema de saúde pública, enquanto aguardam por um tratamento endodôntico (ESTRELA *et al.*, 2011; FRANCISCATTO *et al.*, 2020; FRICHEMBRUDER *et al.*, 2020). Na literatura há relatos que a espera por um tratamento endodôntico no serviço público pode variar de 30 dias (MARTINS *et al.*, 2016) a 5 meses (MAGALHÃES *et al.*, 2018). Desta forma, conhecer o perfil dos pacientes e dos casos, assim como os aspectos que influenciam os tratamentos endodônticos realizados pode ser importante para se traçar estratégias para a melhoria dos serviços prestados.

Desta forma, os objetivos deste trabalho foram verificar os fatores associados aos tratamentos endodônticos realizados nas disciplinas de Endodontia da FAO UFMG, no que diz respeito à finalização dos casos, aos atendimentos de urgência prévios, às informações referentes às fraturas de instrumentos rotatórios de NiTi e a percepção dos alunos frente a esses incidentes e as principais dificuldades encontradas.

OBJETIVOS

2 OBJETIVOS

2.1 Objetivo geral:

Avaliar os tratamentos endodônticos realizados nas clínicas de Endodontia I e Endodontia II da FAO UFMG e as percepções dos alunos sobre sua prática endodôntica.

2.2 Objetivos específicos:

Quantificar e caracterizar os tratamentos endodônticos realizados nas clínicas de Endodontia da FAO UFMG;

Avaliar os fatores relacionados aos atendimentos de pacientes encaminhados para tratamento endodôntico nas clínicas de Endodontia da FAO UFMG, com dentes submetidos a procedimentos de urgência prévios;

Avaliar os fatores relacionados à finalização dos tratamentos endodônticos nas clínicas de Endodontia da FAO UFMG;

Analisar os fatores associados à prevalência de fratura de instrumentos de NiTi nas clínicas de Endodontia da FAO UFMG;

Analisar as percepções dos alunos do último semestre do curso de graduação quanto as suas dificuldades na prática clínica endodôntica;

Analisar as percepções dos alunos do último semestre frente à ocorrência de fratura de instrumentos endodônticos e sua influência no interesse na área da Endodontia e na confiança em realizar tratamentos endodônticos.

METODOLOGIA EXPANDIDA

3 METODOLOGIA EXPANDIDA

Trata-se de um estudo transversal, conduzido na FAO UFMG, dividido em três fases que avaliaram, respectivamente, os fatores associados aos tratamentos endodônticos encaminhados para as clínicas de Endodontia, à prevalência de fraturas de instrumentos endodônticos durante os tratamentos e as percepções dos alunos do último semestre do curso frente à prática endodôntica e frente à ocorrência de fratura de instrumentos.

3.1 FASE I (Pacientes e tratamentos endodônticos) e FASE II (Fraturas de instrumentos endodônticos)

3.1.1 População do Estudo e Cálculo Amostral

A população de referência deste estudo foram os pacientes atendidos nas clínicas de endodontia da FAO UFMG e a base de amostragem encontrou-se na relação de prontuários clínicos. O curso de graduação da FAO UFMG tem um currículo que consiste em 10 semestres. As disciplinas de endodontia fazem parte da grade curricular do quinto e sétimo semestres do programa. Durante o quinto semestre, os alunos cursam a disciplina de Endodontia I e têm seu primeiro contato com a área (através de aulas teóricas, pré-clínicas e clínicas) e suas primeiras oportunidades de realizar tratamentos endodônticos simples (incisivos, caninos e pré-molares; superiores e inferiores). Durante o sétimo semestre, os alunos cursam a disciplina de Endodontia II e realizam tratamentos endodônticos mais complexos (molares superiores e inferiores). A experiência com a prática clínica endodôntica continua ao longo dos semestres subsequentes, nas disciplinas de Clínica Integrada e em alguns Projetos de Extensão.

A coleta de dados foi conduzida durante três semestres letivos (do início do segundo semestre de 2017 até o fim do segundo semestre de 2018). O cálculo amostral foi realizado pelo método de estimativa de proporções, considerando uma prevalência de 50% de tratamentos endodônticos, com nível de confiança e precisão de 5%, acrescentando 20% referentes a possíveis perdas, totalizando uma amostra de 461 casos. Por ser um estudo exploratório, o cálculo serviu exclusivamente para nortear um número adequado de casos para o estudo. Somente tratamentos endodônticos primários de dentes

permanentes foram incluídos, sendo excluídos casos de dentes decíduos e retratamentos endodônticos.

3.1.2 Coleta de Dados

Os dados foram obtidos por meio das fichas clínicas dos pacientes e no acompanhamento do atendimento clínico dos alunos ao longo dos semestres. Para a coleta, foram elaborados dois instrumentos de pesquisa (roteiros) que eram preenchidos durante as clínicas por um pesquisador previamente treinado para esse fim e permitiram conhecer as características dos casos encaminhados (APÊNDICE I) e da ocorrência de fraturas de instrumentos endodônticos rotatórios de NiTi (APÊNDICE II).

A aplicação e preenchimento dos roteiros foram testados previamente em um estudo piloto realizado durante o primeiro semestre de 2017 em que foi possível realizar ajustes à metodologia e um treinamento do pesquisador responsável para a coleta de dados. Os dados obtidos neste estudo piloto não foram utilizados no estudo principal.

3.1.3 Elenco de Variáveis

FASE I – Pacientes e tratamentos endodônticos:

Foram coletados dados referentes a cada tratamento endodôntico iniciado, como: nome do aluno e do paciente, número do registro do paciente, data do início e do término do tratamento. Além destes, foram coletadas as variáveis idade, sexo, tipo do dente a ser tratado, diagnóstico endodôntico, presença de alteração periapical, tratamento de urgência prévio, ocorrência de fraturas de instrumentos endodônticos, número de consultas necessárias para a conclusão do tratamento endodôntico, absenteísmo, abandono e encaminhamentos devido à impossibilidade de resolução dos casos (Quadro 1). Os dados levantados a partir das imagens radiográficas foram obtidos por exame a olho nu e com auxílio do negatoscópio.

Quadro 1: Identificação e categorização das variáveis dos pacientes e dos tratamentos endodônticos

Variáveis	Categorização
Idade	0 - 19 anos 20 - 39 anos 40 - 59 anos 60 - 76 anos
Sexo	Feminino = 0 Masculino = 1
Tipo de dente	Incisivo / canino = 0 Pré-molar = 1 Molar = 2
Diagnóstico	Necrose pulpar = 0 Vitalidade pulpar = 1
Presença de lesão periapical	Sim = 1 Não = 0
Atendimento de urgência prévio	Sim = 1 Não = 0
Fraturas de instrumentos endodônticos	Sim = 1 Não = 0
Número de atendimentos	Até 2 atendimentos = 0 3 atendimentos = 1 4 ou + atendimentos = 3 Trat. não finalizado = 4
Absenteísmo	Sim = 1 Não = 0
Abandono do tratamento	Sim = 1 Não = 0
Tratamentos endodônticos não finalizados	Tratamento finalizado = 0 Cirurgia de aumento de coroa = 1 Tratamento conservador da polpa = 2 Exodontia = 3 Encerramento do semestre = 4 Caso complexo (pós-graduação) = 5 Abandono do tratamento = 6

FASE II - Fraturas de instrumentos endodônticos:

Somente tratamentos endodônticos primários de dentes permanentes foram incluídos nesta fase do estudo, sendo excluídos os tratamentos em dentes decíduos e os retratamentos endodônticos. Os tratamentos endodônticos foram realizados pelos alunos sem a interferência dos pesquisadores e seguiram os protocolos determinados pelas disciplinas de Endodontia da FAO UFMG. Estes eram precedidos de anamnese, análise radiográfica e planejamento. Os tratamentos foram realizados sob anestesia local,

isolamento absoluto e irrigação com hipoclorito de sódio à 2,5%. Limas manuais de aço inoxidável, tipo K#8, K#10 e k#15 foram utilizadas para exploração inicial e odontometria, e posteriormente sucedidas pela instrumentação mecanizada com os sistemas rotatórios ProTaper Universal ou ProTaper Next. O sistema ProTaper Universal foi utilizado durante o segundo semestre de 2017 e a partir do primeiro semestre de 2018 seu sucessor, o sistema ProTaper Next, também passou a ser utilizado. Os canais foram obturados com cones de guta-percha através da técnica da condensação lateral e compressão vertical. Os alunos eram responsáveis pela limpeza, esterilização e controle de uso dos seus próprios instrumentos e receberam, previamente aos atendimentos, instruções teóricas específicas que envolviam os protocolos de uso e diretrizes de descarte dos instrumentos após o uso em uma média de dez canais radiculares curvos.

Quando ocorria a fratura de um instrumento rotatório de NiTi, coletava-se os dados referentes às características da fratura e descrição do evento. As variáveis analisadas nesta fase e suas categorizações estão descritas no quadro 2. As fraturas de limas manuais não foram avaliadas nesta parte do estudo.

Quadro 2: Identificação e categorização das variáveis de fratura de instrumentos rotatórios

Variáveis	Categorização
Tipo de dente	Molares inferiores = 0 Molares superiores = 1
Canal em que se encontra o fragmento	Mesiais dos molares inferiores = 0 Vestibulares dos molares superiores = 1 Distal = 2 Palatina = 3
Localização do fragmento	Terço cervical/médio=0 Terço apical=1
Tamanho do fragmento	≤ 3mm=0 >3mm=1
Sistema rotatório utilizado	ProTaper Universal=0 ProTaper Next=1
Tipo de instrumento	Instrumentos que trabalham no terço cervical/médio = 0 Instrumentos que trabalham no terço apical = 1
Se o fragmento foi removido e/ou ultrapassado	Sim = 1 Não = 0
Se havia o controle do número de usos	Sim = 1 Não = 0

Quantos usos no momento da fratura	Novo (primeiro uso) =0 Segundo uso=1 Terceiro uso=2 Quarto uso ou mais=3 Não faz controle=4
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3.2 FASE III (Percepção dos alunos)

Para entender se a ocorrência de fratura de um instrumento endodôntico pode afetar o interesse de um estudante de graduação na área da Endodontia e sua confiança na realização de tratamentos endodônticos, foi realizado um levantamento sobre suas percepções.

3.2.1 População de estudo e cálculo amostral

Participou desta fase do estudo o universo de alunos do último semestre do curso de Odontologia, no ano de 2020 (n=55). Esta representa uma amostra de conveniência, e foi escolhida considerando que esses alunos já haviam cumprido todos os créditos teórico-práticos das disciplinas de Endodontia e haviam tido o máximo possível de experiências clínicas na prática da Endodontia ao longo do curso.

3.2.2 Coleta e dados

Foi aplicado um questionário online, utilizando a ferramenta Google Forms. Os alunos foram informados sobre os objetivos do estudo e o processamento anônimo dos dados. Então, deram o seu consentimento aceitando participar voluntariamente da pesquisa. Esse consentimento poderia ser retirado a qualquer momento.

As questões foram baseadas em estudos anteriores (MARTINS *et al.*, 2012; MURRAY & CHANDLER 2014; PURYER *et al.*, 2017) e consistiam em nove perguntas com respostas nos formatos de múltipla-escolha e dissertativo. As respostas das questões dissertativas foram analisadas utilizando o método de análise de conteúdo descrito por BAUER *et al.*, 2000 e foram agrupadas em quatro categorias.

3.2.3 Elenco de variáveis

As informações obtidas no questionário e as categorizações estão descritas no quadro 3.

Quadro 3: Identificação e categorização das variáveis relacionadas à percepção dos alunos

Variáveis	Categorização	
Você teve alguma dificuldade durante a execução dos tratamentos endodônticos?	Sim = 1 Não = 0	
Em caso afirmativo na questão anterior, marque quais dificuldades encontradas:	Dificuldades técnicas = 0	Realização de radiografias Realização do isolamento absoluto Realização da cavidade de acesso Realização do diagnóstico pulpar Estabelecimento do comprimento de trabalho Lidar com a ocorrência de perfurações Falta de materiais disponíveis
	Dificuldades relacionadas ao dente = 1	Morfologia do canal radicular Mal posicionamento do dente Qualidade da radiografia pré-operatória Restaurações pré-existent
	Dificuldades relacionadas ao processo de aprendizagem = 2	Restrição de tempo Dificuldades com o orientador Falta de conhecimento teórico
	Dificuldades relacionadas ao paciente=3	História médica do paciente Cooperação do paciente
Qual tipo de dente você acha mais difícil de executar o tratamento endodôntico?	Molares = 0 Outro tipo de dente = 1	

Quais os motivos dessa escolha?	Dificuldades relacionadas ao dente = 0	Visualização e acesso Dificuldades com a visão indireta Variações anatômicas e morfológicas Número de canais no mesmo dente
	Dificuldades técnicas = 1	Realização da cavidade de acesso e localização dos canais Exploração e instrumentação dos canais Realização de radiografias Obturação dos canais Posicionamento dos instrumentos Realização do isolamento absoluto Determinação do comprimento de trabalho
	Dificuldades relacionadas ao paciente = 2	Pouca amplitude a abertura de boca Desconfortos do paciente
	Dificuldades relacionadas ao processo de aprendizagem=3	Falta de experiência e interesse na área
Em sua opinião, os tratamentos endodônticos que você realizou ficaram:	Bons = 0 Ruins = 1 Regulares = 2	
Quão confiante você se sente em realizar um tratamento endodôntico não complicado em um dente anterior?	Não confiante = 0 Pouco confiante = 1 Indiferente = 2 Confiante = 3 Muito confiante = 4	
Quão confiante você se sente em realizar um tratamento endodôntico não complicado em um molar?	Não confiante = 0 Pouco confiante = 1 Indiferente = 2 Confiante = 3 Muito confiante = 4	
Durante algum de seus tratamentos, ocorreram fraturas de instrumentos endodônticos?	Sim = 1 Não = 0	

Em caso de fratura de um instrumento endodôntico em sua prática, você acredita que esse incidente prejudicou ou prejudicaria seu interesse pela especialidade?	<p style="text-align: center;">Sim = 1 Não = 0</p>
Em caso de fratura de um instrumento endodôntico em sua prática, você acredita que esse incidente prejudicou ou prejudicaria seu grau de confiança para realizar novos tratamentos?	<p style="text-align: center;">Sim = 1 Não = 0</p>

3.3 Considerações Éticas

O presente estudo foi encaminhado ao Comitê em Ética em Pesquisa da Universidade Federal de Minas Gerais (COEP/UFMG), obtendo-se o parecer de aprovação de número CAAE – 80164117.2.0000.5149 (ANEXO I). Conforme descrito anteriormente, foram obtidos os Termos de Consentimento Esclarecido para cada aluno participante da Fase III do estudo.

3.4 Análise dos dados

Todos os dados foram digitados e organizados em um banco de dados do software IBM Statistical Package for the Social Sciences versão 22.0 (IBM SPSS Statistics for Windows, Armonk, NY, EUA).

Os dados quantitativos foram analisados pelo teste de Kolmogorov-Smirnov ($p < 0,05$). Dados com distribuição normal ($p > 0,05$) foram descritos por média e desvio padrão e aqueles sem distribuição normal ($p < 0,05$) foram descritos por medianas e percentis.

Os dados categóricos e as percepções dos alunos foram analisados de forma descritiva por frequência absoluta e relativa.

A análise bivariada foi realizada utilizando o teste estatístico Qui-quadrado de Pearson, com correção de Bonferroni considerando um nível de confiança de 95%, e consequentemente uma probabilidade de significância de 5% ($p \leq 0,05$), considerando as variáveis dependentes tratamento de urgência prévio e finalização dos tratamentos endodônticos.

ARTIGOS CIENTÍFICOS

4 ARTIGOS CIENTÍFICOS

Nesta seção serão apresentados os artigos resultantes deste estudo. A formatação seguirá as normas dos periódicos selecionados para a submissão, sendo eles: *International Journal of Public Health* (artigo 1) e *International Journal of Endodontics* (artigo 2)

4.1 ARTIGO 1

Factors associated with previous urgent care and completion of endodontic treatments conducted by undergraduate students: a cross-sectional quantitative study

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Abstract

Objectives: This study analyzed the characteristics of teeth referred for endodontic treatment, factors associated with previous urgent care and those able to interfere in the completion of these treatments performed in an undergraduate clinic of a public dental school. **Materials and Methods:** This cross-sectional quantitative study analyzed data obtained through clinical records of the patients. Results were analyzed in a descriptive way by IBM SPSS. Quantitative data were analyzed by Kolmogorov-Smirnov test ($p < 0.05$). Associations were evaluated through Chi-square test and Bivariate Analysis with Bonferroni Correction, considering a 95% confidence level ($p \leq 0.05$). **Results:** Molar teeth ($p < 0.0001$) and teeth with necrotic pulps ($p < 0.0001$) were more involved in previous urgent care. 85.9% of the total number of endodontic treatments were completed. Treatments were less finalized in adolescents when compared with young ($p = 0.006$) and older adults ($p = 0.003$), in molar teeth when compared with anterior ($p = 0.005$) and pre-molar teeth ($p = 0.003$), in teeth that had previous urgency treatment ($p = 0.002$) and in patients who missed appointments ($p = 0.014$). **Conclusions:** Anatomical complexities, the young age of patients and the absenteeism affected the conclusion of endodontic treatments performed by undergraduate students.

Key words: Dental care. Dental student. Endodontics. Epidemiology. Undergraduate education.

Introduction

Tooth decay is one of the most prevalent oral conditions and when not treated in a timely manner, it can spread considerably and lead to coronary destruction, pulpal inflammation and pain. More often than not, toothache leads patients to seek recurrent urgent care,

while waiting for an endodontic treatment (Estrela et al. 2011; Franciscatto et al. 2020; Frichembruder et al. 2020). In fact, the relief of pulpal symptoms seems to be the most common indication for root canal treatment, followed by asymptomatic pathology, pre-prosthetic preparations, management of dental trauma and also the need for retreatments (Wigsten et al. 2019).

Several studies have already revealed that socioeconomic factors may influence the search for urgent treatments prior to the endodontic treatment itself (Verma and Chambers 2014; Franciscatto et al. 2020), however it is also important to analyze the clinical factors, such as the type of tooth that frequently undergoes a prior care and the pulp and periapical conditions of these teeth.

Root canal treatments are considered challenging and stressful by general clinicians (Dahlström et al. 2017). The skills to perform root canal treatments should be acquired during undergraduate dental training (De Moor et al. 2013). Dentistry students at the Universidade Federal de Minas Gerais School of Dentistry (UFMG SD), a public Brazilian federal dental school, located on southeast of the country, start their pre-clinical and clinical endodontic training in the fifth semester of their 5-year program and continue it in subsequent semesters. As part of the local public health system primary care, UFMG dental clinic receives daily referrals from many different Primary Care Units (PCU) around Belo Horizonte city. In this context, patients have access to endodontic treatments through the endodontics disciplines taught in the undergraduate course.

This study aimed to test the null hypothesis that the characteristics of the teeth referred for endodontic treatment, and the factors associated with previous urgent care do not interfere in the completion of the endodontic treatments performed in undergraduate clinics at UFMG SD. This information can improve our understanding of endodontic treatments performed, monitoring the completion, management and quality of the cases and facilitate targeting of preventive measures to face these oral health problems.

Materials and Methods

This study was approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (COEP / UFMG) (CAAE - 80164117.2.0000.5149).

This is a cross-sectional quantitative study that analyzed data regarding patients referred by local PCU for endodontic treatment to be performed by undergraduate students at UFMG SD endodontic disciplines, during the years of 2017 and 2018. This is an exploratory study, using a convenience, non-probabilistic sample. Sample calculation was performed exclusively to guide an adequate number of cases for this research, using a proportional estimation method, considering a prevalence of 50% endodontic treatment, confidence level and accuracy of 5%. In order to compensate for possible data loss during the study, the number of individuals was increased by 20%, totaling a sample of 460 cases.

Only primary endodontic treatments of permanent teeth were analyzed, all of them performed by students without the interference of the principal investigator. The clinical protocols followed were those taught during Endodontics undergraduate classes. Endodontic procedures were preceded by anamnesis, radiographic analysis and planning. The treatments were performed under local anesthesia, rubber dam isolation and irrigation with 2.5% sodium hypochlorite. K # .08, K # .10, and # .15 stainless steel manual files were used for initial exploration and canal length determination, and later succeeded by mechanized instrumentation with the ProTaper Universal or ProTaper Next nickel-titanium (NiTi) systems (Dentsply Sirona, Ballaigues, Switzerland). Root canals were filled with gutta-percha cones and endodontic sealer using cold lateral condensation technique.

Data were collected for eighteen months and obtained through the clinical records of patients attended. A previously tested question form allowed the collection of the following independent variables: age (0-19, 20-39, 40-59, 60-76 years old) and sex (male or female) of the patients, type of tooth to be treated (incisors/canines, premolars or molars), endodontic diagnosis (necrosis, vital pulp), presence of periapical alteration identified X-ray analysis on negatoscope (yes or no), prevalence of rotary instruments fractures (yes or no) and absenteeism (yes or no). The dependent variables were previous urgent treatment (yes or no) and the completion of the endodontic treatment (yes or no). Variables related to treatment interruption (yes or no), number of sessions performed (up to two sessions, three sessions, four or more sessions) and referrals in cases where the endodontic treatment was not completed were also collected.

Results were analyzed in a descriptive way using IBM Statistical Package for Social Sciences (SPSS), version 22.0 (IBM SPSS Statistics for Windows, Armonk, NY, USA). Quantitative data were analyzed by the Kolmogorov-Smirnov test ($p < 0.05$). Data with normal distribution ($p > 0.05$) were described by mean and standard deviation and those without normal distribution ($p < 0.05$) were described by medians and percentiles. The categorical data were analyzed by absolute and relative frequency. The associations were evaluated through the Chi-square test and Bivariate Analysis with Bonferroni Correction, considering a 95% confidence level, and consequently a 5% probability of significance ($p \leq 0.05$).

Results

During the study, 378 patients were referred to endodontic treatment at UFMG SD undergraduate clinics. Some patients needed treatment in multiple teeth, what raised the number of cases to 478. Eighteen cases were excluded from this study; one because it was an endodontic treatment to be performed in a deciduous tooth, and 17 cases for not having complete clinical records. Therefore, a total of 460 cases were evaluated. The majority of patients were female (64%) with an average age of 42 (P25%=30; P75%=54), ranging from 9 to 76 years old.

Table 1 shows the characteristics of the teeth referred for endodontic treatment. Molars were the most referred to receive endodontic treatment (53.7%). Most of the teeth had an initial diagnosis of pulp necrosis (70.4%) and 48.5% had radiographically apparent periapical lesions. 47.2% of all teeth treated had already undergone previous urgent care, at UFMG SD or other public health service, before starting the root canal treatment (Table 1).

A statistically significant difference was found between the previous urgent care, patient age, type of tooth and initial tooth diagnosis. Adolescents (0-19 years old) had more previous urgency needs than older adults (40-59 years old; $p=0,003$) and elderly patients (60 years old or more; $p=0,001$). Molar teeth ($p < 0,0001$) and teeth with necrotic pulps ($p < 0,0001$) were found to be more commonly involved in previous urgent care (Table 2).

Table 3 shows data regarding the development and completion of endodontic treatments. Of the total number of endodontic treatments performed, the majority were completed (85.9%), out of which, 63.0% required 3 or more sessions. Rotary file fractures occurred in 3.9% of cases. The absenteeism rate was 19.6%. Reasons for not finishing the cases were due to treatment interruption (2.4%), or referrals due to the need for surgical crown lengthening (2.2%), indication for vital pulp therapy (1.3%) or tooth extraction (3.5%). Some cases require to be referred to the postgraduate clinic (2.4%), given their complexity that exceeded student's ability and professional expertise, and 2.4% were not concluded due to lack of time because of the end of the semester.

The completion of endodontic treatments was statistically affected by subject age, tooth type, previous urgency treatment and absenteeism. Endodontic treatments were less finalized in adolescents when compared with young adults (20-39 years old; $p=0,006$) and older adults (40-59 years old; $p=0,003$); in molar teeth when compared with anterior ($p=0,005$) and pre-molar teeth ($p=0,003$), in teeth that had previous urgency treatment ($p=0,002$) and in patients who missed more appointments ($p=0,014$) (Table 4).

Discussion

Epidemiological data about the need for previous urgent care and the ability of undergraduate students to complete endodontic treatment may reflect possible shortcomings in public oral health policies and assist in screening and handling patients for endodontic practice at undergraduate clinics and other public health system units.

The mean age of the patients reported in this research is close to an average age of 40 years old. Other studies have reported results similar to the findings of this study when comparing the age of patients who visit dental clinics (Iqbal et al. 2008; Scavo et al. 2011; Farmakis et al. 2016). With regards to patients' sex, there was a predominance of female subjects among UFMG SD endodontic patients. This finding agrees with other studies that also describe the profile of patients submitted to dental care. The predominance of female patients in dental appointments within the public health system may be related to their inherent tendency to care for their oral health (Scavo et al. 2011; Farmakis et al. 2016; Frichebruder et al. 2020)

Urgent care is considered a common procedure prior to a root canal treatment. Patients requiring endodontic treatment often go through acute pain and report the need for recurrent urgent treatments while waiting for specialized care (Estrela et al. 2011; Franciscatto et al. 2020). Of the total number of patients analyzed in this study 47.1% had sought urgent care before being referred to specialized clinics, which is in coherent to other studies that showed a 50% prevalence of emergency visits due to endodontic issues (Verma and Chambers 2014; Farmakis et al. 2016; Wigsten et al. 2019).

The need for prior urgent care was more prevalent in individuals aged 0 to 19. All dental pulp cell populations undergo age-related modifications. The age-associated decrease in tissue cellularity and the inadequate tissue reparative reactions are intimately linked to the weak immune reaction (Franceschi et al. 2018) which may consequently lead to less painful response. A survey on oral health conducted in Brazil in 2010 (Brasil 2012), showed that almost 30% of adolescents in the country have experienced recent toothache. The same research shows that the rate of visits to the dentist increases with age. Regular visits to the dentist may increase the likelihood of early detecting carious lesions, what could avoid pain episodes and the need for dental emergency care (Franciscatto et al. 2020).

Being a teenager also influenced the percentage of uncompleted endodontic treatments in this study. This may be explained by the avoidance behavior of adolescents facing episodes involving pain, fear and anxiety (Fagerstad et al. 2019). Patient sex has already been identified as a risk factor for the occurrence of urgent related pain and other dental needs (Franciscatto et al. 2020). In this study, however, being male or female did not influence the search for previous urgent treatments or the completion of endodontic treatment.

Also based on the present findings, the need for endodontic treatment was shown to be higher in molars and these teeth were the ones that most underwent previous urgent procedures. These data are compatible with those of other studies that also demonstrated that endodontic treatments are more commonly performed on posterior teeth (Iqbal et al. 2008; Hollanda et al. 2008; Wigsten et al. 2019; Magalhães et al. 2019). One of the reasons that may explain these findings is the fact that these teeth are exposed to a greater cariogenic challenge given the complexity of its external anatomy. That makes them

harder to clean, and consequently, more susceptible to caries (Quadros et al. 2005). It may also be explained by the fact that first molars erupt at an early age and are thus exposed to the oral cavity environment for a longer period of time than many other teeth (Iqbal et al. 2008).

The majority of students normally list molar teeth as the most difficult to perform endodontic procedures at (Martins et al. 2012; Tanalp et al. 2013). When comparing the completion of treatments between the type of the teeth, molars were the teeth with the lowest index of completion in comparison with anterior teeth and premolars. In general, the complete shaping and cleaning of root canals may be more challenging due to variations in canal cross-sectional shapes and the presence of irregularities and curvatures, which are mainly present in molars teeth (Vertucci 2005).

In this study, the majority of the cases evaluated were recognized as pulp necrosis and the analysis of the radiographic findings revealed that periapical alterations were present in almost half of the cases. These findings correlate well with those from an earlier study by Wigsten et al. (2019) in which the most common diagnosis was pulp necrosis associated with apical periodontitis. This may be an indication that the appointments for endodontic treatments in the undergraduate clinics were performed in later phases of the disease, corroborating with the data described in the literature showing that the long waiting time for endodontic treatments may lead to a chronic disease process (Schwendicke and Gostemeyer 2016; Magalhães et al. 2019). Indeed, studies have shown that the waiting time for a treatment in the specialized public service in Brazil can take from 30 days to 5 months (Hollandia et al. 2008; Magalhães et al. 2019). An extended waiting period for endodontic treatment may also generate other several negative consequences, such as frequent exacerbations and constant search for pain relief treatments (Magalhães et al. 2019). The teeth with diagnosis of pulp necrosis, with or without the presence of periapical lesions, were those with a higher need of previous emergency procedures. Apical periodontitis is a chronic process and could be asymptomatic in most cases, as it was seen in this study and is in accordance with previous findings (Franciscatto et al. 2020).

Of the 460 cases involved in this study 85.9% were completed, all of them referred for endodontic treatment to undergraduate clinics. The initial diagnosis, whether pulpitis or

pulp necrosis, did not affect case completion. However, the teeth that had undergone previous emergency were the ones that also presented lower endodontic therapy completion rates. Microbial injury is the major and most common cause of interappointment pain (Siqueira and Barnett 2005), and the teeth with previous history of urgent care may experience new acute processes along the treatment, leading to a delayed obturation. Another possible reason may be the presence of iatrogenic events, such as canal blockages or ledges created during the urgency procedure, what adds an extra difficulty to the endodontic procedure.

Regarding the number of appointments required to complete the treatments in this study, most of the cases required 3 or more sessions. Performing endodontic treatment in one or more sessions is a clinical decision and depends on the difficult of each case, tooth conditions, time available to perform the necessary steps, operator's skills and other patient related factors such as medical history and anatomical considerations (Schwendicke and Gostemeyer 2016; Moreira et al. 2017). Among the many advantages of completing an endodontic treatment in fewer sessions are human resources optimization, less material consumption, not to mention that it allows more patients to be attended (Quadros et al. 2014; Magalhães et al. 2019).

At the UFMG SD, single-appointment endodontic therapy is the first choice of treatment in the absence of pain, exudation and/or swelling, as an attempt to eliminate the chances of interappointment microbial contamination. However, since undergraduate students are in a learning process, consequently expected to have little clinical experience, this is probably why only 22.8% of the endodontic treatments were performed in up to two sessions. As previously mentioned, molars were the most prevalent group of teeth with the need for endodontic treatment in this study, what might have contributed to the high number of sessions, considering that the more distally teeth are positioned in the arch, the harder it is for practitioners to reach and negotiate the root canal system (Dahlström et al. 2017). Molar teeth were also the ones that most underwent emergency procedures and the relation between having undergone previous emergency care and a lower rate of treatment resolution was already alluded to in this paper.

Undergraduate endodontic teaching has undergone significant changes in recent years, influenced by changes in content, techniques and materials as well as educational

approaches (Qualtrough 2014) including the use of NiTi instruments. In this study, NiTi instrumentation techniques were not enough to reduce the time spent in completing the endodontic treatments. It is quite likely that students have experienced other difficulties aside to the instrumentation technique itself, what could influence the time spent on the case and the number of finished endodontic treatments (Peru et al. 2006; Seijo et al. 2013). Among the main factors that may have contributed to this additional difficulty are patient's absenteeism, X-Ray exposure, cavity access related challenges, rubber dam related difficulties, negotiating and filling complex anatomies (Seijo et al. 2013). On the other hand, the prevalence of fractured NiTi rotary instruments in this study was low (3.9%), what converges with the findings of other study on the same subject (Ungerechts et al. 2014) and did not have a negative influence on treatment completion rates. It is noteworthy, however, that this was the first contact with endodontic procedures experienced by most of the students taking part in this study.

The time needed for the completion of an endodontic treatment should also consider patients absenteeism rate. In this study, patients who missed one or more visits had proportionally more unfinished cases, what could lead to an increase in waiting lines, tooth loss, let alone jeopardizing students learning process, since they end up losing the opportunity to properly conduct all stages of endodontic therapy (Magalhães et al. 2019). Patients missed appointments and delays were pointed by undergraduate students as the main factors that could affect endodontics learning process (Seijo et al. 2013). It is, therefore, essential to count on patient's awareness about the importance of adhering to endodontic treatment (Bansal and Jain 2020) and the subsequent need for a final restorative procedure, considering that the treatment does not end with the completion of the endodontic therapy. A favorable outcome is only achieved when the teeth have their masticatory function restored (Magalhães et al. 2019).

Among the uncompleted cases of endodontic treatments there were some needs for referrals to periodontal surgery or extraction. Again, prolonged waiting time for secondary care treatments increases the possibility of dental fracture, irreversibly jeopardizing biological width or the entire dental structure (Magalhães et al. 2019). Another fact observed, although not very prevalent, was the counter-referral of the tooth for pulp preservation therapy, what may indicate a previous diagnostic error. A more interdisciplinary view and an adequate dialogue between the specialties and referral

centers could help in this problem, facilitating patient's adequate referral and reducing the waiting time for any given treatment (Magalhães et al. 2019).

Some limitations are inherent in the methodology of the present study, such as information bias, since it uses secondary data and some retrospective information obtained directly from patient's clinical records. However, during the study period, it was possible to identify the majority of patients who were referred to the UFMG SD and only a few cases were excluded for lack of information in the clinical records. Some findings may be also having limited validity among specialists or experienced clinicians; however, this study represents a rare opportunity to build knowledge about the factors that adversely affect the completion of endodontic treatments. In addition, knowledge about the characteristics of the patient and teeth when the root canal treatment is started can improve our understanding, facilitate the direction of preventive measures and improve the quality of endodontic care provided.

The present study demonstrates that molars teeth with an initial diagnosis of pulp necrosis were the ones most commonly referred for endodontic treatment, having also been most commonly related to previous urgent procedures. Pulp necrosis was associated to a higher occurrence of previous emergency care, but no correlation was found between periapical tissues status and previous emergency care or a low treatment completion rate. The vast majority of endodontic treatments performed by undergraduate students were completed. However, the anatomical complexity of molar teeth, the young age of patients and the absenteeism affected the conclusion of the cases.

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Table 1

Descriptive analysis of the characteristics of the teeth submitted to endodontic treatment (n = 460). Belo Horizonte, 2017-2018.

<i>Variables</i>	<i>n</i>	<i>(%)</i>
teeth		
<i>incisor/canine</i>	103	(22.4%)
<i>pre-molar</i>	110	(23.9%)
<i>molar</i>	247	(53.7%)
initial diagnosis		
<i>necrosis</i>	324	(70.4%)
<i>vital pulp</i>	136	(29.7%)
presence of periapical alteration		
<i>no lesion</i>	237	(51.5%)
<i>lesion presence</i>	223	(48.5%)
previously emergency care		
<i>no</i>	243	(52.8%)
<i>yes</i>	217	(47.2%)

Table 2

Analysis of associations between previous urgency care and independent variables (n = 460). Belo Horizonte, 2017-2018.

<i>Independent variables</i>	<i>test value</i>	<i>p value</i>
age		
<i>0-19 years old x 20-39 years old</i>	4.295	0.038**
<i>0-19 years old x 40-59 years old</i>	8.789	0.003**
<i>0-19 years old x 60-76 years old</i>	11.752	0.001**
<i>20-39 years old x 40-59 years old</i>	2.390	0.122**
<i>20-39 years old x 60-76 years old</i>	5.317	0.021**
<i>40-59 years old x 60-76 years old</i>	1.418	0.234**
sex	0.143	0.231*
tooth type		
<i>anterior teeth x premolar teeth</i>	1.444	0.229**
<i>anterior teeth x molar teeth</i>	40.958	0.0001**
<i>premolar teeth x molar teeth</i>	27.581	0.0001**
endodontic diagnosis	13.810	0.0001*
presence of periapical alteration	2.126	0.145*

In bold, variables with a statistically significant value.

* Chi Square Test

** Chi Square with the Bonferroni correction $\alpha=0.02$

Table 3

Descriptive analysis of endodontic treatment development and finishing (n = 460). Belo Horizonte, 2017-2018.

<i>variables</i>	<i>n</i>	<i>(%)</i>
finished endodontic treatments		
<i>no</i>	65	(14.1%)
<i>yes</i>	395	(85.9%)
number of sessions		
<i>up to 2 sessions</i>	105	(22.8%)
<i>3 sessions</i>	156	(33.9%)
<i>4 or more sessions</i>	134	(29.1%)
<i>unfinished treatments</i>	65	(14.1%)
instrument fracture		
<i>no</i>	442	(96.1%)
<i>yes</i>	18	(3.9%)
absenteeism		
<i>no</i>	370	(80,5%)
<i>yes</i>	90	(19.5%)
treatment interruption		
<i>no</i>	449	(97.6%)
<i>yes</i>	11	(2.4%)
referrals		
<i>no</i>	395	(85.9%)
<i>periodontal surgery</i>	10	(2.2%)
<i>vital pulp treatment</i>	6	(1.3%)
<i>extraction</i>	16	(3.5%)
<i>and of the semester</i>	11	(2.4%)
<i>complex case referral</i>	11	(2.4%)
<i>treatment interruption</i>	11	(2.4%)

Table 4

Analysis of associations between completed cases and independent variables (n = 460).
Belo Horizonte, 2017-2018.

<i>independent variables</i>	<i>test value</i>	<i>p value</i>
age		
<i>0-19 years old x 20-39 years old</i>	7.604	0.006**
<i>0-19 years old x 40-59 years old</i>	8.552	0.003**
<i>0-19 years old x 60-76 years old</i>	2.350	0.125**
<i>20-39 years old x 40-59 years old</i>	0.010	0.919**
<i>20-39 years old x 60-76 years old</i>	1.399	0.237**
<i>40-59 years old x 60-76 years old</i>	1.734	0.188**
sex	0.702	0.402*
tooth type		
<i>anterior teeth x premolar teeth</i>	0.019	0.891**
<i>anterior teeth x molar teeth</i>	7.769	0.005**
<i>premolar teeth x molar teeth</i>	8.956	0.003**
endodontic diagnosis	0.273	0.601*
presence of periapical alteration	0.444	0.505*
previous emergency care	9.240	0.002*
instrument fracture	1.135	0.287*
absenteeism	6.038	0.014*

In bold, variables with a statistically significant value

* Chi Square Test

** Chi Square with the Bonferroni correction $\alpha=0.02$

4.2 ARTIGO 2

Analysis of endodontic files fracture in undergraduate clinical practice and students' perceptions

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Abstract

Aim: This study analyzed the prevalence of endodontic instruments fracture in teeth submitted to endodontic treatments by undergraduate students and their perceptions about their own difficulties, interest in the specialty and confidence in performing endodontic treatments. **Methodology:** This cross-sectional quantitative study collected data about fractures of endodontic rotary instruments during clinical practice and students' perceptions about their endodontic practice through a questionnaire. Data were analyzed in a descriptive way by absolute and relative frequency using IBM SPSS. **Results:** The prevalence of NiTi rotary instruments fracture in undergraduate clinics was 3.9%. Most fractures occurred in curved canals of molar teeth (66.7%), fragments were located in the coronal/middle third of the root canals (61.3%), the majority of which measured more than three millimeters (72.2%). Instruments that fractured the most were those supposed to shape the root canal apical third, with larger dimensions (61.1%). Fragments were removed or bypassed in only half of the occurrences. Most of the students reported controlling the number of times files were being used (88.9%) and in 66.7% of cases, fractures occurred in up to the third use. Students reported some difficulties in performing endodontic treatments (98.0%), most of them related to technical challenges (54.1%) and to teeth morphology and location (26.8%). The majority of those students who did not report the occurrence of instrument fractures stated that their interest (88.2%) and confidence (83.9%) would not be influenced in case of a fracture. Among the students who've experienced fracturing files though, some decrease in these percentages was observed, 44.5% and 33.3%, for interest and confidence respectively. **Conclusions:** The prevalence of NiTi rotary instruments fracture in the undergraduate clinics was low. There was a tendency towards fracturing instruments with larger apical diameters, in curved canals of molar teeth, mostly resulting in long-length fragments, located in the coronal/middle third of root canals and after a small number of file uses. Students reported several difficulties in performing endodontic treatments most of them related to lack of

technical skills or caused by molars inherent anatomical complexity. Their perception about their own confidence and interest in the specialty seems to be directly affected by the occurrence of instruments fracture.

Key words: Dental students. Dental instruments. Dental education. Endodontics. Epidemiology. Fatigue Fractures.

Introduction

Endodontic files are used as mechanical agents during cleaning and shaping of root canals and are manufactured out of stainless steel (SS) or nickel-titanium (NiTi) alloys (Cheung *et al.* 2007, Ungerechts *et al.* 2014). During the endodontic clinical practice, intracanal instrument fracture can occur at any stage of the shaping procedure, caused by flexural fatigue or torsional overloading (Sattapan *et al.* 2000, Bahia & Buono 2005, Parashos & Messer 2006, Shen *et al.* 2009). Incidence rates of file separation have already been reported for both hand and NiTi files and range between 0.25% and 6% (Spili *et al.* 2005, Iqbal *et al.* 2006, Tzanetakis *et al.* 2008; Ungeregchts *et al.* 2014).

Torsional failure occurs when the active section of a given instrument is locked within the canal walls and its shank continues to rotate driven by the motor, generating high torsional loads, leading to a plastic deformation that will culminate with the instrument separation. This type of fracture has been associated with the application of excessive apical force during instrumentation (Sattapan *et al.* 2000, Peters *et al.* 2003, Bahia & Buono 2005, Yared *et al.* 2001, Shen *et al.* 2013, Campbell *et al.* 2014). Flexural fatigue fracture, in turn, is triggered by alternated tensile and compressive stress cycles developed at the point of maximum tensile strain amplitude during the instrumentation of curved canals. When an instrument rotates along curved canals, alternating compression and tensile stresses occur on both sides of the instrument at every revolution. This process triggers crack initiation at the instrument's surface, that slowly propagates cross-sectionally towards instruments core, ultimately leading to ductile rupture (Pruett *et al.* 1997, Sattapan *et al.* 2000, Bahia & Buono 2005). These two fracture mechanisms are influenced by many factors such as root canal anatomy, instrument's dimension and design, raw material mechanical properties, number of times instruments were used and

the operator skills (Gambarini 2001, Parashos & Messer 2006, Haapasalo & Shen 2013, Pedir *et al.* 2016).

The failure of an endodontic file is considered a rather undesired complication that may have a negative impact in the root canal treatments prognosis (Parashos and Messer 2003, Panitvisai *et al.* 2010). More favourable prognosis are usually associated to cases where it was possible to remove or bypass the broken fragment, allowing for proper cleaning, shaping and filling of root canals (Madarati *et al.* 2013). Managing events like this will depend on factors such as the type and anatomy of the tooth, location, size, and cross-sectional design of fragments (Shen *et al.* 2004, Spili *et al.* 2005, Pedir *et al.* 2016, Adl *et al.* 2017).

The prevalence and characteristics of NiTi endodontic instruments fractures during clinical practice have been analyzed when instrumentation was performed by experienced professionals (Sattapan *et al.* 2000, Peng *et al.* 2005, Di Fiore *et al.* 2006, Tzanetakis *et al.* 2008, Alfouzan & Jameleh 2017) or by undergraduate students (Iqbal *et al.* 2006, Vieira *et al.* 2008, Shen *et al.* 2009, García-Font *et al.* 2012, Ungerechts *et al.* 2014, Caballero-Flores *et al.* 2019). The current literature also reports that, when performing endodontic treatments, students are commonly exposed to feelings like anxiety and lack of confidence (Martins *et al.* 2012, Seijo *et al.* 2013, Tanalp *et al.* 2013, Davey *et al.* 2014, Murray & Chandler 2014, Puryer *et al.* 2017, Luz *et al.* 2018, Grock *et al.* 2018, Tavares *et al.* 2018, Baaji *et al.* 2020). Despite such findings, the perception of undergraduate students regarding their first experience of fracturing endodontic instruments has not been well addressed.

This study aimed to test the null hypothesis that the prevalence of endodontic instruments fractures in teeth submitted to endodontic treatments by undergraduate students is low despite their limited experience, and that this incident will neither influence students' perception about their own confidence in performing endodontic treatments nor impact their interest in the specialty.

Material and Methods

This study was approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (COEP / UFMG) (CAAE - 80164117.2.0000.5149) and follows the recommendations of the Appraisal tool for Cross-Sectional Studies (AXIS) (Downes *et al.* 2016).

This is a cross-sectional quantitative study that analyzed endodontic treatments performed by undergraduate students in the endodontic clinics of the Universidade Federal de Minas Gerais School of Dentistry (UFMG SD), during the years of 2017 and 2018. This is an exploratory study, using a convenience, non-probabilistic sample. Sample calculation was performed exclusively to guide an adequate number of cases for this research, using a proportional estimation method, considering a prevalence of 50% endodontic treatment, confidence level and accuracy of 5%. In order to compensate for possible data loss during the study, the number of individuals was increased by 20%, totaling a sample of 460 cases.

Only primary endodontic treatments of permanent teeth were analyzed, all of them performed by students without the interference of the principal investigator. The clinical protocols followed were those taught during Endodontics undergraduate classes. Endodontic procedures were preceded by anamnesis, radiographic analysis and planning. The treatments were performed under local anesthesia, rubber dam and irrigation with 2.5% sodium hypochlorite. K # .08, K # .10, and # .15 stainless steel manual files were used for initial exploration and canal length determination, and later succeeded by mechanized instrumentation with the ProTaper Universal or ProTaper Next NiTi systems (Dentsply Sirona, Ballaigues, Switzerland). Root canals were filled with gutta-percha cones and endodontic sealer using cold lateral condensation technique. Students received specific theoretical instructions that involved usage protocols and disposal guidelines for instruments after being used in an average of ten curved root canals.

Data about the fractures of NiTi rotary instruments were collected during eighteen months and were obtained through a specific form for that purpose. The variables were: type of tooth (mandibular or maxillary molars); root canal (distal, mesial of mandibular molars or buccal of maxillary molars); location of the fragment (coronal/middle thirds or apical

third); size of the fragment ($\leq 3\text{mm}$ or $>3\text{mm}$); NiTi system (ProTaper Universal or ProTaper Next); type of instrument (instruments that work in coronal/middle third of the root canal or instruments that work in the apical third of the root canal); if the fragment was removed or bypassed (yes or no); if there was any control of the number of times files in general were being used (yes or no); how many times that specific file had been used when the fracture occurred (first, second, third, fourth time or more).

To better understand students' difficulties related to endodontic treatments and if the occurrence of endodontic instruments fractures could affect their interest in the area, as well as their confidence in carrying out treatments, a survey on their perceptions was carried out. An online questionnaire was applied to students ($n=55$) of the last semester of the undergraduate dental program, in the year of 2020. Questions were based in previous studies (Martins *et al.* 2012, Murray & Chandler 2014, Puryer *et al.* 2017). This was a convenience sample, considering that these students were about to graduate and by then, they had already received the entire endodontic theoretical content for the discipline and have had most of their endodontic clinical experiences throughout the course.

The questionnaire was sent by e-mail to students using Google forms and consisted in nine questions using multiple-choice and open-ended formats. The questions explored the student's opinions about the endodontic practice. The following questions were considered: Did you have any difficulties during the performance of endodontic treatment? (yes or no); What were the main difficulties found? (open ended question); Which type of tooth offered you more difficulty to perform endodontic treatment in? Why? (open ended question); In your opinion, the quality of endodontic treatments that you performed was? (good, bad, regular); How confident are you in performing an uncomplicated endodontic treatment in a front tooth? (Likert scale values from 1 to 5); How confident are you in performing an uncomplicated endodontic treatment in a back tooth? (Likert scale values from 1 to 5); Was there a fracture of endodontic instruments during any of your treatments? (yes or no); If an endodontic instrument fracture occurs or has occurred in your practice, do you believe that this incident has affected or would affect your interest in the field? (yes or no); If an endodontic instrument fracture occurs or has occurred in your practice, do you believe that this incident has affected or would affect your degree of confidence in performing new treatments? (yes or no).

Results were analyzed using IBM Statistical Package for Social Sciences (SPSS), version 22.0 (IBM SPSS Statistics for Windows, Armonk, NY, USA). The open-ended questions were analyzed using Content Analysis Technique (Bauer *et al.* 2000). This process involved performing several readings of the verbatim transcripts to extract expressions and words leading to the determination of the categories. Researchers went over all disagreements until a consensus was reached. These questions were grouped in four categories: technical difficulties, tooth-related difficulties, patient-related difficulties, learning process difficulties. Categorical data and student's perceptions were analyzed in a descriptive manner by absolute and relative frequency.

Results

During the study, 478 cases were referred to endodontic treatment at UFMG SD undergraduate clinics. Eighteen cases were excluded from this study. One of the cases for being an endodontic treatment to be performed in a deciduous tooth, and 17 others for not having complete information records. Therefore, a total of 460 cases were evaluated (213 anterior and premolar teeth and 247 molars).

Eighteen unexpected fractures occurred in NiTi instruments (3.9% prevalence), all of them in molar teeth. The characteristics of the fractures are shown in table 1. A higher frequency of this incident was found in lower molars (66.7%), mostly in mesial canals (50.0%). The fragments were usually located in the coronal to middle thirds of the root canals in 61.3% of the cases, the majority measuring more than three millimeters (72.2%). Most fractured instruments were the finishing files, the ones that work in the apical third (61.1%) for both systems. The removal or bypassing of fragments was possible in half of the occurrences. With regards to the use of the instruments in the clinical practice, most of the students reported controlling the number of times they were using the files (88.9%) and in 66.7% of cases the fracture occurred in up to the third use of the instrument set (Table 1).

The participation rate in answering the questionnaire was satisfactory (92.7%), with 51 students responding to the questions as demonstrated in Table 2. The majority of students reported having difficulties during endodontic treatments (98.0%). The main challenges reported are related to technical difficulties (54.1%) such as taking radiographs and

placing rubber dams, followed by tooth-related difficulties (26.8%), such as variations in root canal morphology and location of the tooth in dental arch. In student's opinions, molars were considered the most challenging teeth to treat (90.2%) and the reasons more commonly attributed were tooth-related difficulties (69.9%), such as visualization capacity (indirect vision difficulties) and anatomical and morphological variations, followed by technical difficulties (26.0%), such as opening the cavity and identifying root canals. The majority of students regarded the treatments performed during the program as of good quality (80.4%).

About the confidence to perform endodontic treatments, results are presented in Figure 1. Note that, among all students evaluated, 49.0% answered that they feel confident to perform this task in anterior teeth, but only 23.6% feel the same way when it comes to posterior teeth.

The occurrence of an instrument separation seems to have negatively influenced the interest in the endodontic area. For those students who did not report the occurrence of instrument fractures (n=42), 34 answers were obtained for the question that assessed the influence of this occurrence on their interest in the area. Some students may have considered that they could not answer this question since they had never broken an instrument. However, considering the data collected, 88.2% reported that their interest would not be influenced by the fracture incident. Among the students who had the fracture experience (n=9), all of them responded the question, and a decrease in this percentage was observed (44.5%). The same occurred when asked about the influence of an instrument fracture on their confidence to perform endodontic treatments. We obtained 31 answers from the students who did not fracture instruments. The majority (83.9%) responded that their confidence would not be shaken, whereas those who went through the fracture incident and responded the questionnaire (n=9), this percentage was 33.3% (Figures 2A and 2B).

Discussion

This study attempts to determine the prevalence of instrument fractures during the treatments performed by undergraduate students and their perception facing this occurrence in their clinical practice. During the period this study was undertaken, there were no similar studies that examined such parameters. Patients who needed endodontic

therapy at undergraduate clinics of UFMG SD present teeth with different levels of difficulty. For this reason, students were exposed to different clinical experiences that cannot be controlled and these circumstances, in addition to individual variations and operator's skills, may have had an impact on NiTi endodontic rotary instrument fracture.

The results of this clinically based study showed a low prevalence of NiTi rotary instruments fractures in the practice of undergraduate students, rather coincident with the findings of other studies on the same subject (Di Fiore *et al.* 2006, Iqbal *et al.* 2006, Shen *et al.* 2009, Ehrhardt *et al.* 2012, Ungerechts *et al.* 2014, Caballero-Flores *et al.* 2019). This is an important finding and corroborates with previous studies that have revealed that inexperienced dental students can use rotary systems to perform endodontic treatments, making few procedural errors, enhancing their practice and increasing their self-confidence (Shen *et al.* 2009, Unal *et al.* 2012, Martins *et al.* 2012, Bruno *et al.* 2015). In fact, it was previously shown that during clinical practice, student's self-efficacy concept increases due to positive experiences. However, it decreases due to negative ones (Tanalp *et al.* 2013, Baaji *et al.* 2020). It was evidenced in this study that students who fractured an instrument in their practice were more susceptible to that negative experience, what influenced their interest in the endodontic area and their level of confidence to perform future endodontic treatments. Students who had not undergone such practical experience, did not have this perception and kept their interest and confidence in high levels.

When asked about the greatest difficulties encountered during their endodontic clinical practice, the occurrence of instrument fractures was not mentioned, and this is an interesting finding. We already expected that this occurrence would not be one of the most remembered, because only a few students experienced this incident. When answering this question, students had an overview of endodontic practice, reporting that most of the difficulties are related to technical procedures, such as taking radiographs and placing rubber dams. It is not uncommon for recently graduated students and dentists to feel less competent in some basic clinical skills, since time constraints and clinical conditions in undergraduate programs may keep them from practicing the procedures for long enough to make them more proficient (Murray & Chamber 2014).

On the other hand, students are aware of the challenge presented by molars, as they do not hesitate to refer this tooth as the most difficult teeth to treat. Reasons underlying molars reputation are mostly related to their position in the posterior section of the arch, anatomic and morphological variations and the number of root canals in the same tooth. Some other authors (Di Fiore *et al.* 2006, Iqbal *et al.* 2006, Tzanetakis *et al.* 2008, Wu *et al.* 2011, Ungerechts *et al.* 2014, Caballero-Flores *et al.* 2018) also made propositions about the greatest degree of difficulty for endodontic treatment of molar teeth. The perception that molars offer higher degrees of difficulty in performing treatment can also be evidenced by the questionnaire answers presented by the students on their self-confidence to perform an endodontic treatment. While the majority of the students reported feeling confident to perform an endodontic treatment in anterior teeth, that percentage drops to less than half when it comes to posterior teeth.

Results regarding the location and the sizes of the fragments may indicate the fracture mechanism that has occurred. When the fracture is caused by flexural fatigue, fragment length usually coincides with the point where the maximum strain amplitude was imposed along the root curvature (Bahia & Buono 2005). This point is usually located about 3mm far from the apex (Bahia *et al.* 2005, Iqbal *et al.* 2006, Madarati *et al.* 2008). Longer fragments suggest torsional failure, since the instruments deform and fracture at the point where they remained stuck within the dentin canal walls, wherever it was. In this study, most broken fragments were located in the coronal or middle thirds of the root canals and measured more than three millimeters, suggesting that torsional overload was the most likely cause of the fractures found here.

To support this theory, one should observe that our study revealed higher separation rates in instruments designed to the apical shaping of root canals (finishing files). Given its purpose to finish the root canal preparation, such instruments are usually designed with larger dimensions all along its length, and in cases where excessive apical force is applied, when the correct instruments sequence is neglected, or even when previous hand file exploration is insufficient, they may be locked within the canal walls (Yared *et al.* 2001, Shen *et al.* 2013, Campbell *et al.* 2014) which might partly explain the apparent torsional failure suggest here.

In this study, most of files fractured in up to the third use, not an excessive use, which seems to be another suggestion that instrument reutilization and flexural fatigue were probably not the main cause of ruptures. The disposal of NiTi rotary endodontic instruments after a certain number of clinical uses is recommended due to metal fatigue (Sattapan *et al.* 2000, Shen *et al.* 2009). Although there is no consensus about the exact number of uses up to which an instrument can be submitted before failure, some researchers suggest that NiTi instruments could be reused in up to 10 canals (Yared *et al.* 1999, Bahia & Buono 2005, Vieira *et al.* 2008, Bueno *et al.* 2017) or more (Yared *et al.* 2000, Gambarini 2001, Foschi *et al.* 2004, Vieira *et al.* 2008). This result reinforces that instruments might have been inappropriately handled during the course of this study. Other studies have shown that a satisfactory performance in using rotary instrumentation, including the development of fine sensation, requires time and training (Blum *et al.* 1999, Mandel *et al.* 1999, Yared *et al.* 2001, Shen *et al.* 2009). At UFMG SD, students start their endodontic practice in the fifth semester of their 5-year program, with pre-clinical training in extracted teeth, proceeding the clinical care itself. However, by and large, these training sessions do not last more than three weeks. These findings seem to indicate that this model is insufficient and that a more extensive pre-clinical training should be proposed for the syllabus regarding the endodontics related disciplines. That by itself would offer students the opportunity to better develop their skills, get acquainted with the technical guidelines of using rotary instrumentation and build knowledge before treating patients. Thus, it is possible that the incidence of fractures could be further reduced. A previous study by Seijo *et al.* (2013) already showed student's desire for longer periods of practical experience.

Regarding the management of separated instruments, removal or bypassing the fragment is considered the ideal treatment option as it allows proper cleaning and shaping of the root canal system (Spili *et al.* 2005, Madarati *et al.* 2013, Adl *et al.* 2017). However, the success rate of removing or bypassing instruments is related to some factors, such as root canal anatomy (curved and narrow roots of molar teeth), tooth position in the dental arch, fragment length, depth within the root canal, design features of rotary files and the student's lack of experience (Shen *et al.* 2004, Adl *et al.* 2017). In this study, removing or bypassing fragments was not possible in half of the occurrences and may jeopardize the adequate debridement of the root canal system and subsequently, its three-dimensional filling. Interestingly, among the students who answered the questionnaire

and went through the experience of fracturing an instrument, none of them regarded their finished cases as of poor quality. These findings may not be surprising as we can assume that students are generally more concerned with the execution of operational endodontic procedures and the completion of cases, since this is how they are evaluated by their teachers. Students may believe that root canal filling, regardless of the case, is sufficient to guarantee a successful treatment. They possibly lack enough experience to realize that it is equally important to understand the dynamics of the pathological process of pulp and periapical tissues (Murray & Chambers 2014) and that, in infected root canals in particular, it is essential to remove obstacles to avoid leaving bacteria and infected pulp tissue remnants (Sjogren *et al.* 1990, Panitvisai *et al.* 2010) which may have a negative impact on the treatment outcome. Aside to that, dental school attendance dynamics keep students from doing a proper follow up on their cases, and therefore ignore whether the treatment has successful in recovering periapical tissues health. If they could monitor and visualize the failure rate associated with a poor root canal filling, they might hold a different perspective on the quality of the endodontic treatments performed by them.

Some limitations are inherent to the present study methodology, mainly with regard to the convenience sample, which does not allow us to extrapolate the results to every single school or dental service. However, this study represents a good opportunity to build knowledge about students' challenges and perceptions, strategies to minimize iatrogenic mistakes and what can be improved in their educational experience. The need for curriculum improvements and increased training opportunities are good examples that could render students more expertise and confidence in the very first steps of their clinical practice.

Conclusions

The prevalence of NiTi rotary instrument fracture in the undergraduate clinics was quite low, even for students with limited experience. There was a tendency to fracture instruments with larger apical diameters, in curved and narrow molar teeth root canals, with long fragments and located in the coronal to middle thirds of the root, usually after files having been used only a few times. These aspects may lead us to suggest that torsional overload was most likely the cause of such fractures. Students reported several difficulties in performing endodontic treatments, most of them related to lack of technical

skills resulting from their little experience in clinical practice or induced by molars inherent anatomical complexity. Students perceptions on their own confidence and interest in the specialty seem to be directly affected by the occurrence of instruments fracture.

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Table 1

Descriptive analysis of the characteristics of the endodontic instrument fractures (n = 18). UFMG SD, 2017-2018.

Variables	n	(%)
<i>Type of teeth</i>		
Maxillary molar	6	(33.3%)
Mandibular molar	12	(66.7%)
<i>Root canal</i>		
Distal	3	(16.7%)
Mesial of mandibular molars	9	(50.0%)
Buccal of maxillary molars	6	(33.3%)
<i>Location of the fragment</i>		
Coronal/middle third	11	(61.3%)
Apical third	7	(38.9%)
<i>Size of the fragment</i>		
≤ 3mm	5	(27.8%)
>3mm	13	(72.2%)
<i>Type of instrument</i>		
Works at the coronal/middle third – shaping files	7	(38.9%)
Works at the apical third – finishing files	11	(61.1%)
<i>Fragment removed or bypassed</i>		
Yes	9	(50.0%)
No	9	(50.0%)
<i>Control of uses</i>		
Yes	16	(88.9%)
No	2	(11.1%)
<i>Number of uses</i>		
First use	4	(22.2%)
Second use	3	(16.7%)
Third use	5	(27.8%)
Fourth use or more	4	(22.2%)
No control	2	(11.1%)

Table 2

Descriptive analysis of the questionnaire. Belo Horizonte, 2020.

Variables	n	(%)
<i>Difficult during endodontic treatment (n=51)</i>		
Yes	50	(98.0%)
No	1	(2.0%)
<i>Difficulties founded (n=235) **</i>		
Technical difficulties	127	(54.1%)
	n	%
Performing radiographs	41	(32.3%)
Placement of rubber dams	33	(26.0%)
Cavity access	23	(18.1%)
Determination of pulp diagnosis	14	(11.0%)
Determination of working length	13	(10.2%)
Dealing with the occurrence of perforations	2	(1.6%)
Lack of materials available for treatment	1	(0.8%)
Tooth-related difficulties	63	(26.8%)
	n	%
Root canal morphology	40	(63.5%)
Location of the tooth	20	(31.7%)
Pre-existing restorations	3	(4.8%)
Learning process difficulties	40	(17.0%)
	n	%
Lack of time	14	(35.0%)
Difficulties with teacher's orientation	13	(32.5%)
Evaluation of preoperative radiography	10	(25.0%)
Lack of theoretical knowledge	3	(7.5%)
Patient-related difficulties	5	(2.1%)
	n	%
Patient's medical history (comorbidities)	3	(60.0%)
Patient's behavior (lack of cooperation)	2	(40.0%)
<i>Most difficult type of tooth (n=51)</i>		
Molar teeth	46	(90.2%)
Other type of teeth	5	(9.8%)
<i>Why (n=73) **</i>		
Tooth-related difficulties	51	(69.9%)
	n	%
Visualization and reach (indirect vision difficulties)	25	(49.1%)
Anatomical and morphological variations	14	(27.4%)
Number of root canals in the same tooth	12	(23.5%)
Technical difficulties	19	(26.0%)
	n	%
Opening the cavity and identifying root canals	9	(47.4%)
Exploration and shaping root canals	3	(15.8%)
Exposure of radiographs	2	(10.6%)
Root canal filling	2	(10.6%)
Instrument positioning	1	(5.2%)
Placement of rubber dam	1	(5.2%)

Determination of working length	1	(5.2%)		
Patient-related difficulties			2	(2.7%)
	n	%		
Patient mouth opening amplitude	1	(50.0%)		
Patient discomforts	1	(50.0%)		
Learning process difficulties			1	(1.4%)
	n	%		
Lack of experience and interest	1	(100.0%)		
<i>The quality of the treatment performed (n=51)</i>				
Good			41	(80.4%)
Regular			9	(17.6%)
Bad			1	(2.0%)
<i>Endodontic instrument fracture (n=51)</i>				
Yes			9	(17.6%)
No			42	(82.4%)

** Open-ended question that was categorized.

Figure 1

Confidence in performing endodontic treatment in anterior and in posterior teeth.

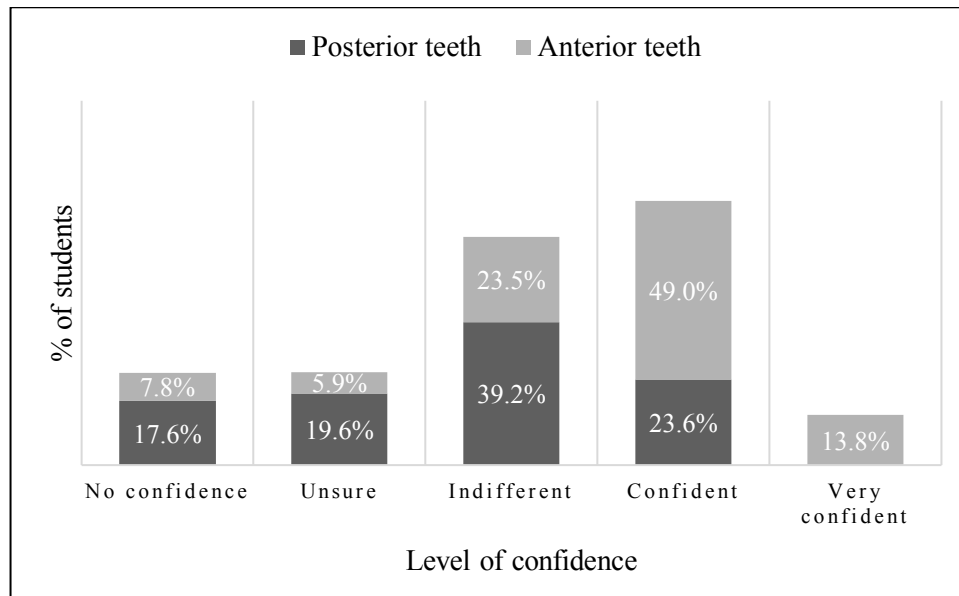
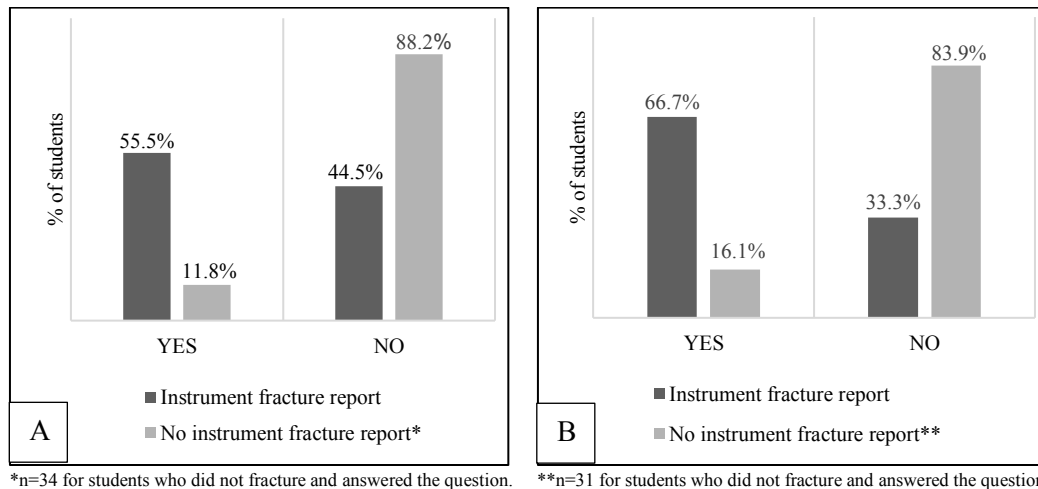


Figure 2

Influence of an instrument fracture on the interesting (A) and confidence (B) of the students.



CONSIDERAÇÕES FINAIS

5 CONSIDERAÇÕES FINAIS

O conhecimento dos dados epidemiológicos sobre os tratamentos endodônticos realizados por estudantes de graduação é importante para melhorar nosso entendimento sobre as características dos pacientes, dos dentes encaminhados e sobre os fatores associados aos atendimentos de emergência prévios e finalização destes casos.

Neste estudo, a grande maioria dos tratamentos endodônticos encaminhados para as disciplinas de Endodontia da FAO UFMG foram concluídos, no entanto três variáveis afetaram estatisticamente a conclusão dos casos: a complexidade anatômica inerente dos molares, a pouca idade dos pacientes e a taxa de absenteísmo.

A necessidade de tratamento endodôntico mostrou-se maior nos molares e esses dentes foram os que mais foram submetidos a procedimentos de urgência anteriores e tiveram o menor índice de finalização em comparação com os pré-molares e dentes anteriores. Esses achados podem ser associados ao fato de que em geral, esse tipo de dente apresenta mais variações anatômicas como a presença de maior número de canais, ramificações, curvaturas e calcificações, que tornam as etapas de limpeza, modelagem e obturação mais desafiadoras. A ocorrência de atendimentos de urgência prévios, pode também ter propiciado a presença de fatores iatrogênicos, como bloqueios, desvios e degraus, o que adiciona dificuldades extras para a realização dos tratamentos.

A necessidade de atendimento prévio de urgência foi mais prevalente em indivíduos de 0 a 19 anos e estes também apresentaram as menores taxas de finalização dos tratamentos endodônticos. Isso nos leva a sugerir que falta de maturidade dos jovens pode interferir no número de visitas regulares ao dentista, agravamento dos casos, episódios de dor e, conseqüentemente a necessidade de atendimento de urgência. Para os que já iniciaram o tratamento, a falta de maturidade interfere na regularidade de presença às consultas o que pode interferir na taxa de finalização dos tratamentos endodônticos.

O tempo necessário para a conclusão de um tratamento endodôntico também deve considerar a taxa de absenteísmo dos pacientes. Neste estudo, os pacientes que perderam uma ou mais consultas tiveram proporcionalmente mais casos inacabados, o que poderia levar a um aumento nas filas de espera, perda dos dentes e o comprometimento do

processo de aprendizagem dos alunos, que acabam perdendo a oportunidade de conduzir adequadamente todas as etapas do processo da terapia endodôntica.

De fato, os alunos relataram várias dificuldades, a maioria delas relacionada à falta de habilidades técnicas, resultante da pouca experiência clínica ou causada pela complexidade anatômica inerente aos molares. Entre as principais dificuldades estão, a realização das tomadas radiográficas durante os tratamentos, a adaptação dos isolamentos absolutos e os desafios relacionados ao acesso à cavidade.

A prevalência de fraturas de instrumentos rotatórios de NiTi foi baixa, o que nos leva a sugerir que o ensino e aplicação da instrumentação mecanizada na prática clínica de estudantes inexperientes é desejável. Os aspectos relacionados às fraturas, como a localização (terço cervical ou médio) e comprimento dos fragmentos (maiores que 3 milímetros), baixo número de usos (terceiro uso ou menos) e o tipo de instrumento fraturado (limas de preparo apical, com maiores calibres) podem indicar que a maioria delas ocorreu por sobrecargas torcionais. Este tipo de fratura tem sido associado à aplicação de força apical excessiva durante a instrumentação, quando os instrumentos se deformam e fraturam no ponto em que permaneceram presos nas paredes de dentina radiculares.

As percepções dos alunos sobre sua própria confiança e interesse na especialidade estão diretamente relacionadas às experiências negativas e dificuldades encontradas na prática clínica, como a ocorrência de fratura de instrumentos endodônticos. O treinamento pré-clínico é essencial no desenvolvimento de habilidades e competências na prática dos alunos. Levando em consideração todas as limitações curriculares envolvidas, como os pré-requisitos de conteúdo para a evolução dos períodos e as restrições de tempo para o curso de 5 anos, pode-se sugerir que um treinamento endodôntico pré-clínico mais longo seja proposto nas disciplinas de endodontia, para propiciar o ganho de experiência e confiança por parte dos alunos e assim ampliar suas experiências educacionais.

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APÊNDICES E ANEXOS

APÊNDICE I – Formulário de coleta de dados dos pacientes

Faculdade de Odontologia - Universidade Federal de Minas Gerais
Programa de Pós-Graduação em Odontologia – Nível Doutorado

Aluna responsável: Luiza Cruz Guimarães – (31) 99235-0120

FORMULÁRIO DE COLETA DE DADOS DOS PACIENTES

Disciplina: Endodontia ____	Data: __/__/__
Aluno: _____	
Paciente: _____	
Registro: _____	Idade: ____
Sexo: F (<input type="checkbox"/>) M (<input type="checkbox"/>)	
Dente (s) tratado (s): ____	
Alterações Cardiovasculares: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Diabetes: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Portador de HIV: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Alterações Hepáticas: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Tabagista: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Etilista: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Usuário de drogas ilícitas: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Diagnóstico inicial: Necrose (<input type="checkbox"/>) Pulpite (<input type="checkbox"/>) Finalidade Protética (<input type="checkbox"/>)	
Recebeu atendimento de urgência: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Há presença de alteração periapical na radiografia: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Se sim:	
Espessamento do lig. period (<input type="checkbox"/>) Lesão periapical(<input type="checkbox"/>)	
Quantas sessões de atendimento: 1 ou 2 (<input type="checkbox"/>) 3 sessões(<input type="checkbox"/>) 4 ou mais(<input type="checkbox"/>)	
Faltas do paciente: Nenhuma (<input type="checkbox"/>) Uma ou + (<input type="checkbox"/>)	
Houve abandono: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Tratamento não finalizado: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Motivo: Tratamento conservador (<input type="checkbox"/>) Aumento de coroa (<input type="checkbox"/>)	
Exodontia (<input type="checkbox"/>) Encerramento do semestre (<input type="checkbox"/>) Caso complexo (<input type="checkbox"/>)	
Sistema utilizado: ProTaper Universal (<input type="checkbox"/>) Next (<input type="checkbox"/>) Manual (<input type="checkbox"/>)	
Há controle do número de utilizações de cada kit: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>)	
Se sim, quantas: Novo(<input type="checkbox"/>) 1uso(<input type="checkbox"/>) 2usos(<input type="checkbox"/>) 3usos(<input type="checkbox"/>) 4usos(<input type="checkbox"/>) 5usos(<input type="checkbox"/>)+5(<input type="checkbox"/>)	
(CONTAR COMO DENTES, E NÃO POR CANAL)	
Envolve utilização em pré-clínico: Sim (<input type="checkbox"/>) Não (<input type="checkbox"/>) Quantos: ____	
Como é feita a contagem: Marcação (<input type="checkbox"/>) “de cabeça” (<input type="checkbox"/>)	

APÊNDICE II – Formulário de coleta de dados de fraturas de limas de NiTi

Faculdade de Odontologia - Universidade Federal de Minas Gerais
Programa de Pós-Graduação em Odontologia – Nível Doutorado

Aluna responsável: Luiza Cruz Guimarães – (31) 99235-0120

FORMULÁRIO DE COLETA DE DADOS DE FRATURAS DE INSTRUMENTOS

Data:								
Clínica / Disciplina:								
Endo I – SEG manhã () Endo I QUA tarde ()				Endo II – TER tarde () Endo II – QUA manhã ()				
Paciente:				Aluno:				
Idade:				Idade:				
Sexo: M () F ()				Sexo: M () F ()				
Número do dente:								
Canal em que se encontra o fragmento:								
Molar inferior:		D ()		MV ()		ML ()		Outro: _____
Molar Superior:		P ()		MV ()		DV ()		MV2 ()
Pré-molar sup:		P ()		V ()		Outro: _____		
Único: ()								
Localização do fragmento:								
Terço cervical ()			Terço médio ()			Terço apical ()		
Sistema Utilizado:			ProTaper Universal ()			ProTaper Next ()		
Instrumento fraturado:								
S1 ()	S2 ()	F1 ()	F2 ()	F3 ()	SX ()	X1 ()	X2 ()	X3 ()
Tamanho do fragmento:			0-3mm ()		4-6mm ()		+ de 6 ()	
Fragmento removido:			Sim ()			Não ()		
Fragmento ultrapassado:			Sim ()			Não ()		
Há controle do número de utilizações do kit: Sim () Não ()								
Se sim, quantas:		1 ()	2 ()	3 ()	4 ()	5 ()	+de 5 ()	
Envolve utilização em pré-clínico: Sim () Não ()								
Se sim, quantos: _____								
Como é feito o controle:			Marcação ()			Estimativa ()		

ANEXO I – Termo de aprovação do Comitê de Ética em Pesquisa da UFMG



UNIVERSIDADE FEDERAL DE MINAS GERAIS
COMITÊ DE ÉTICA EM PESQUISA - COEP

Projeto: CAAE – 80164117.2.0000.5149

Interessado (a): Profa. Ana Cecilia Diniz Viana De Castro
Depto. Odontologia Restauradora
Faculdade de Odontologia- UFMG

DECISÃO

O Comitê de Ética em Pesquisa da UFMG – COEP aprovou, no dia 20 de março de 2018, o projeto de pesquisa intitulado “**Fraturas de Instrumentos Endodônticos de Níquel-Titânio**”.

O relatório final ou parcial deverá ser encaminhado ao COEP um ano após o início do projeto.

A handwritten signature in blue ink, reading 'Vivian Resende'.

Profa. Dra. Vivian Resende
Coordenadora do COEP-UFMG