UNIVERSIDADE FEDERAL DE PELOTAS
Faculdade de Odontologia
Programa de Pós-graduação em Odontologia

Tese

Associação da presença de canais acessórios com reabsorções perirradiculares utilizando tomografia computadorizada de feixe cônico de alta resolução

Lucas Pinto Carpena

Pelotas, 2025

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Tese apresentada ao Programa de Pós-Graduação em Odontologia Faculdade de Odontologia da Universidade Federal de Pelotas, como requisito parcial à obtenção do título de Doutor em Clínica Odontológica com Ênfase em Endodontia.

Orientadora: Profa. Dra. Nádia de Souza Ferreira

Pelotas, 2025

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Resumo

CARPENA, Lucas Pinto. **Associação da presença de canais acessórios com reabsorções perirradiculares utilizando tomografia computadorizada de feixe cônico de alta resolução**. Orientadora: Nadia de Souza Ferreira. 2025. 64f. Tese (Doutorado em Clínica Odontológica – Ênfase em Endodontia) - Programa de Pós-graduação em Odontologia, Faculdade de Odontologia, Universidade Federal de Pelotas, Pelotas, Brasil, 2025.

Os canais acessórios (CA) podem representar um desafio para o controle da infecção endodôntica, uma vez que a permanência de bactérias no interior dos canais pode ter repercussões no periodonto. Assim, o objetivo desta tese foi descrever características morfológicas de CA observados em Tomografia Computadorizada de Feixe Cônico (TCFC) e sua associação com reabsorção óssea perirradicular. Também foram descritos 7 casos clínicos onde ocorreu a instrumentação intencional de CA, com acompanhamento clínico e de TCFC. Foram acessados 3223 laudos de exames de TCFC de um banco de dados de uma clínica de Radiologia. Através de um mecanismo de busca, foram selecionados exames de TCFC de pacientes onde observou-se presença de CA e esses exames foram incluídos para análise e coleta de dados. Foram coletados os seguintes dados: dente onde há CA; em casos de dentes multirradiculares, raiz onde se encontra; terço de localização do CA na raiz; face onde se encontra o CA, angulação em relação ao canal principal e presença de obturação. Além disso, foram coletados dados quanto a presença de reabsorção óssea perirradicular. Foi realizada estatística descritiva dos dados. Foram identificados 45 casos de CA. A maior prevalência foi observada em pré-molares superiores e incisivos superiores, com predomínio de localização no terço médio da raiz. A maioria dos CA localizava-se nas faces palatina/lingual e vestibular da raiz. A angulação entre os CA e o canal principal variou de 87° a 147°, com média de 102,4°. Algum tipo de reabsorção óssea perirradicular foi observada em 39 casos (86,7%). Dentre esses, a combinação de reabsorção óssea apical e lateral foi a mais prevalente, seguida pela reabsorção exclusivamente associada ao CA. Foram relatados sete casos clínicos de tratamento e retratamento endodôntico em dentes com CA identificados por TCFC, todos associados a necrose pulpar e reabsorção óssea. Os CA estavam localizados em diferentes regiões radiculares: face palatina do terço médio da raiz vestibular (caso 1), terço apical da face mesial (caso 2), terço apical da face vestibular (caso 3), terço médio da face palatina da raiz vestibular (caso 4), face distal do terço médio da raiz mesiolingual (casos 5 e 6) e terço cervical da raiz vestibular voltado para face palatina (caso 7). Os tratamentos seguiram protocolo padronizado, com remoção de materiais restauradores e pinos, preparo químico-mecânico até a lima 40.05, associado a gel de clorexidina 2%, irrigação com solução salina e EDTA 17% ativado por ultrassom. Os CA foram intencionalmente debridados com limas manuais e, quando possível, rotatórias. A obturação foi realizada com guta-percha e cimento AH Plus Jet, seguida de restauração em resina composta. Nos acompanhamentos clínicos e tomográficos, realizados entre 8 e 24 meses, todos os casos evoluíram com cicatrização completa ou parcial e ausência de sintomatologia. Os achados reforçam a relevância clínica dos CA e sua associação com reabsorção óssea perirradicular.

Palavras-chave: anatomia; tratamento do canal radicular; tomografia computadorizada de feixe cônico.

Abstract

CARPENA, Lucas Pinto. **Association of Accessory Canal with perirradicular resorption Using High-Resolution Cone-Beam Computed Tomography.** Advisor: Nadia de Souza Ferreira. 2025. 64 f. Thesis (Phd in Dental Clinic – Emphasis on Endodontics)– Postgraduate Program in Dentistry, Faculty of Dentistry, Federal University of Pelotas, Pelotas, Brazil, 2025.

Accessory canals (AC) represent a significant challenge in the control of endodontic infection, as the persistence of bacteria within these canals may lead to periodontal repercussions. Therefore, the aim of this thesis was to describe the morphological characteristics of AC observed on cone-beam computed tomography (CBCT) and their association with periradicular bone resorption. Additionally, 7 clinical cases involving intentional instrumentation of AC are reported, with clinical and CBCT follow-up. A total of 3,223 CBCT reports from a private radiology clinic database were reviewed. Through a keyword search system, cases with reported AC were selected and included for data collection and analysis. The following data were recorded: the tooth in which the AC was present; in multirooted teeth, the root where the AC was located; canal location along the root (cervical, middle, or apical third); root surface on which the AC was found; angulation relative to the main canal; and presence or absence of root canal filling. Additionally, data regarding periradicular bone resorption were collected and categorized as absent, apical, associated with a AC, or both apical and lateral. Descriptive statistics were applied. A total of 45 cases of AC were identified. The highest prevalence was observed in upper premolars and upper incisors, with a predominance in the middle third of the root. Most AC were located on the palatal/lingual and buccal root surfaces. The angle between the AC and the main canal ranged from 87° to 147°, with a mean of 102.4°. Periradicular bone resorption was observed in 39 cases (86.7%). Among these, the combination of apical and lateral bone resorption was the most prevalent, followed by resorption exclusively associated with the AC. Seven clinical cases of endodontic treatment and retreatment in teeth with AC identified by CBCT were reported, all associated with pulp necrosis and bone resorption. AC were located in various root regions: palatal surface of the middle third of the buccal root (case 1), apical third of the mesial surface (case 2), apical third of the buccal surface (case 3), middle third of the palatal surface of the buccal root (case 4), distal surface of the middle third of the mesiolingual root (cases 5 and 6), and cervical third of the buccal root toward the palatal surface (case 7). Treatments followed a standardized protocol, including removal of restorations and posts, chemomechanical preparation up to file 40.05 with 2% chlorhexidine gel, irrigation with saline and 17% EDTA activated by ultrasonic agitation. ACs were intentionally debrided with hand files and, when possible, rotary instruments. Obturation was completed using gutta-percha and AH Plus Jet sealer, followed by composite resin restoration. Clinical and tomographic follow-up between 8 and 24 months showed complete or partial healing and absence of symptoms in all cases. Findings reinforce the clinical relevance of AC and their association with periradicular bone resorption.

Keywords: anatomy; root canal therapy; cone beam computed tomography.

Sumário

1 INTRODUÇÃO

Historicamente a anatomia do sistema de canais radiculares tem sido objeto de estudo e desafio para endodontia (VERTUCCI, 1984). Dentre as complexidades anatômicas encontradas, os canais acessórios (CA) representam um desafio particular.

A definição de CA varia na Literatura. De acordo com De-Deus (1975) a morfologia do sistema de canais radiculares pode ser categorizada em: canal lateral - se estende do canal principal até o ligamento periodontal (principalmente no corpo da raiz); canal secundário - se estende do canal principal até o ligamento periodontal na região apical e canal acessório - derivado do canal secundário, ramificando-se para o ligamento periodontal na região apical.

De acordo com o Glossário de Termos Endodônticos da Associação Americana de Endodontistas (AAE) (AAE 2020), o CA é definido como uma ramificação do canal principal ou da câmara pulpar que se comunica com a superfície externa da raiz e o canal lateral é definido como um CA localizado no terço coronário ou médio da raiz, geralmente estendendo-se horizontalmente a partir do canal principal.

Com o objetivo de simplificar a classificação, Ahmed, Neelakantan e Dummer (2018) propõe que CA é um pequeno canal com origem no canal principal e se comunica com a superfície externa da raiz ou furca, podendo estar localizado em qualquer lugar ao longo do comprimento da raiz (terço coronal, médio ou apical) e pode ser de qualquer tipo (patente, cego ou em alça), incluindo também o que parte da literatura denomina de canais laterais. Com isso, os autores propõem que apenas o termo acessório deve ser utilizado para tais canais, e termos como lateral não são necessários para evitar qualquer confusão potencial.

Ao longo do tempo, a anatomia do sistema de canais radiculares foi estudada através de diversas metodologias que incluem: diafanização, imagens de radiografias e mais recentemente de tomografias computadorizadas de feixe cônico (TCFC) e micro tomografias computadorizadas (micro-CT) (AHMED, 2022).

A precisão diagnóstica de imagens radiográficas bidimensionais para a detecção de CA, é considerada baixa (SCARFE; FANA; FARMAN, 1995). Já a micro-CT apresenta imagens em alta resolução, o que faz com que essa tecnologia seja atualmente considerada a ferramenta de pesquisa mais importante e precisa para o estudo do sistema de canais radiculares, e tem sido bastante utilizada para o estudo da anatomia dos canais (AKSOY et al., 2021). Dados coletados por micro-CT podem ser submetidos à reconstrução e análise tridimensionais, e ao utilizar essa metodologia, a presença de CA varia entre grupos dentários e diferentes populações, e sua prevalência é relatada variando de 24% a 52% (XU et al., 2019; AHMED et al., 2025). Entretanto, esse é um método de aplicação limitado a ambientes laboratoriais, utilizando dentes extraídos (BLANK-GONÇALVES et al., 2025).

Neste contexto, a TCFC de alta resolução se tornou uma importante aliada no diagnóstico, planejamento de tratamento e acompanhamentos na Endodontia (PATEL et al., 2019; TAY et al., 2022) e particularmente para o estudo de anatomia dos canais radiculares *in vivo* (BLANK-GONÇALVES et al. 2025). Esse tipo de exame se mostrou eficiente para avaliação de CA (JI et al., 2017), entretanto não se sabe a repercussão da presença desses canais no periodonto.

A presença dos CA têm sido associada à manutenção de tecido necrótico e infectado após o tratamento endodôntico, podendo contribuir para a persistência da periodontite apical e para o insucesso clínico. Mesmo o uso de medicação intracanal e extrusão de cimento endodôntico por esses canais não parece garantir o controle da infecção endodôntica (RICUCCI; SIQUEIRA, 2010; RICUCCI; LOGHIN; SIQUEIRA, 2013).

A infecção bacteriana persistente no sistema de canais radiculares e sua comunicação com o periodonto é considerada a principal causa de falhas do tratamento endodôntico (SIQUEIRA Jr., 2001). Dentes com canais esquecidos/não tratados apresentam maiores chances de desenvolvimento ou manutenção de periodontite apical (COSTA et al., 2019).

Com base nisso, parece lógico buscar a instrumentação e obturação dos CA. No entanto, essa abordagem encontra limitações na prática clínica. O pequeno diâmetro desses canais restringe significativamente a possibilidade de instrumentação efetiva (DAMMASCHKE et al., 2004). Ainda, os CA podem apresentar curvaturas acentuadas, o que dificulta ainda mais sua instrumentação (PARIROKH; HATAMI, 2022).

Esses desafios anatômicos e técnicos tornam a instrumentação e obturação intencional dos CA um procedimento altamente complexo. Como consequência, a documentação clínica disponível na literatura é escassa, com publicações restritas a poucos relatos de casos com níveis variáveis de detalhamento e acompanhamento (PARIROKH; HATAMI, 2022; JIMÉNEZ-ROJAS et al., 2024).

Os CA são um tema crescente de debate na literatura, porém faltam evidências de seu impacto e potencial de desencadear um quadro de periodontite e levar a um insucesso endodôntico.

Neste contexto, esta tese tem como objetivo contribuir para o conhecimento clínico-científico sobre os CA por meio de dois estudos:

- O primeiro artigo apresenta uma análise baseada em TCFC, avaliando a presença de CA e sua associação com alterações periodontais.
- O segundo artigo descreve uma série de casos clínicos nos quais os CA foram intencionalmente instrumentados e obturados, com acompanhamento clínico e por TCFC, contribuindo com documentação sobre a viabilidade técnica e os desfechos clínicos dessa abordagem.

2 Objetivos

2.1 Objetivo geral

Avaliar a presença de canais acessórios utilizando tomografia computadorizada de feixe cônico de alta resolução e sua relação com reabsorções ósseas perirradiculares.

2.2 Objetivos específicos

- Descrever em quais grupos dentários são observados canais acessórios;
- Em caso de dentes multirradiculares descrever em qual raíz o CA se encontra;
- Medir o grau de curvatura dos CA em relação ao canal principal;
- Descrever a localização do canal lateral (terço cervical, médio ou apical),
- Descrever a face da raiz em que se localiza o CA;
- Descrever uma série de casos clínicos onde o CA foi observado, instrumentado e obturado intencionalmente.

2. Projeto de Pesquisa

1. Introdução

Historicamente a anatomia interna dos canais radiculares tem sido objeto de estudo e desafio para endodontia. O assunto anatomia já se mostrava complexo quando estava limitado somente as técnicas radiográficas bidimensionais. Nos últimos anos, a introdução da tomografia computadoriza cone beam (TCCB) de alta resolução na endodontia se tornou uma importante aliada no diagnóstico, planejamento de tratamento e acompanhamentos. (1,2)

A rotina do especialista em endodontia é lidar com situações que fogem a normalidade e nesses casos o uso da TCCB de alta resolução é de grande valia. Casos como canais em C, *dens in dent*, taurodontismo, germinação/fusão e variações anatômicas, dentre elas a presença de canais adicionais. (3,4,5)

O sistema de canais radiculares frequentemente apresenta variações anatômicas, como canais acessórios ou laterais. Este último é definido como uma ramificação do canal principal que se estende de forma horizontal da luz principal até o ligamento periodontal, podendo estar presente no terço cervical, médio ou apical.(6) Quando essas ramificações laterais do canal radicular estão presentes, temos um grande desafio de limpeza e modelagem durante o preparo do conduto radicular, isso se dá devido ao seu posicionamento tridimensional geométrico que dificulta ou as vezes torna impossível a ação mecânica dos instrumentos endodônticos e dos irrigantes químicos, independente da solução. (7)

A principal causa de insucessos de tratamentos endodônticos é a permanência de bactérias no interior do canal radicular e sua migração para o ligamento periodontal. Isso se dá muitas vezes pela falha ou dificuldade técnica de modelagem e selamento do canal radicular, levando a um quadro de periodontite. (8,9) Quando comparado com dentes com todos os canais tratados, os canais esquecidos/não tratados podem levar as chances de a periodontite apical serem 6,25 vezes maiores. (10) Os canais laterais podem ser um abrigo perfeito para microrganismos colonizarem e possivelmente trazerem repercussões periodontais levando a insucesso endodôntico, devido a dificuldade de desinfecção, mesmo com a utilização de recursos complementares. (7)

As ramificações laterais presentes no interior do canal radicular são um tema crescente de debate na literatura, porém faltam evidências de seu impacto e potencial de desencadear um quadro de periodontite e levar a um insucesso endodôntico. Assim, o objetivo do presente estudo é avaliar por meio de TCCB de alta resolução a anatomia interna de dentes onde existam canais laterais e pesquisar se existe repercussões periodontais associada a essas ramificações, bem como avaliar sua posição e anatomia. A hipótese a ser testada é que os canais laterais estão frequentemente associados à periodontite apical.

1. Justificativa

A anatomia dos canais radiculares é notoriamente complexa e muitas vezes imprevisível. A identificação e compreensão das variações anatômicas são fundamentais para o sucesso dos tratamentos endodônticos. A TCCB proporciona uma visualização tridimensional que supera as limitações das técnicas radiográficas bidimensionais, permitindo uma avaliação mais precisa da anatomia interna. O entendimento da microanatomia e suas repercussões nos desfechos do tratamento endodôntico é de grande importância para a prática da endodontia, pois busca elucidar questões cruciais relacionadas à anatomia interna dos canais radiculares, especialmente no que diz respeito à presença de canais laterais e seu impacto no insucesso endodôntico.

2 Objetivos

2.1 Objetivo geral

Avaliar a presença de canais laterais utilizando tomografia computadorizada *cone beam* de alta resolução e sua relação com repercussões periodontais.

2.2 Objetivos específicos

- Descrever em quais dentes são observados canais laterais;
- Em caso de dentes multirradiculares descrever em qual canal a ramificação lateral se encontra;
- Avaliar o grau de curvatura do canal da abertura foraminal em relação ao canal principal;
- Avaliar a localização do canal lateral (terço cervical, médio ou apical), bem como sua face.

3 Metodologia

3.1 Aspectos éticos

O presente projeto de pesquisa será submetido para apreciação do Comitê de Ética em Pesquisa da Faculdade de Odontologia da Universidade Federal de Pelotas. Será acessado um banco de dados de exames de TCCB de alta resolução de uma clínica privada de Radiologia Odontológica da cidade de Pelotas/RS. Os pacientes tiveram os exames realizados de acordo com as indicações clínicas não relacionadas ao estudo. Nenhuma modificação na aquisição dos exames foi realizada para atender o estudo. Os dados serão coletados por um dos pesquisadores (L.P.C.). Não serão feitos contatos com os pacientes para coleta de dados, sendo assim, será solicitado ao CEP a dispensa do Termo de Consentimento Livre e Esclarecido (TCLE) para uso destes exames (Apêndice A).

Este trabalho não trará riscos aos participantes no que se refere ao atendimento propriamente dito, uma vez que se trata de um estudo observacional, com coleta de dados de exames de TCCB. Os riscos referem-se à possibilidade de quebra de sigilo dos dados e serão minimizados pela codificação da identificação dos mesmos durante a coleta e análise de dados e pelo comprometimento dos pesquisadores em divulgar os dados de forma anônima. O participante poderá beneficiar-se indiretamente, uma vez que o estudo poderá trazer informações relacionados a anatomia interna de dentes onde exista canais laterais. Não haverá benefícios diretos para os pacientes.

Os dados coletados durante a pesquisa serão armazenados em notebook do pesquisador responsável, com acesso restrito e protegido por senha. Os dados serão mantidos armazenados por um período de 5 anos após o término da pesquisa, conforme recomendado pelas diretrizes de boas práticas em pesquisa. Após esse período, os dados serão devidamente descartados de acordo com as normas de segurança da informação, garantindo a privacidade e confidencialidade dos participantes.

3.2 Delineamento do estudo

Por tratar-se de um estudo observacional transversal, este trabalho de pesquisa será desenvolvido e reportado de acordo com as recomendações estabelecidas no STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) (VON ELM E. et al.; 2008).

3.3 Seleção dos casos

Serão acessados exames de TCCB de um banco de dados com aproximadamente 2500 TCCB de alta resolução do período de janeiro de 2023 a dezembro de 2024. Todos os exames foram realizados com o mesmo tomógrafo (Eagle Edge 0.2 FS) com um FOV reduzido (5x5 cm) e um voxel de 0.075 mm. Através de um mecanismo de busca, serão localizados e selecionados os exames de TCCB de pacientes onde observou-se presença de canais laterais e todos esses exames serão incluídos para análise e coleta de dados. Estima-se que o número de casos incluídos será de aproximadamente 80 pacientes. Com base nisso, a amostra pode ser considerada finita. Portanto, será realizado um censo das informações de interesse disponíveis para o estudo, dispensando a realização de cálculo amostral.

3.4 Avaliação dos Casos

Todas as avaliações serão realizadas por um único pesquisador que será calibrado pelo Coeficiente de Concordância Kappa com índice superior a 0,8. Será utilizado o volume tomográfico em formato DICOM. A análise será feita através do software OnDemand 3D (Cybermed, Daejeon, Coreia). A análise será realizada através da navegação dinâmica por todo o volume tomográfico, com os ajustes necessários feitos nos 3 planos (axial, sagital e coronal) e com regulação de contraste e brilho para melhor visualização da imagem. O pesquisador irá coletar os seguintes dados: dente onde há canal lateral; em casos de dentes multirradiculares, canal onde se encontra a ramificação lateral; localização do canal lateral (terço cervical, médio ou apical do canal radicular); posição do canal lateral (face). Também será realizada a avaliação do grau de curvatura do canal lateral em relação ao canal principal através de uma ferramenta de medida de ângulo do software.

Além disso, serão coletados dados quanto a periodontite apical (associada ao canal lateral ou não), presença de obturação e/ou perfurações.

3.5 Análise estatística

Os dados serão tabulados em uma planilha em Excel. Será realizada estatística descritiva dos dados obtidos.

4 Orçamento

Tabela 1. Orçamento do estudo

Descrição	Quantidade	Preço Unitário (R$)	Preço Total (R$)
Notebook	1	3.500,00	3.500,00

Os pesquisadores declaram que custearão todos os itens descritos neste orçamento.

5 Cronograma de atividades

Tabela 2. Cronograma do estudo

	DEZ/24	JAN/25	FEV/25	MAR/25	ABR/25	MAI/25	JUN/25	JUL/25	AGO/25	SET/25
Levantamento bibliográfico e delineamento do projeto	X	X								
Envio para o comitê de ética em Pesquisa			X							
Calibração do pesquisador				X						
Coleta de dados					X	X	X			
Análise e interpretação dos dados								X		
Redação de artigo científico									X	X

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3 Relatório de Trabalho de Campo

O presente relatório de campo tem por objetivo descrever as etapas práticas de desenvolvimento da pesquisa que fundamenta a presente tese de doutorado, composta por dois estudos complementares. Ambos possuem delineamento retrospectivo, sendo um deles baseado na análise de exames de TCFC de alta resolução realizados em uma clínica privada de radiologia e o outro composto por uma série retrospectiva de casos clínicos provenientes de atendimentos realizados em consultório particular de um dos pesquisadores.

Com relação ao primeiro artigo a coleta de dados foi realizada por meio do acesso ao banco de dados de uma clínica privada de radiologia odontológica localizada na cidade de Pelotas, Rio Grande do Sul. Foram revisados laudos e exames de TCFC arquivados entre janeiro e dezembro de 2024.

Foram inicialmente acessados 3.223 laudos de TCFC. Utilizando um mecanismo de busca interno no banco de dados, foram selecionados os exames que apresentavam registros descritivos da presença de CA. As análises foram realizadas com o software e-Vol DX (CDT Software, São José dos Campos, Brasil), que permite navegação dinâmica pelos cortes multiplanares (axial, coronal e sagital), além de reconstruções volumétricas 3D.

Foram coletadas, para cada caso analisado, informações referentes ao dente no qual o CA estava presente, bem como à raiz correspondente, no caso de dentes multirradiculares. Também foram registradas a localização do CA na raiz, classificada em terço cervical, médio ou apical, e a face da raiz em que o canal se encontrava, categorizada como vestibular, palatina/lingual, mesial, distal ou combinações dessas. Adicionalmente, foi mensurado o ângulo de emergência do CA em relação ao eixo do canal principal. Foram ainda avaliadas a presença ou ausência de material obturador no sistema de canais e a existência de reabsorção óssea perirradicular, com sua respectiva localização, sendo está classificada como ausente, restrita à região apical, associada ao CA ou concomitantemente apical e lateral.

Durante o desenvolvimento desta etapa, os principais desafios estiveram relacionados à interpretação das imagens nos casos com artefatos provenientes de materiais metálicos ou restaurações, que poderiam dificultar a visualização precisa dos CA e de possíveis reabsorções ósseas associadas.

Adotou-se, como estratégia, a utilização de ajustes finos de contraste, brilho e espessura dos cortes, além da correlação entre os diferentes planos anatômicos e as reconstruções tridimensionais, a fim de minimizar o impacto dos artefatos.

O segundo artigo foi desenvolvido a partir da análise retrospectiva dos prontuários clínicos e dos exames de imagem dos pacientes atendidos no consultório particular do pesquisador, situado na cidade de Pelotas, Rio Grande do Sul.

Foram incluídos os casos atendidos no período de 2023 e 2024, nos quais foi possível realizar a instrumentação e obturação intencional de CA, devidamente documentados com exames clínicos, radiográficos e de TCFC. A amostra foi composta por sete pacientes que apresentavam reabsorções ósseas associadas à presença de CA, previamente identificados nos exames tomográficos. Esses pacientes foram encaminhados para tratamento ou retratamento endodôntico, sendo que todos assinaram termo de consentimento livre e esclarecido. O critério fundamental para inclusão foi a identificação inequívoca de CA no exame de TCFC, associado a um quadro de necrose pulpar e reabsorção óssea.

O desenvolvimento do trabalho de campo envolveu diversas etapas. Inicialmente, foi realizada uma avaliação clínica detalhada, complementada por exames radiográficos periapicais e TCFC. As imagens obtidas foram analisadas e processadas por meio do software Blue Sky Plan®, que possibilitou a segmentação tridimensional dos volumes, permitindo uma melhor compreensão da anatomia dos CA e auxiliando no planejamento dos procedimentos.

Durante os procedimentos endodônticos, foi utilizado microscópio operatório para maximizar a precisão e segurança das intervenções. A localização dos CA foi feita com base na correlação entre as imagens de TCFC, as medidas obtidas no software e a exploração clínica da cavidade de acesso. O debridamento dos CA foi realizado de forma intencional, utilizando limas manuais de pequeno calibre (K-files #10, #15 e, quando necessário, #20), com extremo cuidado devido às curvaturas acentuadas, que variaram entre 90° e 132° em relação ao canal principal.

O preparo químico-mecânico dos canais principais foi realizado com instrumentação rotatória até a lima 40.05, associado ao uso de gel de clorexidina 2%, irrigação ativa com solução salina e ativação ultrassônica de EDTA 17% em ciclos de 20 segundos. A obturação dos canais principais e acessórios foi feita com guta-percha e cimento AH Plus Jet, seguida de restauração provisória ou definitiva em resina composta.

Após os procedimentos, foi realizado o acompanhamento dos casos com nova TCFC e radiografias periapicais, em um intervalo médio de aproximadamente 13 meses. Todos os pacientes permaneceram assintomáticos, e as imagens tomográficas demonstraram sinais de cicatrização óssea parcial ou total das reabsorções ósseas perirradiculares.

Durante o trabalho de campo, foi possível observar que a correta identificação e negociação dos canais acessórios exige não apenas domínio técnico, mas também a integração de recursos tecnológicos, como a TCFC de alta resolução, a segmentação volumétrica e a magnificação óptica. Ficou evidente que esses canais, frequentemente negligenciados ou não identificados em exames bidimensionais, podem estar diretamente relacionados à persistência de processos infecciosos e falhas terapêuticas em tratamentos endodônticos.

Em síntese, o campo proporcionou uma vivência prática extremamente rica, reforçando a importância da abordagem tridimensional na endodontia contemporânea e sugerindo que a debridamento intencional dos CA pode ser uma estratégia relevante na resolução de lesões periapicais. No entanto, os achados observados durante este trabalho também apontam para a necessidade de mais estudos controlados, que possam validar de forma robusta o impacto dessa abordagem nos desfechos clínicos de longo prazo.

4 Artigo 1

Artigo formatado de acordo com as normas do periódico *Journal of Endodontics* (Qualis A1| FI: 3.6)

Accessory Canal Detection and Its Periodontal Impact: A retrospective Study Based on High-Resolution Cone-Beam Computed Tomography

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ABSTRACT

Introduction: Accessory canals (ACs) are anatomical variations that may contribute to persistent endodontic infection and treatment failure. This study aimed to describe morphological characteristics of ACs observed in cone-beam computed tomography (CBCT) and its association with periradicular bone resorption. **Methods:** A total of 3,223 CBCT reports performed in a private radiology clinic were retrospectively reviewed. Reports that describe the presence of ACs were selected, and data regarding tooth group, canal location, angulation in relation to the main canal, and association with periradicular bone resorption were collected and analyzed. **Results:** Forty-five cases of ACs were identified. The highest prevalence was observed in upper premolars and upper incisors, with a predominance of location in the middle third of the root. Most ACs were located on the palatal/lingual and buccal root surfaces. The angulation between accessory and main canals ranged from 87° to 147° (mean: 102.4°). Some type of periradicular bone resorption was observed in 39 cases (86.7%). Among these, the combination of apical and lateral bone resorption was the most prevalent, followed by bone resorption exclusively associated with the AC. **Conclusions:** The findings of this study highlight the anatomical complexity and clinical relevance of ACs, particularly their association with periaradicular bone resorption.

Key-words: Accessory canal; cone beam computed tomography, root canal anatomy; root canal morphology; bone resorption.

1. Introduction

Historically, the anatomy of the root canal system has been both a subject of study and a challenge for endodontics (1). Among the anatomical complexities encountered, accessory canals (ACs) represent a particular challenge.

Definitions of ACs vary across literature. De-Deus (1975) (2) categorized root canal morphology into lateral canals (extending from the main canal to the periodontal ligament, mainly along the root), secondary canals (extending to the ligament in the apical region), and accessory canals (branching from secondary canals toward the ligament in the apical third).

According to the American Association of Endodontists (AAE, 2020) (3), an AC is defined as a branch of the main canal or pulp chamber that communicates with the external surface of the root. A lateral canal is defined as an AC located in the coronal or middle third of the root, usually extending horizontally from the main canal.

With the aim of simplifying this classification, Ahmed et al. (2018) (4) proposed that an AC is any small canal that originates from the main canal and communicates with the external surface of the root or the furcation area. It can be located anywhere along the root (coronal, middle, or apical third) and may present in different forms (patent, blind, or looped), also including what part of the literature refers to as lateral canals. Thus, the authors recommend using only the term “accessory” for these canals and avoiding terms like “lateral” to prevent potential confusion.

Root canal anatomy has been investigated using various techniques, including clearing, radiography, micro-computed tomography (micro-CT), and cone-beam computed tomography (CBCT) (5).

Two-dimensional radiographs offer limited accuracy for AC detection (6), while micro-CT provides high-resolution imaging, making it the current gold standard for anatomical studies (7). Using micro-CT, the prevalence of ACs has been reported to range from 24% to 52% depending on the tooth group and population (8,9). However, micro-CT is restricted to ex vivo research involving extracted teeth (10).

High-resolution CBCT has emerged as a valuable tool for in vivo analysis of root canal anatomy, aiding in diagnosis, treatment planning, and follow-up (11,12). Although CBCT has demonstrated efficacy in detecting ACs (13), the clinical significance of these anatomical features—particularly their impact on periodontal health—remains poorly understood.

ACs have been associated with persistent necrotic tissue and bacterial biofilms, potentially contributing to apical periodontitis and endodontic failure, even when intracanal medications and sealers reach these areas (14,15). While ACs are increasingly discussed in the literature, few studies have directly assessed their clinical implications. Therefore, the aim of this study was to evaluate, using high-resolution CBCT, the association between the presence of ACs and periradicular bone resorption.

2 Materials and Methods

Ethical Aspects

This retrospective analysis received approval from the local ethics committee (CAAE: 86445225.4.0000.5318).

Study design

As it is an endodontic cross-sectional observational study, the study was developed and reported following the recommendations established in the Preferred Reporting items for Observational studies in Endodontics (PROBE) 2023 guidelines, the completed checklist is provided in **Supplementary File 1** (16).

Sample Selection

A database of high-resolution CBCT examination reports from a private dental radiology clinic from January to December 2024 was accessed, resulting in a total of 3223 CBCT examination reports. The examinations were performed with an Eagle Edge 0.2 FS equipment (Dabi Atlante; Ribeirão Preto – Brazil) with the FOV protocol and voxel size according to the clinical indication. The reports were performed by a radiologist using the On Demand3D software (Cybermed, Daejeon, Korea).

Inclusion and Exclusion Criteria

Through a search engine, the study included CBCT scans where the examination report included the word “lateral canal” or “accessory canal”, resulting in 45 CBCT scans.

Sample Evaluation

The 45 CBCT scans included were accessed by a previously calibrated researcher. The tomographic volumes of the examinations were accessed and reassessed using the e-Vol DX CBCT software (CDT Software; São José dos Campos, Brazil). The following data were collected: tooth with an AC; in cases of multirooted teeth, the root where it is located; third of the AC location (cervical, middle or apical); root face where the AC is located. The degree of curvature of the AC in relation to the main canal was also measured using an angle measurement tool in the software.

In addition, data was collected regarding the presence of bone resorption (apical, related to the AC or both) and the presence of endodontic filling.

Statistical Analysis

Descriptive statistics were performed on the data obtained. The association between the third of the root and the dental group where the AC was located was evaluated using the Chi-square test with a significance level of 5%.

Results

A total of 45 cases of AC identified in CBCT reports were analyzed, selected from a total sample of 3,223 reports. The study sample included 29 female patients (64.4%) and 16 male patients (35.6%). Patient age ranged from 22 to 73 years, with a mean age of 51.2 years.

ACs were observed across several tooth groups, with the highest prevalence in maxillary premolars (n = 15; 33.3%) and maxillary central incisors (n = 13; 28.9%). Regarding their location along the root, ACs were most frequently identified in the middle third (n = 24; 53.3%), followed by the apical third (n = 20; 44.4%). Table 1 presents the distribution of ACs by tooth group and root third. Statistical analysis using the Chi-square test revealed no significant association between tooth group and canal location along the root third ($p = 0.778$).

Regarding root surface distribution, ACs were most frequently located on the palatal surface (n = 13; 28.9%), followed by the buccal (n = 11; 24.4%), distal (n = 10; 22.2%), and mesial surfaces (n = 10; 22.2%). One case was observed on the distopalatal surface (2.2%).

The curvature angle of the AC in relation to the main canal ranged from 87° to 147°, with a mean of 102.4°.

Some type of periradicular bone resorption was observed in 39 cases (86.7%). Among these, the combination of apical and lateral bone resorption was the most prevalent (n = 22), followed by bone resorption exclusively associated with the AC (n = 15). Bone resorption limited to the apical region was observed in only 2 cases (4.4%). Figures 1 to 3 present illustrative cases of the three types of periradicular bone resorption.

Root canal filling was observed in 28 teeth (62.2%). Table 2 shows the distribution of root-filled and non–root-filled teeth in relation to the presence or absence of bone resorption.

Discussion

The present study analyzed the presence, location, and morphological characteristics of ACs in CBCT reports, based on a sample of 3,223 scans, totaling 45 included cases. The results revealed a wide distribution of these canals across different tooth groups, with a higher occurrence in upper premolars and upper incisors, and a predominance of location in the middle third of the root.

These findings are consistent with previous studies that highlight the anatomical complexity of ACs and their higher prevalence in premolars (8), although part of the literature reports a predominance of their occurrence in the apical third (8,9,17). Variations among these studies may be explained by the inclusion of distinct ethnic populations, differences in assessment methodologies, and the use of diverse terminologies to describe accessory and lateral canals. The establishment of a standardized definition of this anatomical feature would facilitate more consistent reporting of cases and enhance the comparability of findings across studies (9).

Most of the Acs in the sample were located on the palatal/lingual and buccal surfaces, in agreement with previous studies (17). This location may hinder the visualization of these canals in periapical radiographs (6), as well as the detection of associated bone resorption.

These findings reinforce the importance of CBCT as a complementary diagnostic tool in endodontic treatment planning and evaluation, particularly in cases involving nonspecific clinical signs and symptoms, inconclusive conventional radiographic findings, and complex root morphology. Such indications are consistent with the recommendations provided by both the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology (AAE/AAOMR, 2015) (18), as well as the European Society of Endodontology (ESE, 2019) (19), which emphasize the selective use of CBCT in situations where it can significantly impact diagnosis or treatment outcomes.

Another relevant finding was the observation of the curvature angle of ACs in relation to the main canal, which ranged from 87° to 147°, with a mean of 102.4°. The literature addressing this specific morphological aspect is still limited, making this an original contribution of the present study. The positioning of the AC may affect the therapeutic approach by complicating its access and disinfection.

The high prevalence of bone resorption associated with ACs (82.2% of cases) reinforces their potential contribution to persistent infection and endodontic treatment failure. Different strategies involving the use of chemical irrigants have shown effects on the main canal but do not appear to improve disinfection of ACs in in vitro models (20,21).

Among the strengths of the study are the use of a large CBCT database and the detailed analysis of the positive cases. However, some limitations should be acknowledged: the relatively small number of cases with identified AC limits the statistical analysis and prevents the generalization of the results. Furthermore, reliance on previously issued radiology reports may have led to an underestimation of the actual prevalence of these canals, as undetected or undocumented cases may not have been included in the analysis.

As future perspectives, studies with prospective evaluations could contribute to a deeper understanding of the morphology of ACs and their role in the pathogenesis and persistence of periradicular bone resorption.

In conclusion, the findings of this study highlight the anatomical complexity and clinical relevance of ACs, particularly their association with periradicular bone resorption and potential role in endodontic treatment failure.

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Conflict of Interest

The authors declare no conflicts of interest.

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Table 1 – Distribution according to tooth group and thirds of the root canal.

Tooth group	Apical	Cervical	Midle
Lower anterior	0	0	1
Upper anterior	9	0	11
Mandibular molars	4	0	1
Maxillary molars	1	0	2
Lower premolars	0	0	1
Upper premolars	6	1	8

Table 2 - Distribution of cases according to the presence and location of bone resorption in relation to the root canal filling status.

Bone resorption	Non–root-filled Teeth	Root-Filled Teeth
None	2	4
Apical	1	1
Lateral	6	9
Apical + lateral	8	14

Figure 1 – Multiplanar CBCT views and 3D reconstruction of a representative case showing periradicular bone resorption exclusively associated with an accessory canal.

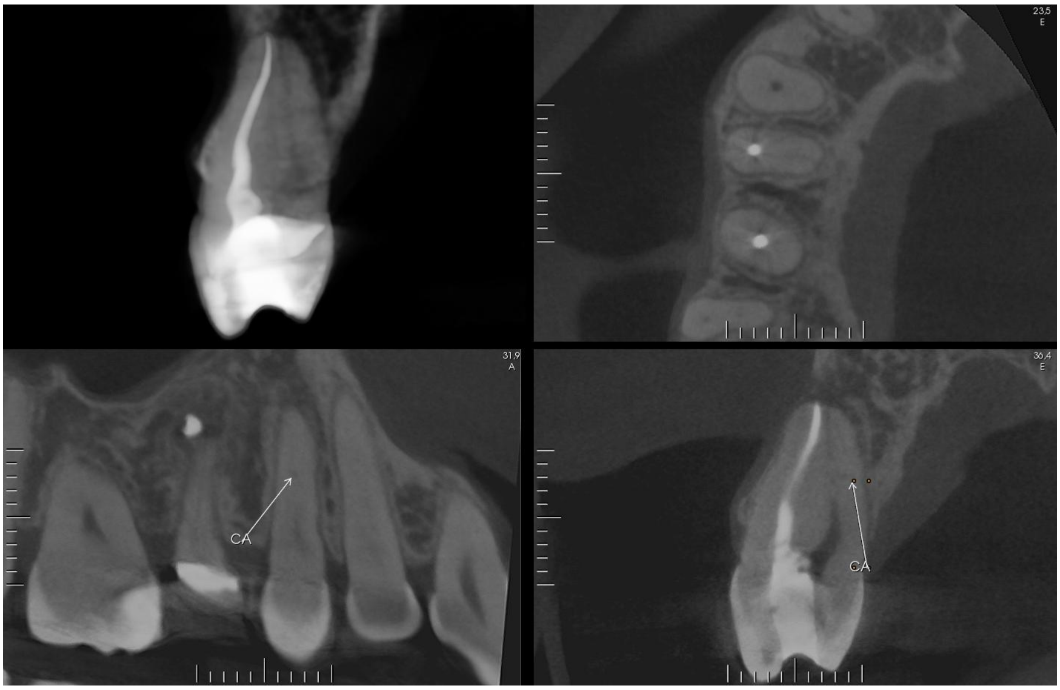

Figure 2 – Multiplanar CBCT views and 3D reconstruction of a representative case showing exclusively apical bone resorption.

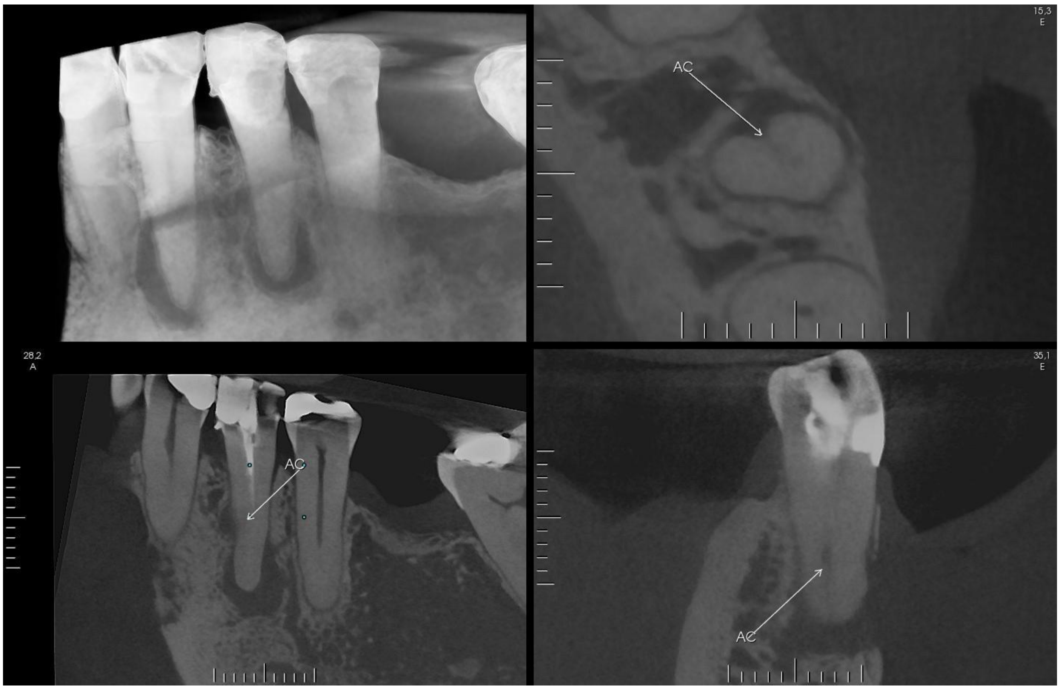

Figure 3 - Multiplanar CBCT views and 3D reconstruction of a representative case showing combined apical and lateral periradicular bone resorption associated with an accessory canal.

Supplementary File 1: PROBE 2023 checklist

Section/ Topic	Item Number	Checklist items	Reported on page number
Title	1a	The specific area(s) of interest must be provided using words and phrases that identify the clinical problem(s) and focus of the study	1
	1b	The study design must be included in the Title, e.g., cross-sectional, cohort, case-control, case-series etc.	1
Keywords	2a	Keywords indicating the specific area(s) of interest using MeSH terms or other more applicable terms must be included	1
Abstract	3a	The Introduction/Background must briefly explain the rationale or justification for the study	1
	3b	The aim(s)/objective(s) of the study must be provided	1
	3c	The Methodology must provide (where relevant) essential information on the nature of the study design (retrospective, cross-sectional, prospective, etc.), setting, location(s), and relevant dates, including periods of recruitment, exposure, follow-up, outcome(s) assessed and statistical analysis	1
	3d	The Results must describe the number of subjects that were included and analysed as well as the most significant results for all experimental and control groups. The results of statistical analysis must be reported in terms of unadjusted and confounder-adjusted outcomes (if relevant). Adverse events or side-effects must also be reported if present or confirmed as absent	1
	3e	The Conclusion must interpret and summarise the primary aim/objective and main findings as well as emphasise the clinical implications	1
	3f	The source(s) of funding must be provided	1
Introduction	4a	The clinical problem/question, scientific background and rationale for the study must be provided, including the gap(s) or inconsistencies in the existing knowledge base	2
	4b	The primary and, if applicable, any additional/secondary aim(s) and objective(s) of the study must be provided, including any pre-specified hypotheses	2
Methods *Ethics*	5a	The details (name, reference number, date) of the approval or exemption granted by an ethics committee, such as an Institutional Review Board, must be provided	3

	5b	The process used for obtaining and storing informed consent must be provided	3
Study design	5c	The key elements of the study design must be described early in the Methods section	3
Setting	5d	The details of setting(s), location(s), socioeconomic status of participants (if available) and relevant dates, including periods of recruitment, exposure, follow-up, and data collection must be provided	3
Sample size	5e	Information on how the sample size was determined *a priori* must be provided as well as the rationale for sample size calculation, preferably with reference to the published literature or a pilot study with additional detail as to why the defined sample size makes the study worthwhile	-
Participants – unmatched studies	5f	All studies should include inclusion/exclusion criteria as well as the sources and methods of participant selection. Methods of follow-up must also be provided in cohort studies and the rationale for the choice of 'cases' and 'controls' in case-control studies	4
Participants – matched studies	5g	For matched studies (e.g., cohort, case-control) the matching criteria and the numbers of participants in each group must be provided	-
Variables	5h	All outcomes, exposures, predictors, potential confounders, and effect modifiers must be defined clearly	4
Data sources/ measurement	5i	Sources of data and details of the methods of assessment (measurement) for each variable of interest must be provided	4
Bias	5j	Efforts taken to identify and address potential sources of bias must be provided	-
Quantitative variables	5k	The handling of quantitative variables in the analyses must be explained. Decisions on how groupings were made and/or how category boundaries were defined for continuous variables must be described	4
Statistical methods	5l	All statistical methods, including those used to control of confounding factors in the study and in the analysis of the data, must be described	4
	5m	The methods used to examine subgroups and interactions must be described, if applicable	-
	5n	Missing data (e.g. drop-outs, data not reported) must be addressed and described	-
	5o	The analytical methods that take account of the sampling strategy (if applicable) in *Cross-sectional studies* must be described	-
	5p	Sensitivity analyses, must be described when used	-

Results *Participants*	6a	The number of participants in each stage of the study (i.e., eligibility, recruitment, available at follow-up and included in analyses for relevant outcome(s)) must be described	4
	6b	Reasons for non-participation (e.g., not eligible, losses/drop-outs) must be described	-
Dates	6c	Changes in baseline dates of recruitment, follow-up, and study duration reported in the Methodology must be described, if applicable	-
Descriptive data	6d	The baseline demographic and clinical characteristics of study participants as well as information on exposures and potential confounders must be provided	4-5
	6e	The number of participants with missing data must be provided for each variable. If relevant, follow-up times should be summarised clearly and accurately (e.g., average or total time)	4-5
Outcome data	6f	Information on number of outcomes or summary measures over time must be described	4-5
	6g	For multivariable analyses developing risk profiles or reducing the effect of confounders, the effect of all included independent variables may be reported, as well as their effects on the prediction model (if applicable)	-
Main results	6h	Unadjusted (or uncorrected or crude) estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence intervals) must be described. Which confounders were adjusted for and why they were included must also be described	-
	6i	Results in terms of relative risk should also be translated to absolute risk for a meaningful time period, if relevant	-
Additional analyses	6j	The results from any other analyses (e.g., sensitivity, subgroup analyses) must be described, if applicable, as well as adjusted analyses, distinguishing pre-specified from exploratory	-
Discussion *Key results*	7a	The main findings must be summarized with reference to the study aim(s)/objective(s)	5
Rationale	7b	The rationale for inclusion/exclusion criteria, exposure, and duration must be provided	5-6
Clinical relevance	7c	An explanation of the clinical relevance of the primary and any additional/secondary outcome(s) must be provided	5-7
Strength	7d	The strength(s) of the study must be provided	6
Limitations	7e	The limitations of the study must be provided - addressing the sources of potential bias, imprecision, study design, study size and potentially	6

		important but missing confounding variables. Both direction and magnitude of any potential bias must be discussed	
Summary and validity	7f	The discussion of the strength and limitations should be summarized in an overall assessment of the internal validity of the study	5-7
Interpretation	7g	A detailed interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence must be provided	5-7
Generalisability	7h	The generalizability (external validity, applicability, real-world relevance etc.) of the study findings must be discussed	6
Future directions	7i	Implication for future research and clinical practice must be described	7
Conclusion(s)	8a	Explicit conclusion(s) from the study must be provided and address all the aims/objectives	7
Funding details	9a	All sources of funding and other support (such as supply of drugs, equipment etc.) as well as the role of funders must be acknowledged and described	7
Conflict of interest	10a	An explicit statement on conflicts of interest must be provided, together with full affiliations of every author(s)	7
Quality of images (if applicable)	11a	Details of the equipment, software and settings used to acquire the image(s) must be described in the text or legend (if applicable)	3
	11b	The reason why the image(s) was acquired and the rationale for its inclusion in the manuscript must be provided in the manuscript. A justification for all images that involve ionising radiation must be included	3
	11c	The circumstances (conditions) under which the image(s) were viewed and evaluated by the author(s) must be provided in the text	3
	11d	The resolution, any magnification of the image(s) or modifications/enhancements (e.g., adjustments for brightness, colour balance, magnification, image smoothing, staining, etc.) that were carried out must be described in the text or figure legend	3/10
	11e	Patient(s) identifiers (names, patient numbers) must be removed for General Data Protection Regulation (GDPR) and to ensure they are anonymized or de-identified in all images	3
	11f	An interpretation of the findings (meaning and implications) from the image(s) must be provided in the text	4-5
	11g	The figure legend associated with each image must describe clearly what the subject is and what specific feature(s) is illustrated. If cases are offered to illustrate descriptions of a cohort, then the age, gender, ethnicity, and other specific attributes that are relevant to the cohort should be provided	10-11

	11h	Markers/labels must be used to identify the key information in the image(s) and defined in the figure legend	10-11
	11i	The figure legend of each image must include an explanation on whether it is pre-, intra- or post-treatment and follow-up and, if relevant, how images were standardised over time	10-11

5 Artigo 2

Artigo formatado de acordo com as normas do periódico *Journal of Endodontics* (Qualis A1| FI: 3.6)

Intentional negotiation and filling of accessory canals: a series of seven cases with tomographic follow-up and three-dimensional segmentation

Lucas Pinto Carpena, Gabriel Lima Braz, Henrique Timm Vieira, Nadia de Souza Ferreira

Introduction: Accessory canals (ACs) are anatomical features that may harbor residual infected tissue and contribute to persistent periapical inflammation when not adequately treated. Although obturation of these structures is occasionally achieved passively, their intentional mechanical negotiation remains rarely documented in clinical practice. This case series aims to describe the clinical approach, outcomes, and imaging strategies used in the intentional debridement and obturation of ACs. **Methods**: Seven teeth presenting with periapical lesions and identifiable ACs on cone-beam computed tomography (CBCT) were included. All cases underwent chemomechanical preparation using rotary instrumentation with 2% chlorhexidine gel, active saline irrigation, and final EDTA activation with passive ultrasonic irrigation. Intentional mechanical debridement of ACs was performed using small-diameter hand files. All fillings were performed with gutta-percha and AH Plus Jet sealer. Follow-up was performed using CBCT and periapical radiographs after a mean period of 13.48 months. Pulp space segmentation was used to aid localization and planning. **Results:** All ACs were successfully negotiated and filled with endodontic sealer. Tomographic analysis confirmed evidence of partial or complete periapical healing in all seven cases. No patients presented with clinical symptoms at follow-up. **Conclusion**: This case series presents successful intentional instrumentation and obturation of ACs, supported by CBCT-based planning and follow-up. Although limited by the lack of a control group, the findings highlight the potential role of CBCT imaging and segmentation in identifying and accessing complex anatomy. Further prospective studies are needed to determine the impact of this approach on long-term clinical outcomes.

Key-words: Accessory canal; cone beam computed tomography, root canal anatomy; root canal treatment.

Introduction

Managing the internal anatomy of the root canal system is a demanding task that frequently presents challenges, even for experienced endodontists. Among the anatomical complexities encountered, accessory canals (ACs), a branch of the main root canal that can communicate with the external surface of the root— pose difficulties during root canal treatment (1, 2). These structures have been reported to harbor necrotic and infected tissue following root canal treatment, potentially contributing to persistent apical periodontitis and clinical failure (3).

Persistent bacterial infection within the root canal system remains the main cause of endodontic failure (4). Based on this, it seems logical to pursue the instrumentation and obturation of ACs when present. However, this rationale encounters several limitations in clinical practice. First, ACs are often undetectable in routine periapical radiographs and are difficult to visualize during treatment, particularly without the aid of a magnification device (5). Second, their small diameter greatly restricts the possibility of effective instrumentation, making mechanical debridement a more feasible approach than active shaping (6). Third, ACs can exhibit severe curvatures, with angles of approximately 90 degrees relative to the main canal, which further hinders negotiation and instrumentation (7).

These anatomical and technical challenges make the intentional instrumentation and filling of ACs a highly complex procedure. As a result, clinical documentation in the literature is scarce, and existing publications are limited to a small number of reports with varying levels of detail and follow-up (8; 9). In this context, the present study aims to expand the current body of knowledge by presenting a series of seven well-documented cases of intentional mechanical negotiation and obturation of ACs, with cone-beam computed tomography (CBCT) follow-ups. By offering detailed documentation of clinical strategies and outcomes, this series provides relevant guidance for clinicians and contributes to the development of future research hypotheses in this underexplored area of endodontics.

Methodology

Informed consent was obtained from all individual participants included in this study. This report follows the Preferred Reporting items for Observational studies in Endodontics (PROBE) 2023 guidelines, the completed checklist is provided in **Supplementary File 1** (10). The study also complies with the principles outlined in the Declaration of Helsinki.

The cases were performed by the same experienced endodontist (L.P.C.) in a private practice, all procedures were performed using a dental operating microscope (OPMI Pico, Zeiss, Oberkochen, Germany) for enhanced magnification and precision. For recording, an EOS Rebel T7i Camera (Canon, Tokyo, Japan) was used, coupled to a 50 T-type beam splitter (Zeiss). Initial and follow-up cone-beam computed tomography (CBCT) scans were performed in all cases using the same tomograph Eagle Edge 0.2 FS (Dabi Atlante, Ribeirão Preto, São Paulo, Brazil) with a reduced FOV (5x5 cm) and a voxel size of 0.075 mm. Additionally, three-dimensional segmentations were performed based on the initial and follow-up CBCT scans in the Blue Sky Plan® software. Automated and manual segmentation techniques were used for the tooth and the pulp space structures, respectively, in order to enhance visualization of the ACs. **Table 1** summarizes the clinical and demographic information of the included cases.

Results

Case 1

A 54-year-old female patient was referred for root canal treatment due to pain on percussion. Tooth #15 presented with pulp necrosis and symptomatic apical periodontitis, as well as an AC located in the middle third of the palatal aspect of the buccal root canal ($^{2}15\ B^{(M1)}\ P$), confirmed via CBCT imaging. During the procedure, all previous restorative materials were removed. Marginal elevation was performed, followed by chemomechanical preparation using a combination of rotary instruments and 2% chlorhexidine gel, with active irrigation using saline solution. The main canals (buccal and palatal) were instrumented up to a size 40.05 rotary file (Easy Bassi, Minas Gerais, Brazil). The AC was intentionally debrided using size 10 and 15 K-files (Dentsply, Ballaigues, Switzerland). Final irrigation was carried out with 17% EDTA activated by passive ultrasonic irrigation (PUI), through three 20-second cycles per canal. Obturation was completed in a single visit using gutta-percha and AH Plus Jet sealer (Dentsply, Ballaigues, Switzerland).

The tooth was sealed with composite resin. The procedure was performed on September 7, 2024, and follow-up imaging (periapical radiography and CBCT) conducted on May 15, 2025, demonstrated partial periapical healing. The patient remained asymptomatic at follow-up.

Case 2

A 56-year-old male patient was referred for root canal treatment due to pain on percussion. Tooth #25 presented with pulp necrosis and symptomatic apical periodontitis, along with an AC located in the apical third on the mesial aspect of the root canal ($^{1}25^{(A1)}$), as confirmed by CBCT imaging. During treatment, all existing restorative material were removed. Marginal elevation was performed, followed by chemomechanical preparation using rotary instruments combined with 2% chlorhexidine gel, and active irrigation with saline solution. The main canal was instrumented up to a size 40.05 rotary file (Easy Bassi, Minas Gerais, Brazil), and the AC was intentionally debrided using size 10 and 15 K-files (Dentsply, Ballaigues, Switzerland). Final irrigation was performed with 17% EDTA activated with PUI in three 20-second cycles. Obturation was completed in a single visit using gutta-percha and AH Plus Jet sealer. The tooth was restored with composite resin.

The procedure was performed on June 8, 2024, and follow-up radiographic and tomographic imaging on May 8, 2025, revealed evidence of partial periapical healing. The patient remained asymptomatic at the time of follow-up.

Case 3

A 33-year-old female patient was referred for root canal treatment due to pain on percussion. Tooth #11 presented with pulp necrosis and symptomatic apical periodontitis, along with an AC located in the apical third on the buccal root canal ($^{1}11^{(A1)}$), as confirmed by CBCT imaging. During treatment, all existing restorative material was removed. Chemomechanical preparation was performed using rotary instruments combined with 2% chlorhexidine gel, and active irrigation with saline solution. The main canal was instrumented up to a size 40.05 rotary file (Easy Bassi, Minas Gerais, Brazil), and the AC was intentionally debrided using size 10 and 15 K-files (Dentsply, Ballaigues, Switzerland). Final irrigation was performed with 17% EDTA activated with PUI in three 20-second cycles. Obturation was completed in a single visit using gutta-percha and AH Plus Jet sealer (Dentsply, Ballaigues, Switzerland). The tooth was restored with composite resin.

The procedure was performed on April 9, 2024, and follow-up radiographic and tomographic imaging on May 15, 2025, revealed evidence of partial periapical healing. The patient remained asymptomatic at the time of follow-up.

Case 4

A 59-year-old female patient was referred for root canal treatment due to pain on percussion. Tooth #14 presented with pulp necrosis and symptomatic apical periodontitis, along with an AC located in the middle third on the buccal aspect of the buccal root canal ($^{2}14\ B^{(M1)}\ P$), as confirmed by CBCT imaging. During treatment, all existing restorative material was removed. Chemomechanical preparation was performed using rotary instruments combined with 2% chlorhexidine gel, and active irrigation with saline solution. The main canals (buccal and palatal) were instrumented up to size 40.05 rotary files (Easy Bassi, Minas Gerais, Brazil), and the AC was intentionally debrided using size 10, 15, and 20 K-files (Dentsply, Ballaigues, Switzerland). Final irrigation was performed with 17% EDTA activated with PUI in three 20-second cycles per canal. Obturation was completed in a single visit using gutta-percha and AH Plus Jet sealer (Dentsply, Ballaigues, Switzerland). The tooth was restored with composite resin.

The procedure was performed on May 4, 2023, and follow-up radiographic and tomographic imaging on December 18, 2024, revealed evidence of complete periapical healing. The patient remained asymptomatic at the time of follow-up.

Case 5

A 48-year-old female patient was referred for root canal retreatment due to pain on percussion. Tooth #46 had a previous root canal treatment and a metallic intracanal post in the distal canal. CBCT imaging revealed periapical radiolucency, and an AC located in the middle third on the distal aspect of the mesiolingual root canal (^{2}46 M$^{(M1)}$ D). During the intervention, all existing restorative material and the metallic post were removed using ultrasonic tips (Helse Ultrasonic, São Paulo, Brazil). Marginal elevation was performed, followed by chemomechanical preparation using rotary instruments in combination with 2% chlorhexidine gel and active irrigation with saline solution. The main canals (distal, mesiobuccal, and mesiolingual) were instrumented up to size 40.05 rotary files (Easy Bassi, Minas Gerais, Brazil), and the AC was intentionally debrided using size 10, 15, and 20 K-files (Dentsply, Ballaigues, Switzerland). Final irrigation was performed with 17% EDTA activated with PUI in three 20-second cycles per canal. Obturation was completed in a single visit using gutta-percha and AH Plus Jet sealer (Dentsply, Ballaigues, Switzerland). A fiber post was immediately cemented in the distal canal, and the tooth was restored with composite resin.

The procedure was performed on August 7, 2023, and follow-up radiographic and tomographic imaging on May 20, 2024, revealed evidence of complete periapical healing. The patient remained asymptomatic at the time of follow-up.

Case 6

A 19-year-old female patient was referred for root canal retreatment due to pain on percussion. Tooth #46 had a previous root canal treatment and presented with periapical radiolucency, along with an AC located in the middle third on the distal aspect of the mesiolingual root canal (^{2}46 M$^{(C1)}$ D), as confirmed by CBCT imaging.

An initial emergency appointment was performed, involving access through the existing restoration and chemomechanical preparation using a reciprocating R25 file (VDW, Munich, Germany) for removal of the previous obturation material. Instrumentation was combined with 2% chlorhexidine gel and active irrigation with saline solution, allowing for proper cleaning of the root canal system and drainage of an intraosseous abscess that was causing severe pain. The tooth was medicated with 2% chlorhexidine gel and temporarily sealed.

In the second session, the main canals were prepared up to size 40.05 rotary files (Easy Bassi, Minas Gerais, Brazil), and the AC was intentionally debrided using size 10 and 15 K-files (Dentsply, Ballaigues, Switzerland). The canals were then medicated with calcium hydroxide paste mixed with 2% chlorhexidine gel. During the third session, the canals were re-instrumented using size 40.05 files, and further debridement of the AC was performed. Final irrigation was carried out with 17% EDTA, activated with PUI in three 20-second cycles per canal. Obturation was completed using gutta-percha and AH Plus Jet sealer (Dentsply, Ballaigues, Switzerland). The tooth was restored with composite resin.

The procedure was completed on December 18, 2023, and radiographic and tomographic follow-up on February 17, 2025, demonstrated evidence of complete periapical healing. The patient remained asymptomatic at the time of follow-up.

Case 7

A 75-year-old male patient was referred for root canal retreatment due to the presence of a chronic abscess, despite the absence of symptoms. Tooth #24 had a previous root canal treatment and presented with a cast metal post in both canals, covered by a ceramic crown. CBCT imaging revealed a periapical radiolucency associated with an AC located in the cervical third on the distal aspect of the buccal root canal ($^{2}24\ B^{(C1)}\ P$), which was considered the likely cause of the sinus tract.

During treatment, the ceramic crown and cast post were removed. Chemomechanical preparation was initiated using a reciprocating R25 file (VDW, Munich, Germany) to remove the previous filling material, combined with 2% chlorhexidine gel and active irrigation with saline solution.

The main canals were prepared up to size 40.05 rotary files (Easy Bassi, Minas Gerais, Brazil), and the AC was intentionally debrided using size 10, 15, and 20 manual K-files (Dentsply, Ballaigues, Switzerland), as well as 15.05 and 25.05 rotary files (Easy Bassi, Minas Gerais, Brazil). Final irrigation was performed with 17% EDTA activated with PUI in three 20-second cycles per canal. Obturation was completed in a single visit using gutta-percha and AH Plus Jet sealer (Dentsply, Ballaigues, Switzerland). The tooth was restored with composite resin.

The procedure was performed on November 14, 2024, and radiographic and tomographic follow-up on May 8, 2025, demonstrated evidence of partial periapical healing. The patient remained asymptomatic, and the sinus tract was completely resolved at the time of follow-up.

Discussion

The presence of ACs has long been recognized as a challenging anatomical feature in RCT. Although traditionally considered less critical in treatment outcomes, some reports suggest that these structures may contribute to persistent periapical inflammation and treatment failure due to the retention of infected tissue (11). This case series explores the intentional mechanical negotiation and filling of ACs in seven cases, followed for a mean of 13.48 months with CBCT imaging, with favorable periapical healing observed in all treated teeth.

Missed canals are a well-established cause of post-treatment apical periodontitis; however, this discussion typically focuses on main root canals (12). Currently, no clinical studies with large samples have analyzed the association between detectable AC and the presence of periapical radiolucency. In the present case series, all ACs were associated with periapical radiolucency. Notably, three included patients were endodontic retreatment cases, supporting the hypothesis that these untreated structures may have played a role in the treatment failure.

Untouched areas within the root canal system are a frequent topic of discussion in contemporary endodontic practice, especially with the growing use of advanced imaging technologies (13). It is well established that mechanical instrumentation alone is unable to contact all internal surfaces of the root canal system (14). As a result, the chemical phase of treatment has gained increasing relevance. Several studies have demonstrated the significant impact of irrigant activation in reducing bacterial load. However, it is important to emphasize that adequate access cavity and mechanical instrumentation are essential to facilitate effective irrigant distribution (15, 16, 17). This reinforces the potential benefits of mechanically penetrating ACs, not only to remove tissue but also to allow deeper irrigant reach. In the present series, all cases underwent three 20-seconds cycles of PUI with 17% EDTA during the final irrigation protocol.

Filling of the ACs via sealer extrusion was achieved in all cases within this series. However, the common assumption that sealer extrusion alone substantially improves treatment success may be overly simplistic. Microbiological studies indicate that even when sealer is extruded into the AC, residual inflamed tissue can remain embedded within the canal alongside the filling material (3). Although the clinical impact of mechanically addressing ACs remains uncertain, their debridement, when feasible, may help reduce residual infected or inflamed tissue, acknowledging that complete sterilization of the root canal system is unattainable.

All cases in this series were performed under operative microscopy and guided by CBCT-based planning. It is important to emphasize that the successful negotiation of ACs relies heavily on the use of advanced technological resources and the clinician's experience. Modern CBCT softwares enable precise measurement of the AC's emergence point and its distance from reproducible anatomical references, which has the potential to enhance the predictability and accuracy of this procedure (18). As the global adoption of endodontic technologies continues to grow, the need for adequate training in CBCT interpretation becomes increasingly critical (19). In this context, a close collaboration between endodontists and oral and maxillofacial radiologists is essential, as effective communication can optimize the use of the acquired tomographic volume and improve clinical outcomes (20).

The degree of curvature of ACs in relation to the main root canal has not been comprehensively evaluated in the endodontic literature. Although some reports describe ACs with sharp angulations, no quantitative data is currently available to inform clinicians about the typical or critical curvature thresholds that might compromise negotiation or instrumentation (7,8). This represents a relevant gap in knowledge, as the angle between the main canal and an AC may directly influence both the feasibility of mechanical negotiation and the risk of procedural complications, such as instrument fracture or canal transportation. In this case series, CBCT analysis revealed the presence of curvatures ranging from 90º to 132º, which made their negotiation particularly challenging. Future studies designed to evaluate the angulation and trajectory of ACs using CBCT may contribute significantly to treatment planning and case selection in AC negotiation.

The present case series contributes to the growing body of evidence on the clinical management of ACs, providing the most thoroughly documented sets of cases involving intentional instrumentation of these anatomical structures. By detailing clinical techniques and raising hypotheses, this report aims to highlight technical considerations for future investigation. However, as with all case studies, the absence of a control group precludes any inference of causality between AC instrumentation and clinical outcomes. Therefore, well-designed prospective studies are needed to determine whether the mechanical treatment of ACs offers a measurable benefit to treatment success compared to alternative strategies.

Conclusion

This case series provides a detailed clinical and tomographic description of intentional instrumentation of ACs in seven teeth, with all cases showing evidence of periapical healing after a mean follow-up of over a mean 13.48 months. Advanced planning with CBCT imaging and operative microscopy were key elements in identifying and negotiating these anatomical structures. Although the outcomes were favorable, these findings must be interpreted with caution due to the inherent limitations of case-based research. Nonetheless, the technical strategies and observations reported may help inform future studies and support the development of more predictable approaches to managing complex root canal anatomies.

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Conflict of Interest

The authors declare no conflicts of interest.

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Table 1. Clinical and demographic features of the case series

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Age	54	56	33	59	48	19	75
Sex	Female	Male	Female	Female	Female	Female	Male
Tooth	15	25	11	14	46	46	24
Root with AC	Buccal	-	-	Buccal	Mesial	Mesial	Buccal
Root segment with AC	Middle	Apical	Apical	Middle	Middle	Coronal	Coronal
Root surface of AC emergence	Palatal	Mesial	Buccal	Palatal	Distal	Distal	Palatal
AC classification*	$^{2}15\ B^{(M1)}\ P$	$^{1}25^{(A1)}$	$^{1}11^{(A1)}$	$^{2}14\ B^{(M1)}\ P$	$^{2}46\ M^{(M1)}\ D$	$^{2}46\ M^{(C1)}\ D$	$^{2}24\ B^{(C1)}\ P$
AC angulation**	132º	107º	103º	130º	92º	90º	127º
CBCT scan	Initial and follow-up	Initial and follow-up	Initial and follow-up	Initial and follow-up	Initial and follow-up	Initial and follow-up	Initial and follow-up
Pulp diagnosis	Pulp necrosis	Pulp necrosis	Pulp necrosis	Pulp necrosis	-	-	-
Periapical diagnosis	Symptomatic apical periodontitis	Symptomatic apical periodontitis	Symptomatic apical periodontitis	Symptomatic apical periodontitis	Asymptomatic apical periodontitis	Acute apical abcess	Chronic abcess
Periradicular bone resorption adjacent to the AC	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mechanical penetration of the AC	Intentional	Intentional	Intentional	Intentional	Intentional	Intentional	Intentional
Intrumentation in the AC	K #10 K #15	K #10 K #15	K #10 K #15	K #10 K #15 K #20	K #10 K #15 K #20	K #10 K #15	K #10 K #15 K #20 Rotary file 15.05 Rotary file 25.05

Intracanal dressing	No	No	No	No	No	$Ca(OH)_2$ + 2% CHX (14 days)	No
Irrigants	2% CHX + sterile saline	2% CHX + sterile saline	2% CHX + sterile saline	2% CHX + sterile saline	2% CHX + sterile saline	2% CHX + sterile saline	2% CHX + sterile saline
Irrigation activation	PUI (17% EDTA) - 3 cycles of 20s	PUI (17% EDTA) - 3 cycles of 20s	PUI (17% EDTA) - 3 cycles of 20s	PUI (17% EDTA) - 3 cycles of 20s	PUI (17% EDTA) - 3 cycles of 20s	PUI (17% EDTA) - 3 cycles of 20s	PUI (17% EDTA) - 3 cycles of 20s
Filling matherial	Single-cone + AH Plus Jet	Single-cone + AH Plus Jet	Single-cone + AH Plus Jet	Single-cone + AH Plus Jet	Single-cone + AH Plus Jet	Single-cone + AH Plus Jet	Single-cone + AH Plus Jet
Obturation technique	Schilder's vertical condensation	Schilder's vertical condensation	Schilder's vertical condensation	Schilder's vertical condensation	Schilder's vertical condensation	Schilder's vertical condensation	Schilder's vertical condensation
Sealer extrusion into AC	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Magnification device	Microscope	Microscope	Microscope	Microscope	Microscope	Microscope	Microscope
Follow-up (months)	9 months	12 months	13 months	24 months	14 months	14 months	8 months
Apical repair	Ongoing	Ongoing	Ongoing	Complete	Complete	Complete	Ongoing
AC CBCTPAI scores* **	4 to 2	5 to 3	3 to 2	4 to 0	2 to 0	3 to 0	4 to 3

* Classification according to Ahmed et al., 2018 ** Degree of curvature in relation to the main canal; *** Classification according to Estrela et al., 2008, initial and follow-up CBCTPAI scores of the periapical radiolucency associated with the ACs are shown; AC (Acessory canal); CBCT (Cone-Beam Computed Tomography); CHX (chlorhexidine); PUI (Passive Ultrasonic Irrigation); EDTA: Ethylenediamine tetraacetic acid; PAI (Periapical Index).

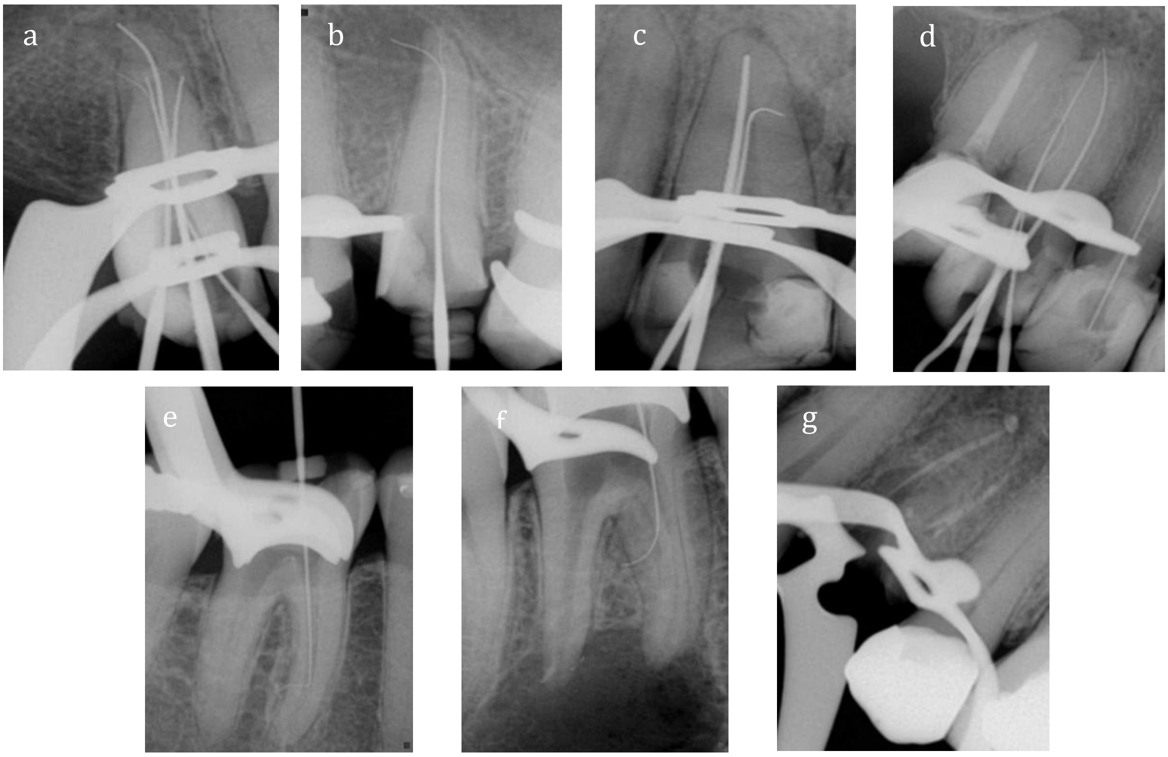

Figure 1 – Periapical radiograph after mechanical access of the accessory canal. (a) case 1; (b) case 2; (c) case 3; (d) case 4; (e) case 5; (f) case 6; (g) case 7.

Figure 2 – Final periapical radiograph after root canal system obturation. (a) case 1; (b) case 2; (c) case 3; (d) case 4; (e) case 5; (f) case 6; (g) case 7.

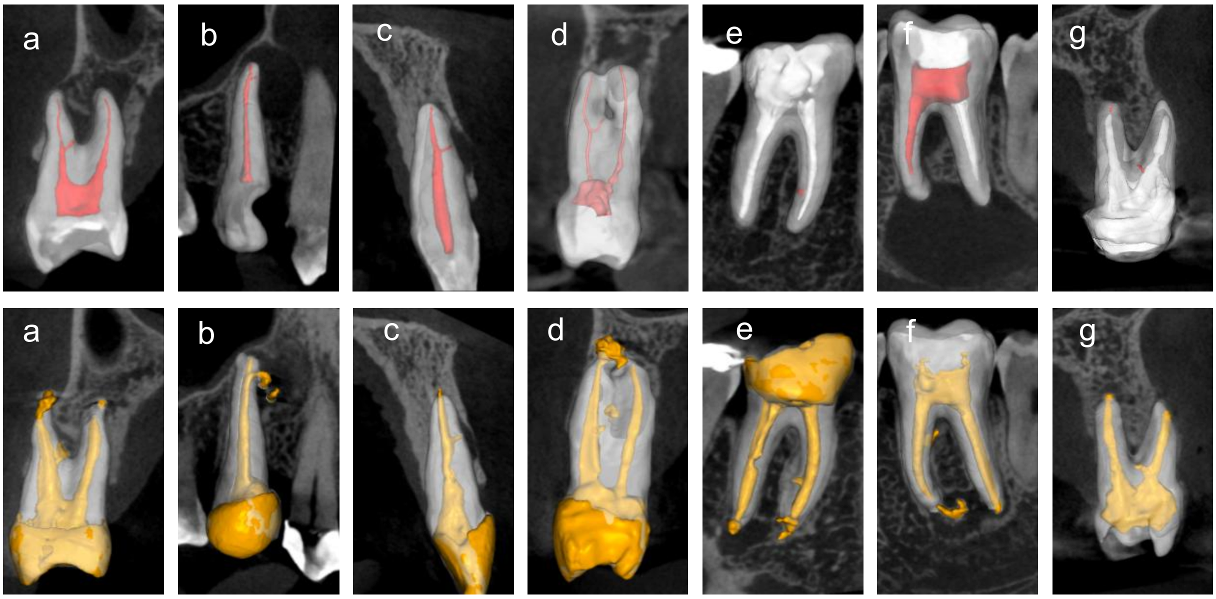

Figure 3 – Tomographic follow-up with three-dimensional segmentation. Initial tomographic (red); Tomographic follow-up (yellow); (a) case 1; (b) case 2; (c) case 3; (d) case 4; (e) case 5; (f) case 6; (g) case 7.

Supplementary File 1: PROBE 2023 checklist

Section/ Topic	Item Number	Checklist items	Reported on page number
Title	1a	The specific area(s) of interest must be provided using words and phrases that identify the clinical problem(s) and focus of the study	1
	1b	The study design must be included in the Title, e.g., cross-sectional, cohort, case-control, case-series etc.	1
Keywords	2a	Keywords indicating the specific area(s) of interest using MeSH terms or other more applicable terms must be included	1
Abstract	3a	The Introduction/Background must briefly explain the rationale or justification for the study	1
	3b	The aim(s)/objective(s) of the study must be provided	1
	3c	The Methodology must provide (where relevant) essential information on the nature of the study design (retrospective, cross-sectional, prospective, etc.), setting, location(s), and relevant dates, including periods of recruitment, exposure, follow-up, outcome(s) assessed and statistical analysis	1
	3d	The Results must describe the number of subjects that were included and analysed as well as the most significant results for all experimental and control groups. The results of statistical analysis must be reported in terms of unadjusted and confounder-adjusted outcomes (if relevant). Adverse events or side-effects must also be reported if present or confirmed as absent	1
	3e	The Conclusion must interpret and summarise the primary aim/objective and main findings as well as emphasise the clinical implications	1
	3f	The source(s) of funding must be provided	1
Introduction	4a	The clinical problem/question, scientific background and rationale for the study must be provided, including the gap(s) or inconsistencies in the existing knowledge base	2
	4b	The primary and, if applicable, any additional/secondary aim(s) and objective(s) of the study must be provided, including any pre-specified hypotheses	2

Methods *Ethics*	5a	The details (name, reference number, date) of the approval or exemption granted by an ethics committee, such as an Institutional Review Board, must be provided	3
	5b	The process used for obtaining and storing informed consent must be provided	3
Study design	5c	The key elements of the study design must be described early in the Methods section	3
Setting	5d	The details of setting(s), location(s), socioeconomic status of participants (if available) and relevant dates, including periods of recruitment, exposure, follow-up, and data collection must be provided	3
Sample size	5e	Information on how the sample size was determined *a priori* must be provided as well as the rationale for sample size calculation, preferably with reference to the published literature or a pilot study with additional detail as to why the defined sample size makes the study worthwhile	-
Participants – unmatched studies	5f	All studies should include inclusion/exclusion criteria as well as the sources and methods of participant selection. Methods of follow-up must also be provided in cohort studies and the rationale for the choice of 'cases' and 'controls' in case-control studies	3
Participants – matched studies	5g	For matched studies (e.g., cohort, case-control) the matching criteria and the numbers of participants in each group must be provided	-
Variables	5h	All outcomes, exposures, predictors, potential confounders, and effect modifiers must be defined clearly	3
Data sources/ measurement	5i	Sources of data and details of the methods of assessment (measurement) for each variable of interest must be provided	3
Bias	5j	Efforts taken to identify and address potential sources of bias must be provided	-
Quantitative variables	5k	The handling of quantitative variables in the analyses must be explained. Decisions on how groupings were made and/or how category boundaries were defined for continuous variables must be described	-
Statistical methods	5l	All statistical methods, including those used to control of confounding factors in the study and in the analysis of the data, must be described	-
	5m	The methods used to examine subgroups and interactions must be described, if applicable	-
	5n	Missing data (e.g. drop-outs, data not reported) must be addressed and described	-

	5o	The analytical methods that take account of the sampling strategy (if applicable) in *Cross-sectional studies* must be described	-
	5p	Sensitivity analyses, must be described when used	-
Results *Participants*	6a	The number of participants in each stage of the study (i.e., eligibility, recruitment, available at follow-up and included in analyses for relevant outcome(s)) must be described	4-8
	6b	Reasons for non-participation (e.g., not eligible, losses/drop-outs) must be described	-
Dates	6c	Changes in baseline dates of recruitment, follow-up, and study duration reported in the Methodology must be described, if applicable	4-8
Descriptive data	6d	The baseline demographic and clinical characteristics of study participants as well as information on exposures and potential confounders must be provided	4-8
	6e	The number of participants with missing data must be provided for each variable. If relevant, follow-up times should be summarised clearly and accurately (e.g., average or total time)	4-8
Outcome data	6f	Information on number of outcomes or summary measures over time must be described	4-8
	6g	For multivariable analyses developing risk profiles or reducing the effect of confounders, the effect of all included independent variables may be reported, as well as their effects on the prediction model (if applicable)	-
Main results	6h	Unadjusted (or uncorrected or crude) estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence intervals) must be described. Which confounders were adjusted for and why they were included must also be described	-
	6i	Results in terms of relative risk should also be translated to absolute risk for a meaningful time period, if relevant	-
Additional analyses	6j	The results from any other analyses (e.g., sensitivity, subgroup analyses) must be described, if applicable, as well as adjusted analyses, distinguishing pre-specified from exploratory	-
Discussion *Key results*	7a	The main findings must be summarized with reference to the study aim(s)/objective(s)	8
Rationale	7b	The rationale for inclusion/exclusion criteria, exposure, and duration must be provided	8
Clinical relevance	7c	An explanation of the clinical relevance of the primary and any additional/secondary outcome(s) must be provided	8

Strength	7d	The strength(s) of the study must be provided	8-10
Limitations	7e	The limitations of the study must be provided - addressing the sources of potential bias, imprecision, study design, study size and potentially important but missing confounding variables. Both direction and magnitude of any potential bias must be discussed	9-10
Summary and validity	7f	The discussion of the strength and limitations should be summarized in an overall assessment of the internal validity of the study	10
Interpretation	7g	A detailed interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence must be provided	10
Generalisabilit y	7h	The generalizability (external validity, applicability, real-world relevance etc.) of the study findings must be discussed	10
Future directions	7i	Implication for future research and clinical practice must be described	10
Conclusion(s)	8a	Explicit conclusion(s) from the study must be provided and address all the aims/objectives	10
Funding details	9a	All sources of funding and other support (such as supply of drugs, equipment etc.) as well as the role of funders must be acknowledged and described	10
Conflict of interest	10a	An explicit statement on conflicts of interest must be provided, together with full affiliations of every author(s)	10
Quality of images (if applicable)	11a	Details of the equipment, software and settings used to acquire the image(s) must be described in the text or legend (if applicable)	3
	11b	The reason why the image(s) was acquired and the rationale for its inclusion in the manuscript must be provided in the manuscript. A justification for all images that involve ionising radiation must be included	3
	11c	The circumstances (conditions) under which the image(s) were viewed and evaluated by the author(s) must be provided in the text	3
	11d	The resolution, any magnification of the image(s) or modifications/enhancements (e.g., adjustments for brightness, colour balance, magnification, image smoothing, staining, etc.) that were carried out must be described in the text or figure legend	11
	11e	Patient(s) identifiers (names, patient numbers) must be removed for General Data Protection Regulation (GDPR) and to ensure they are anonymized or de-identified in all images	3/11
	11f	An interpretation of the findings (meaning and implications) from the image(s) must be provided in the text	4-8

	11g	The figure legend associated with each image must describe clearly what the subject is and what specific feature(s) is illustrated. If cases are offered to illustrate descriptions of a cohort, then the age, gender, ethnicity, and other specific attributes that are relevant to the cohort should be provided	11
	11h	Markers/labels must be used to identify the key information in the image(s) and defined in the figure legend	11
	11i	The figure legend of each image must include an explanation on whether it is pre-, intra- or post-treatment and follow-up and, if relevant, how images were standardised over time	11

6 Considerações finais

Os resultados desta tese reforçam que os CA representam uma complexidade anatômica relevante, com potencial impacto sobre a saúde periodontal dos dentes, estando frequentemente associados à reabsorção óssea perirradicular, especialmente na forma combinada (apical e lateral).

A partir da análise tomográfica de alta resolução, foi possível observar que os CA estão presentes com frequência em pré-molares superiores e incisivos superiores, predominando no terço médio da raiz e, principalmente, nas faces palatina/lingual e vestibular. Esses achados ressaltam que a anatomia radicular é mais desafiadora e complexa do que se assume nas avaliações bidimensionais.

Além disso, a série de casos clínicos demonstrou que, embora a instrumentação e obturação intencional dos CA seja um procedimento tecnicamente desafiador, trata-se de uma abordagem viável e clinicamente efetiva, capaz de promover a resolução ou a significativa redução das lesões periapicais associadas, desde que corretamente planejada e executada com o auxílio de recursos como TCFC de alta resolução, magnificação óptica e softwares de segmentação tridimensional.

Diante disso, os achados desta pesquisa destacam que a detecção e o manejo dos CA devem ser considerados na prática clínica, especialmente em casos de lesões periapicais persistentes. Evidencia-se que o uso da TCFC de alta resolução se consolida como uma ferramenta indispensável não apenas para o diagnóstico, mas também para o planejamento e o acompanhamento de casos endodônticos complexos.

Por fim, apesar dos resultados promissores, é fundamental reconhecer que este trabalho não permite conclusões definitivas sobre o real impacto dos CA no prognóstico endodôntico. Os achados apresentados devem ser interpretados como uma contribuição relevante, porém inicial, para a compreensão desse tema. Assim, torna-se evidente a necessidade de novos estudos, com maior casuística e metodologias robustas, que aprofundem o conhecimento sobre a influência dos CA nos desfechos clínicos e na saúde periodontal.

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Apêndice A - Solicitação de Dispensa de Termo de Consentimento Livre e Esclarecido (TCLE)

Ao Comitê de Ética em Pesquisa da FO-UFPel

Eu, Nadia de Souza Ferreira, responsável pelo projeto de pesquisa intitulado "Associação da presença de canais laterais com repercussões periodontais utilizando tomografia de alta resolução" solicito a dispensa da obtenção do Termo de Consentimento Livre e Esclarecido (TCLE) para os participantes envolvidos neste estudo, conforme as justificativas apresentadas abaixo.
1. Natureza do Estudo: O estudo é observacional e os dados coletados são de natureza secundária, não havendo coleta de informações diretamente junto aos participantes.
2. Risco Mínimo: O risco associado à pesquisa é mínimo, considerando que os dados analisados são anonimizados e não contêm informações que possam identificar os indivíduos envolvidos.

Embora a dispensa do TCLE seja solicitada, garanto que todas as medidas necessárias serão tomadas para proteger a privacidade e a confidencialidade dos dados. Os dados serão anonimizados e armazenados de forma segura em um notebook protegido por senha, acessível apenas pela equipe de pesquisa autorizada. Não será divulgada qualquer informação que possa identificar os participantes. Os resultados da pesquisa serão apresentados de forma agregada, sem permitir a identificação dos indivíduos.

Diante do exposto, solicito a análise e aprovação desta solicitação de dispensa do TCLE. Estou à disposição para fornecer informações adicionais que possam auxiliar na avaliação desta solicitação.

Atenciosamente,

Nadia de Souza Ferreira
Pesquisadora Responsável