

[DOI]10.12016/j.issn.2096-1456.2023.07.005

· 临床研究 ·

基于锥形束CT影像的下颌第一恒磨牙根管治疗后根分叉病变的分类研究

唐蓉, 胡燕妮, 林梓桐

南京大学医学院附属口腔医院, 南京市口腔医院口腔颌面医学影像科, 江苏 南京(210008)

【摘要】 目的 探讨基于口腔颌面锥形束CT(cone beam CT, CBCT)的下颌第一恒磨牙根管治疗后根分叉病变(furcation involvement, FI)的分类,为根分叉病变个体化治疗提供参考。方法 回顾性收集就诊于南京大学医学院附属口腔医院的163例患者的164颗下颌第一恒磨牙根管治疗后根分叉病变的CBCT影像资料。根据患牙牙周及根尖周骨吸收的形态和范围,髓室底和根管侧壁剩余牙本质的厚度,结合患者全口其他牙情况,将根分叉病变分为牙周来源、根尖周来源、穿孔性因素及混合来源;并对根尖周来源根分叉病变患牙的根管充填情况进行评估。结果 164颗下颌第一恒磨牙根管治疗后根分叉病变患牙中,根尖周来源的根分叉病变最多,占41.5%,其次是混合来源,占26.2%,穿孔性因素占18.3%,牙周来源占14.0%。68例根尖周来源的根分叉病变患牙中,CBCT图像显示48.5%的患牙根充良好,44.1%的患牙根充不全,7.4%的患牙超填。43例混合来源的根分叉病变患牙中,同时存在牙周来源和根尖周来源的患牙最多,占72.1%。结论 CBCT可对根分叉病变进行细致的评价并进行分类,对临床治疗有指导意义。

【关键词】 锥形束CT; 下颌第一恒磨牙; 根分叉病变; 根管治疗; 牙周病; 根尖周炎; 穿孔; 危险区

【中图分类号】 R78 **【文献标志码】** A **【文章编号】** 2096-1456(2023)07-0488-06

【引用著录格式】 唐蓉,胡燕妮,林梓桐.基于锥形束CT影像的下颌第一恒磨牙根管治疗后根分叉病变的分类研究[J].口腔疾病防治,2023,31(7):488-493. doi:10.12016/j.issn.2096-1456.2023.07.005.

Classification of furcation involvement of endodontically treated mandibular first permanent molars based on cone beam CT TANG Rong, HU Yanni, LIN Zitong. Nanjing Stomatological Hospital, Medical School of Nanjing University, Department of Dentomaxillofacial Radiology, Nanjing 210008, China

Corresponding author: LIN Zitong, Email: linzitong710@163.com, Tel: 86-25-83620351

【Abstract】 Objective To classify the furcation involvement (FI) of endodontically treated mandibular first permanent molars based on cone beam computed tomography (CBCT), provide reference for individualized treatment of FI.

Methods CBCT images of the FI of 164 endodontically treated mandibular first permanent molars from 163 patients in Nanjing Stomatological Hospital, Medical School of Nanjing University were collected retrospectively. On the CBCT images, the shape and extent of periapical and periodontitis bone resorption, the thickness of residual dentin in the pulp floor and root canal wall, and the periodontal bone resorption of the complete dentition were evaluated. The FI was classified into periodontal, periapical, perforated and mixed types. **Results** Among the 164 FIs of endodontically treated mandibular first permanent molars, the periapical type was the most common (41.5%), followed by the mixed type (26.2%), perforated type (18.3%), and periodontal type (14.0%). Among the 68 periapical-type FIs of endodontically treated mandibular first permanent molars, 48.5% were proper root canal filling, 44.1% were insufficient filling and 7.4% were overfilling. Among the 43 mixed-type FIs, the periodontal mixed periapical type was the most common

【收稿日期】 2022-11-13; **【修回日期】** 2022-12-11

【基金项目】 国家自然科学基金青年基金项目(82201135);江苏省卫生健康委面上项目(M2021077);江苏省医学会科研专项资金资助项目[SYH-3201150-0007(2021002)]

【作者简介】 唐蓉, 医师, 学士, Email: 1610083316@qq.com

【通信作者】 林梓桐, 副教授, 博士, Email: linzitong710@163.com, Tel: 86-25-83620351



微信公众号

(72.1%). **Conclusion** Detailed evaluation and classification of furcation involvement could be performed using CBCT images; therefore, the study has guiding significance for clinical treatment.

【Key words】 cone beam CT; mandibular first permanent molars; furcation involvement; root canal therapy; periodontal disease; apical periodontitis; perforation; danger zone

J Prev Treat Stomatol Dis, 2023, 31(7): 488-493.

【Competing interests】 The authors declare no competing interests.

This study was supported by the grants from Nature Science Foundation of China (No. 82201135), General Project of Jiangsu Commission of Health (No. M2021077), the Jiangsu Province Medical Association Roentgen Imaging Research and Special Project Funds [No. SYH-3201150-0007(2021002)].

根分叉病变(furcation involvement, FI)是指病变波及多根牙的根分叉区的一种病变,可继发于牙周炎、牙髓炎和根尖周炎,是牙齿脱落的风险因素^[1-2]。对于非根管治疗的后牙而言,牙周病是根分叉病变的最常见原因,当牙周病引起的骨吸收进入多根牙的根分叉区时,即导致根分叉病变^[3]。而对于根管治疗后的后牙而言,根分叉病变的来源更加复杂。锥形束CT(cone beam CT, CBCT)因具有更高的空间分辨率已被广泛运用于疑难牙体牙髓病的诊断,对于根分叉病变而言,目前对其分类,通常是基于临床探查和二维影像数据,而通过CBCT影像数据可以对患牙的骨吸收范围和骨吸收类型进行更好的观察和评价,进而对根分叉病变的来源进行判断及分类,从而有助于治疗方案的制定^[4-6]。本研究回顾性收集了下颌第一恒磨牙根管治疗后根分叉病变病例,探讨基于CBCT图像的根分叉病变的影像学分类,为根分叉病变的个体化治疗提供参考。

1 资料和方法

1.1 研究对象

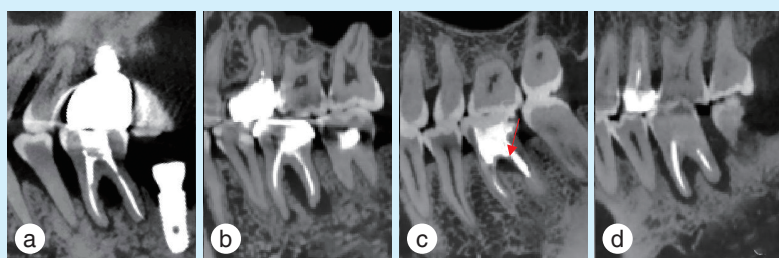
回顾性检索2019年10月-2022年10月间南京大学医学院附属口腔医院口腔颌面医学影像科

PACS (picture archiving and communication system)系统,查找就诊于南京大学医学院附属口腔医院牙体牙髓科和牙周科的由于疾病诊疗需要而拍摄的CBCT图像,共收集163名患者共计164颗下颌第一恒磨牙根管治疗后根分叉病变的CBCT图像资料。患者纳入时不区分是否为我院行根管治疗患者。纳入标准为:①患牙CBCT图像显示根分叉区骨质吸收;②患牙根尖发育完成;③患牙已行根管治疗;④CBCT影像清晰无伪影。排除标准:①患牙发生牙根折裂;②患牙冠部未充填;③正畸治疗史;④明显咬合创伤;⑤明确的折裂或可疑折裂。

1.2 CBCT影像分析

根分叉病变的诊断以在CBCT轴位、冠状位及矢状位图像上看到根分叉处骨质吸收破坏为依据。根据患牙根尖周及牙周骨吸收的形态及范围,髓室底和根管侧壁剩余牙本质的厚度、结合患者全口其他牙的情况^[7-8],将根分叉病变分为4类(图1、2);其中牙周来源、根尖周来源及穿孔性因素的分类依据见表1,混合来源为存在上述3类中的任意2类或3类。

对根尖周来源的根分叉病变患牙的CBCT图像进行根管充填情况评估,评判标准^[9]:①根充不



a: peridontal type, horizontal periodontal bone absorption involves furcation involvement; b: periapical type, periapical bone resorption extends upward to the furcation involvement; c: perforated type, the arrow shows the perforation of the pulp floor; d: mixed type, both periodontal and apical bone resorption involved the furcation involvement

Figure 1 Four types of furcation involvement in endodontically treated mandibular first permanent molars

图1 下颌第一恒磨牙根管治疗后根分叉病变的四种分类

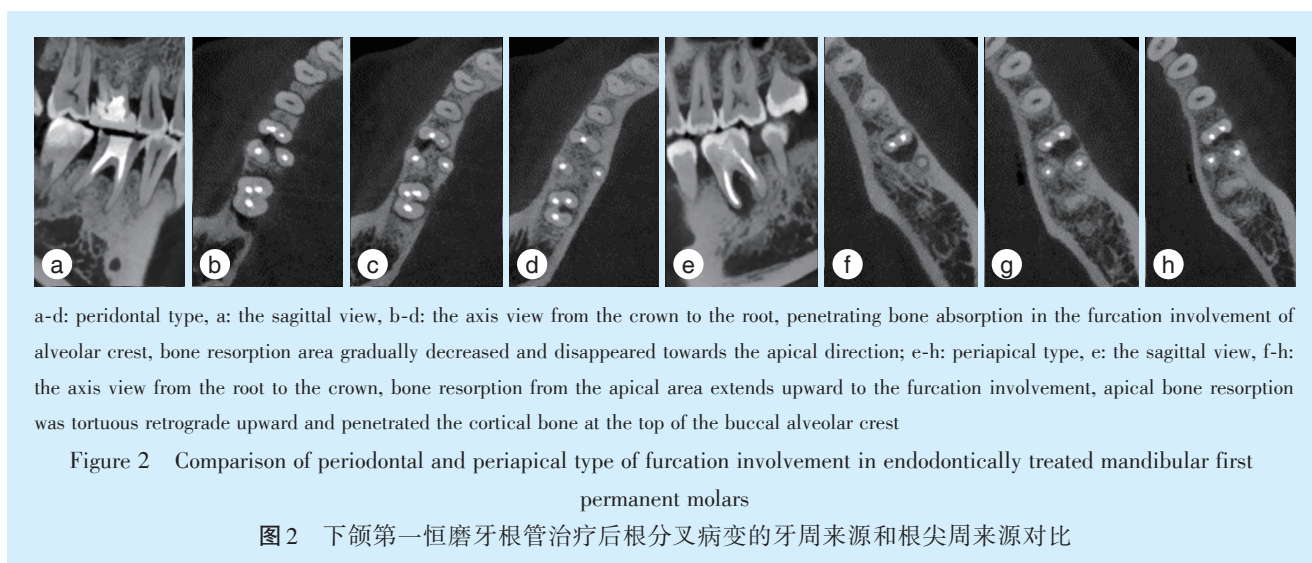


表1 下颌第一恒磨牙根管治疗后根分叉病变的牙周来源、根尖周来源及穿孔性因素的分类依据

Table 1 Classification of periodontal type, periapical type and perforated type of furcation involvement in endodontically treated mandibular first permanent molars

	Periodontal conditions of teeth	Periodontal condition of the whole mouth	Thin or perforated pulp chamber floor or root canal wall	Periapical periodontitis
Periodontal type	"Penetrating" absorption of buccal lingual alveolar bone in furcation involvement	Extensive resorption of alveolar bone in the whole mouth	None	None or slight periapical periodontitis
Periapical type	None or the distance from the top of alveolar ridge to the cemento-enamel junction ≤ 2 mm	None or the distance from the top of alveolar ridge to the cemento-enamel junction ≤ 2 mm	None	Periapical periodontitis retrogradely furcation involvement area and penetrates buccal or lingual bone plate
Perforated type	None or the distance from the top of alveolar ridge to the cemento-enamel junction ≤ 2 mm	None or the distance from the top of alveolar ridge to the cemento-enamel junction ≤ 2 mm	Thin or perforated pulp floor or root canal wall	None or slight periapical periodontitis

全:根管充填材料距根尖孔大于2 mm,遗漏根管,根管内充填材料存在间隙;②恰填:根管充填材料末端距根尖孔0~2 mm;③超填:牙胶尖超出根尖孔。

CBCT图像评价分类由2名口腔颌面医学影像学研究生分别进行,当两者分类结果不一致时,由1名具有5年以上临床经验的影像科诊断医师再次进行评价分类。在图像评价前,对评价者进行诊断及分类标准的培训。

2 结果

163例患者的164颗下颌第一恒磨牙根分叉病变分类结果见表2,其中根尖周来源的根分叉病变最多,其次是混合来源,然后是穿孔性因素,包括根管治疗或桩冠修复造成根管壁或髓室底穿通引起的根分叉病变,牙周来源占比最少。

68颗根尖周来源的根分叉病变患牙根管充填

表2 164颗下颌第一恒磨牙根管治疗后根分叉病变4种来源的牙数及占比

Table 2 The number and proportion of four types of furcation involvement in 164 endodontically treated mandibular first permanent molars

	Number of teeth	Percentage (%)
Periodontal type (A)	23	14.0
Perforated type (B)	30	18.3
Periapical type (C)	68	41.5
Mixed type	43	26.2

Mixed type: A+B / A+C / B+C / A+B+C

情况见表3,48.5%的患牙根充良好,44.1%的患牙根充不全,7.4%的患牙超填。

43颗混合来源的根分叉病变患牙的具体来源情况见表4,同时存在牙周来源和根尖周来源的患牙最多(72.1%),其次是同时存在穿孔性因素和根尖周来源的患牙(13.9%),同时存在牙周来源、穿

表3 68颗根管治疗后根尖周来源根分叉病变下颌第一恒磨牙根管治疗情况分析

Table 3 The analysis of extent of root canal filling of 68 endodontically treated mandibular first permanent molars with periapical type furcation involvement

	Number of teeth	Percentage (%)
Insufficient filling	30	44.1
Proper filling	33	48.5
Overfilling	5	7.4

表4 43颗根管治疗后下颌第一恒磨牙混合来源根分叉病变的病因分析

Table 4 The etiological analysis of 43 endodontically treated mandibular first molars with mixed type furcation involvement

	Number of teeth	Percentage (%)
A+ B	3	7.0
A+ C	31	72.1
B+ C	6	13.9
A+ B+ C	3	7.0

A: periodontal type; B: perforated type; C: periapical type

孔性因素和根尖周来源的患牙(7.0%)和同时存在牙周来源和穿孔性因素的患牙(7.0%)较少。

3 讨论

下颌第一恒磨牙作为口腔内最早萌出的恒牙,患各类口腔疾病的概率较高,是龋齿和牙周炎的好发牙位,也是接受根管治疗最多的牙位之一^[10-11]。在临床中,笔者发现根管治疗后下颌第一恒磨牙的根分叉病变较为多见,且来源较为复杂。首先,牙周炎患者菌斑进入根分叉处,并在此大量堆积,且不易去除,可导致根分叉病变的发生;其次,来自根尖周的炎症扩散波及根分叉区域也会造成根分叉病变^[12];再次,下颌第一恒磨牙近中根通常是弯曲的,尤其是近中颊侧根管,且近中根的远中面往往存在一个向内凹陷的危险区域,过度的根管预备则会造成管壁菲薄甚至条状穿孔,造成根分叉区域牙周组织的破坏,形成根分叉病变^[13-15]。由于不同来源的根分叉病变对应不同的治疗策略,因此有必要对根分叉病变进行详细的病因分析和分类。因此,本研究收集了下颌第一恒磨牙根管治疗后根分叉病变的CBCT图像,探讨如何通过CBCT图像对根分叉病变进行来源分析和病变分类,进而为临床诊治下颌第一恒磨牙根分叉病变提供参考。

在本研究中笔者对根分叉患牙的牙周及根尖周骨吸收的形态和范围、髓室底和根管侧壁剩余牙本质的厚度及患者全口其他牙牙周情况进行细致的评估,将根分叉病变分为4类。对于牙周来源的根分叉病变,患牙牙槽嵴顶骨吸收并累及根分叉区,并且全口其他牙也表现出不同程度的牙周骨吸收;对于根尖周来源的根分叉病变,其病变中心区在根尖周,可以在CBCT连续轴位图像上观察到骨吸收区迂曲逆行向上累及根分叉区,其牙周大部分牙槽嵴顶是连续的,往往仅表现为颊侧或舌侧根分叉区牙槽嵴顶骨吸收。对于根尖周来源的根分叉病变一定要注意在连续轴位图像上观察骨吸收区的走行。对于穿孔性因素,则可以在CBCT图像上看到髓室底和根管侧壁剩余牙本质的厚度菲薄,局部还可以看到穿孔。由于CBCT图像可以从冠状位、矢状位和轴位等连续各个层面进行观察,可以对骨吸收的范围、形态及走向,根管治疗的情况进行细致的评价,从而为判断根分叉病变的来源提供了可能。

本研究中,164颗根管治疗后下颌第一恒磨牙根分叉病变中,根尖周炎症来源(41.5%)最多。对根尖周来源的68颗下颌第一恒磨牙根分叉病变患牙中的根管治疗情况的评价显示,33颗根管恰填(48.5%),30颗存在根充不全(44.1%)。对于存在明确的根充不全病例,可结合患者情况考虑行根管再治疗。研究表明,根尖部的炎症与根管充填的长度及质量存在着一定的关联^[16-17]。由于本研究为回顾性分析,大部分根管恰填却仍存在根尖周炎的患牙病例未能追踪到根管治疗前影像。因此虽然这部分患者的根分叉病变为根尖周来源,但不明确是否患牙在根管治疗前已存在根尖周病变,也不确定根管治疗与根分叉病变转归之间的关系,对这类患者而言,后续治疗的重点为根尖周炎症的消除,非手术根管再治疗是治疗根管治疗后疾病的首要考量,对于难治性根尖周炎,可联合手术治疗^[18]。

本研究中,引起根分叉病变的第二个独立病因是根分叉区域根管治疗形成的穿孔导致的炎症病变。下颌第一恒磨牙的近中根在分叉点下方存在一个凹陷的危险区,该处的牙本质厚度有限,且近颊根管在根分叉处的弯曲度大于近舌根管,根上段过度的根管预备、未获得足够直线通路的弹性小的大锥度器械预备弯曲根管等都容易在该处造成条状穿孔^[19]。这类根分叉病变也是在临床上

比较容易被忽略的一类根分叉病变。对于下颌第一恒磨牙根管治疗后根分叉病变患牙,一定要注意在CBCT图像上观察髓室底和根管侧壁剩余牙本质厚度,评估是否为穿孔性因素导致的根分叉病变。而这种类型的根分叉病变的病因分析也非常有助于其后续医患沟通和治疗决策。穿孔的位置、大小等因素都会影响其预后,而CBCT图像有助于确定是否存在穿孔、定位穿孔、穿孔的大小以及骨质破坏的范围,并决定治疗方案^[20-21]。

本研究中仅有14%根分叉病变是牙周来源,这与本研究的数据来源有关,由于牙周破坏较严重且已累及根分叉区时的患牙很多会直接拔除并不会进行根管治疗,且轻度的根分叉病变患者往往因没有明显的临床症状未能及时就诊,因此本研究中这部分患牙占比较少。如为牙周来源的根分叉病变,则其治疗仍以牙周治疗为主。轻度根分叉病变以牙周基础治疗为主,对于牙周基础治疗效果较差及Ⅲ或Ⅳ度根分叉病变患牙,可采用翻瓣术、隧道成形术、截根术或牙半切术等手术治疗^[7, 22]。

在本研究中,下颌第一恒磨牙根管治疗后根分叉病变第二来源为混合因素(26.2%),其中,同时存在牙周来源和根尖周来源的患牙(72.1%)较多。混合来源的根分叉病变在制定治疗方案及诊疗时应兼顾多因素,明确病因,对牙体或牙周来源进行相对应的治疗或牙体牙周联合治疗。

临床上牙折裂或隐裂也是可能导致根分叉病变的原因之一,因此,在本研究对CBCT影像上明确诊断折裂或可疑折裂患牙进行了排除,但是临床上还可能存在着发生于髓底区的细小隐匿型裂纹,这些裂纹也可能导致根分叉病变的发生。由于这类裂纹只能通过牙周翻瓣探查或牙拔除后借助染色剂和显微镜才能明确诊断,因此在本研究也可能存在着极少数隐匿性裂纹导致根分叉病变,这也是本研究不足。

本研究通过CBCT影像数据对牙周及根尖周骨吸收的形态和范围、髓室底和根管侧壁剩余牙本质的厚度及患者全口其他牙情况的细致评价,将根分叉病变分为不同类型,探讨下颌第一恒磨牙根管治疗后根分叉病变的病因,为临床分析病来源提供一定参考。

【Author contributions】 Tang R collected, processed and analyzed the data and wrote the article. Hu YN processed and analyzed the data. Lin ZT designed the study and reviewed the article. All authors read

and approved the final manuscript as submitted.

参考文献

- [1] Helal O, Göstemeyer G, Krois J, et al. Predictors for tooth loss in periodontitis patients: systematic review and meta-analysis[J]. *J Clin Periodontol*, 2019, 46(7): 699-712. doi: 10.1111/jcpe.13118.
- [2] 苏文祺, 史佳虹, 程艳, 等. 下颌第一磨牙根分叉病变治疗随访27年1例[J]. *华西口腔医学杂志*, 2021, 39(3): 347-354. doi: 10.7518/hxkq.2021.03.016.
Su WQ, Shi JH, Cheng Y, et al. Periodontal treatment of furcation involvement at the mandibular first molar with a follow-up of 27 years[J]. *West China J Stomatol*, 2021, 39(3): 347-354. doi: 10.7518/hxkq.2021.03.016.
- [3] Pilloni A, Rojas MA. Furcation involvement classification: a comprehensive review and a new system proposal[J]. *Dent J (Basel)*, 2018, 6(3): 34. doi: 10.3390/dj6030034.
- [4] Woelber JP, Fleiner J, Rau J, et al. Accuracy and usefulness of CBCT in periodontology: a systematic review of the literature[J]. *Int J Periodontics Restorative Dent*, 2018, 38(2): 289-297. doi: 10.11607/prd.2751.
- [5] Zhang W, Foss K, Wang B. A retrospective study on molar furcation assessment via clinical detection, intraoral radiography, and cone beam computed tomography[J]. *Oral Surg Oral Med Oral Pathol Oral Radiol*, 2019, 128(4): e176. doi: 10.1016/j.oooo.2019.01.063.
- [6] Choi IGG, Cortes ARG, Arita ES, et al. Comparison of conventional imaging techniques and CBCT for periodontal evaluation: a systematic review[J]. *Imaging Sci Dent*, 2018, 48(2): 79-86. doi: 10.5624/isd.2018.48.2.79.
- [7] 孟焕新. 牙周病学[M]. 5版. 北京: 人民卫生出版社, 2020.
Meng HX. *Periodontology*[M]. 5th ed. Beijing: People's Medical Publishing House, 2020.
- [8] 张祖燕. 口腔颌面医学影像诊断学[M]. 7版. 北京: 人民卫生出版社, 2020.
Zhang ZY. *Imaging diagnosis of oral and maxillofacial medicine* [M]. 7th ed. Beijing: People's Medical Publishing House, 2020.
- [9] Liang YH, Li G, Wesselink PR, et al. Endodontic outcome predictors identified with periapical radiographs and cone-beam computed tomography scans[J]. *J Endod*, 2011, 37(3): 326-331. doi: 10.1016/j.joen.2010.11.032.
- [10] Jakovljevic A, Nikolic N, Jacimovic J, et al. Prevalence of apical periodontitis and conventional nonsurgical root canal treatment in general adult population: an updated systematic review and meta-analysis of cross-sectional studies published between 2012 and 2020[J]. *J Endod*, 2020, 46(10): 1371-1386.e8. doi: 10.1016/j.joen.2020.07.007.
- [11] Harris SP, Bowles WR, Fok A, et al. An anatomic investigation of the mandibular first molar using micro-computed tomography[J]. *J Endod*, 2013, 39(11): 1374-1378. doi: 10.1016/j.joen.2013.06.034.
- [12] Sabeti M, Tayeed H, Kurtzman G, et al. Histopathological investigation of dental pulp reactions related to periodontitis[J]. *Eur En-*

- dod J, 2021, 6(2): 164-169. doi: 10.14744/ej.2021.96268.
- [13] Dwivedi S, Dwivedi CD, Mittal N. Correlation of root dentin thickness and length of roots in mesial roots of mandibular molars[J]. J Endod, 2014, 40(9): 1435-1438. doi: 10.1016/j.joen.2014.02.011.
- [14] Tabrizzadeh M, Reuben J, Khalesi M, et al. Evaluation of radicular dentin thickness of danger zone in mandibular first molars[J]. J Dent (Tehran), 2010, 7(4): 196-199.
- [15] Zhou G, Leng D, Li M, et al. Root dentine thickness of danger zone in mesial roots of mandibular first molars[J]. BMC Oral Health, 2020, 20(1): 43. doi: 10.1186/s12903-020-1026-8.
- [16] Meirinhos J, Martins JNR, Pereira B, et al. Prevalence of apical periodontitis and its association with previous root canal treatment, root canal filling length and type of coronal restoration - a cross-sectional study[J]. Int Endod J, 2020, 53(4): 573-584. doi: 10.1111/iej.13256.
- [17] dos Santos GNA, Faria-e-Silva AL, Ribeiro VL, et al. Is the quality of root canal filling obtained by cone-beam computed tomography associated with periapical lesions? A systematic review and meta-analysis[J]. Clin Oral Invest, 2022, 26(8): 5105-5116. doi: 10.1007/s00784-022-04558-y.
- [18] 林正梅, 何颖聪, 黄舒恒, 等. 显微根尖外科手术临床决策的口腔多学科考量[J]. 口腔疾病防治, 2022, 30(10): 685-691. doi: 10.12016/j.issn.2096-1456.2022.10.001.
- Lin ZM, He YC, Huang SH, et al. Oral multidisciplinary considerations for clinical strategies of endodontic microsurgery[J]. J Prev Treat Stomatol Dis, 2022, 30(10): 685 - 691. doi: 10.12016/j.issn.2096-1456.2022.10.001.
- [19] Bhuvra B, Ikram O. Complications in endodontics[J]. Prim Dent J, 2020, 9(4): 52-58. doi: 10.1177/2050168420963306.
- [20] Pontius V, Pontius O, Braun A, et al. Retrospective evaluation of perforation repairs in 6 private practices[J]. J Endod, 2013, 39(11): 1346-1358. doi: 10.1016/j.joen.2013.08.006.
- [21] Torabinejad M, Parirokh M, Dummer PMH. Mineral trioxide aggregate and other bioactive endodontic cements: an updated overview - part II: other clinical applications and complications[J]. Int Endod J, 2018, 51(3): 284-317. doi: 10.1111/iej.12843.
- [22] Dommisch H, Walter C, Dannewitz B, et al. Resective surgery for the treatment of furcation involvement: a systematic review[J]. J Clin Periodontol, 2020, 47(Suppl 22): 375 - 391. doi: 10.1111/jcpe.13241.

(编辑 周春华, 曾雄群)



官网

· 短讯 ·

《口腔疾病防治》入选 2022 年度中国高校科技期刊建设示范案例库优秀科技期刊

2022 年 12 月 1 日, 在中国高校科技期刊研究会第 26 次年会上发布了 2022 年度中国高校科技期刊建设示范案例库·杰出/百佳/优秀科技期刊入库案例名单。由南方医科大学口腔医院主办的科技期刊《口腔疾病防治》入选 2022 年度中国高校科技期刊建设示范案例库优秀科技期刊。

《口腔疾病防治》编辑部