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超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用效果 *

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摘要 目的:探究超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用效果。**方法:**2015 年 8 月到 2020 年 5 月选择在本院进行诊治的可复性牙髓炎患者 123 例作为研究对象,根据随机信封 1:1 抽签原则把患者分为超声组 62 例与对照组 61 例,所有患者均给予 iRoot BP Plus 牙髓切断术,对照组给予常规冲洗,超声组给予超声冲洗,对比患牙边缘状况、术后不良反应、钙化桥形成与手术成功率。**结果:**(1)超声组术后 3 个月、6 个月与 12 个月的手术成功率分别为 100.0 %、100.0 %、98.4 %,对照组分别为 100.0 %、95.1 %、86.9 %,超声组术后 12 个月的手术成功率高于对照组($P<0.05$)。(2)超声组术后 3 个月、6 个月与 12 个月的钙化桥形成率分别为 51.6 %、98.4 %和 100.0 %,对照组为 18.0 %、50.8 %、100.0 %,超声组术后 3 个月、6 个月钙化桥形成率均高于对照组($P<0.05$)。(3)超声组术后 12 个月的不良反应发生率为 3.2 %,低于对照组的 16.4 %($P<0.05$)。(4)超声组术后 12 个月的患牙边缘染色完整性、边缘完整性分别为 98.4 %、98.4 %,高于对照组的 85.2 %和 88.5 %($P<0.05$)。**结论:**超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用能改善患牙边缘状况,减少术后不良反应的发生,还可促进钙化桥形成,提高手术成功率。

关键词:超声冲洗;磨牙;iRoot BP Plus;牙髓切断术

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The Application Effect of Ultrasonic Irrigation Technique in Molar Pulpotomy with iRoot BP Plus*

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ABSTRACT Objective: To explore the application effect of ultrasonic irrigation technology in molar pulpotomy with iRoot BP Plus.

Methods: From August 2015 to May 2020, 123 cases of patients with reversible pulpitis who were undergoing diagnosis and treatment were selected as the research objects. All the cases were divided into 62 cases in the ultrasound group and 61 cases in the control group accorded to the random envelope 1:1 lottery principle. All patients were treated with iRoot BP Plus pulpotomy. The control group were treated with conventional irrigation, and the ultrasound group were treated with ultrasound. The two groups of patients were compared with the edge condition of the hand-affected tooth, the grade of smear layer, postoperative adverse reactions, calcification bridge formation, and the success rate of the operation. **Results:** (1) The surgical success rates of the ultrasound group were 100.0 %, 100.0 %, and 98.4 % at 3 months, 6 months, and 12 months after surgery, respectively, while those in the control group were 100.0 %, 95.1 %, and 86.9 %, respectively. The surgical success rates of the ultrasound group at 12 months after operation were higher than that of the control group ($P<0.05$). (2) The rate of calcification bridge formation at 3 months, 6 months and 12 months after surgery in the ultrasound group were 51.6 %, 98.4 %, and 100.0 %, respectively, and the control group were 18.0 %, 50.8 %, and 100.0 %. The rate of calcification bridge formation in the at 3 months, 6 months after surgery were higher than that of the control group ($P<0.05$). (3) The incidence of adverse reactions 12 months after operation in the ultrasound group was 3.2 %, which was lower than that in the control group (16.4 %) ($P<0.05$). (4) The edge staining integrity and edge integrity of the teeth in the ultrasound group 12 months after surgery were 98.4 % and 98.4 %, respectively, which were higher than 85.2 % and 88.5 % in the control group ($P<0.05$). **Conclusion:** The application of ultrasonic irrigation technology in molar pulpotomy with iRoot BP Plus can improve the condition of the edge of the tooth, reduce the occurrence of postoperative adverse reactions, and increase the success rate of surgery.

Key words: Ultrasonic irrigation; Molars; iRoot BP Plus; Pulpotomy

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前言

可复性牙髓炎是口腔科较常见的病症,牙髓切断术是可复性牙髓病的主要治疗技术。牙髓切断术可对腐质进行清除,尽最大可能保留牙根部活髓^[1,2]。常用的牙髓切断术盖髓剂包括矿物三氧化物凝聚体、无机三氧化物聚合物、甲醛甲酚、iRoot BP Plus、硫酸亚铁等^[3]。无机三氧化物聚合物是当前临床上使用较多的盖髓剂,但在操作上的便利性不强,也易引起牙齿变色^[4]。作为一种新型生物材料,iRoot BP Plus 具有很好的组织相容性好,对牙髓细胞组织毒性较低,当前在临床上广泛使用^[5]。但由于各种因素的影响,多数患者在根管预备方法中被发现,根管侧壁牙本质表面产生大量玷污层,特别是大量弯曲根管因弯曲程度、解剖位置等,致使在手术过程中易出现急性根尖周炎症。由于根管未冲洗干净,不利于根管充填,或在充填过程中产生微渗漏^[6,7]。部分牙本质碎屑可阻塞牙本质小管,使消毒药物不能被有效利用,从而影响牙本质碎屑的清除效果^[8]。积极去除玷污层可使牙本质小管口开放,减少牙本质小管内的细菌数量,也可增加药物的渗透性,提高根管充填的密闭性^[9]。超声冲洗技术可产生声流效应,提高冲洗液的冲刷作用,从而增强其溶解

髓和有机碎屑、杀菌、消毒等综合作用^[10]。本文具体探讨了超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用效果,以促进超声冲洗技术的应用。

1 资料与方法

1.1 研究对象

2015 年 8 月到 2020 年 5 月选择在本院进行诊治的可复性牙髓炎患者 123 例作为研究对象。

纳入标准:符合可复性牙髓炎的诊断标准;影像学显示患牙龋坏低密度暗影近髓;年轻恒牙;发病部位为磨牙;自愿参加,积极配合;无自发痛症状;根尖周无异常;牙周膜、根尖周组织无异常;根尖无明显吸收;本院伦理委员会批准了此次研究;无牙龈红肿和瘘管。

排除标准:牙髓感染侵犯根尖周组织且形成慢性弥漫性炎症;自发痛、夜间痛;合并恶性肿瘤患者;精神异常或认知功能障碍的患者;具有手术或牙髓切断术禁忌的患者。

根据随机信封 1:1 抽签原则把患者分为超声组 62 例与对照组 61 例,两组患者的性别、根管弯曲度、磨牙位置等对比无差异($P>0.05$)。见表 1。

表 1 两组一般资料对比

Table 1 Comparison of general data between the two groups

Groups	n	Gender (male/female)	Root canal curvature (°)	Position of molars (maxillary/mandibular)	Age (years)	Body mass index (kg/m ²)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Ultrasound group	62	32/30	13.42± 0.28	33/29	32.01± 3.61	22.18± 1.32	124.77± 10.42	78.76± 2.15
Control group	61	31/30	13.41± 0.33	32/29	31.98± 2.42	22.10± 1.11	124.09± 9.33	78.33± 3.16

1.2 手术方法

所有患者均给予 iRoot BP Plus 牙髓切断术,由同一组医生(具有≥5 年工作经验)完成。患牙进行局部麻醉后,上橡皮障并清洁牙面。在洁净环境下打开灭菌牙髓切断手术包,髓腔暴露可见成形的牙髓组织,观察牙髓形态、出血量及颜色,使用球钻和挖匙去除冠髓后,采用生理盐水冲洗髓腔,去除牙本质碎屑和牙髓残片等碎屑,并用生理盐水湿棉球轻压牙髓断面 5 min 左右。将预混合的 iRoot BP Plus 盖于根管口牙髓断面,厚度在 2 mm 左右,用生理盐水棉球轻压使之与髓壁密切贴合,盖髓剂上方放置氧化锌及玻璃离子水门汀。使用树脂进行充填修复。

对照组:应用常规方法进行冲洗,冲洗液为双氧水、生理盐水,用注射器吸取上述液体 10 mL 后进行 60 s 左右冲洗。

超声组:给予超声技术冲洗,冲洗液为生理盐水,每次超声持续时间为 10 s 左右,超声过程中可轻微上下移动。

1.3 观察指标

1.3.1 手术总体效果评价 在术后 3 个月、6 个月与 12 个月进行手术成功率评价,成功标准:患牙无自发痛、叩痛,牙髓断面可见明显钙化物,未见明显松动,未见低密度影或者牙根吸收,牙龈未见红肿或者出现瘘管^[11]。

1.3.2 钙化桥形成情况 观察两组在术后 3 个月、6 个月与 12

个月的钙化桥形成情况。

1.3.3 不良反应情况 观察与记录所有患者术后 12 个月的不良反应情况,无反应:无疼痛不适,牙龈正常;轻度反应:稍有疼痛不适,牙龈正常,无松动;重度反应:根尖区明显红肿,伴有明显自发疼痛、咬物痛,伴或不伴有牙齿松动^[12]。

1.3.4 患牙边缘染色、边缘完整性 在术后 12 个月对所有患者进行患牙边缘染色完整性、边缘完整性评价。

1.4 统计方法

本研究使用 SPSS19.00 软件,计量与计数数据以($\bar{x} \pm s$)、(n/%)表示,对比方法为 t 检验与卡方 χ^2 检验等,检验水准为 $\alpha=0.05$ 。

2 结果

2.1 手术总体效果对比

超声组术后 3 个月、6 个月与 12 个月的手术成功率分别为 100.0 %、100.0 %、98.4 %, 对照组分别为 100.0 %、95.1 %、86.9 %, 超声组术后 12 个月的手术成功率高于对照组($P<0.05$)。见表 2。

2.2 钙化桥形成情况对比

超声组术后 3 个月、6 个月与 12 个月的钙化桥形成率分别为 51.6 %、98.4 %和 100.0 %,对照组为 18.0 %、50.8 %、100.0 %,

超声组术后 3 个月、6 个月的钙化桥形成率高于对照组($P<0.05$)。见表 3。

表 2 两组手术总体效果对比(n)

Table 2 Comparison of overall results between the two groups (n)

Groups	n	After surgery 3 months	After surgery 6 months	After surgery 12 months
Ultrasound group	62	62(100.0 %)	62(100.0 %)	61(98.4 %)*
Control group	61	61(100.0 %)	58(95.1 %)	53(86.9 %)

Note: compared with the control group, * $P<0.05$.

表 3 两组钙化桥形成情况对比(n)

Table 3 Comparison of calcification bridge formation between the two groups (n)

Groups	n	After surgery 3 months	After surgery 6 months	After surgery 12 months
Ultrasound group	62	32(51.6 %)*	61(98.4 %)*	62(100.0 %)
Control group	61	11(18.0 %)	31(50.8 %)	61(100.0 %)

Note: compared with the control group, * $P<0.05$.

2.3 不良反应情况对比

组的 16.4 %($P<0.05$)。见表 4。

超声组术后 12 个月的不良反应发生率为 3.2 %, 低于对照

表 4 两组术后 12 个月的不良反应情况对比(n)

Table 4 Comparison of adverse reactions between the two groups 12 months after surgery (n)

Groups	n	No response	Mild reaction	Severe reaction	Total incidence
Ultrasound group	62	60	2	0	2(3.2 %)*
Control group	61	51	6	4	10(16.4 %)

Note: compared with the control group, * $P<0.05$.

2.4 患牙边缘染色完整性、边缘完整性对比

分别为 98.4 %、98.4 %，高于对照组的 85.2 %和 88.5 %($P<0.05$)。见表 5。

超声组术后 12 个月的患牙边缘染色完整性、边缘完整性

表 5 两组术后 12 个月的患牙边缘染色、边缘完整性对比(n)

Table 5 Comparison of edge staining and edge integrity of affected teeth between the two groups at 12 months after surgery (n)

Groups	n	Edge staining integrity	Edge integrity
Ultrasound group	62	61(98.4 %)*	61(98.4 %)*
Control group	61	52(85.2 %)	54(88.5 %)

Note: compared with the control group, * $P<0.05$.

3 讨论

磨牙为可复性牙髓炎的主要发病部位，一般常见深龋洞，各种因素会造成刺激性疼痛，当刺激消失时，这种症状立刻褪消，自觉症状不明显，在青少年中很少引起重视^[13]。但多数患者患牙可保存有大量腐质，使得各种细菌及其代谢产物释放的毒素波及牙髓组织，导致牙齿缺失与全身炎症反应^[14]。牙髓切断术为可复性牙髓炎的主要治疗方法，可在清除腐质基础上，保留健康牙髓组织与剩余活髓，尽量保留健康牙髓组织^[15]。积极使用盖髓剂进行覆盖，可促进截断部分的愈合，促进患牙发挥正常功能，防止患牙进一步感染。生物相容性好的材料是牙髓切断术成功的关键因素，以往常采用无机三氧化物聚合物作为牙髓切断的盖髓剂，但具有细胞毒性大、边缘封闭性差等不足，也使得牙髓组织中的破骨细胞活性增加，抑制牙髓细胞的增

加，增加不良反应的发生率^[16,17]。iRoot BP Plus 的主要成分包括磷酸二钙、氧化钽、硅酸钙、氧化锆等，具有非水溶性、不可吸收性、良好封闭性、良好牙体组织粘结性、生物相容性等特点^[18]。本研究显示：超声组术后 12 个月的手术成功率高于对照组；超声组术后 3 个月、6 个月的钙化桥形成率都高于对照组，表明超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用能促进钙化桥形成，提高手术成功率。这一结果与 Crozeta BM 等人^[19]的结果一致，即超声冲洗技术的使用优化了填充材料的去除，增强了整体清洁，有助于手术的成功。进一步分析可知：超声冲洗技术可利用热效应、瞬间空穴效应、声流效应等作用，活化根管内冲洗液，产生升温、搅动效果，其本身具有的杀菌与机械冲刷作用相结合发挥综合治疗作用^[20]。同时超声冲洗能与冲洗液可产生协同作用，形成了较大的液体切应力，可杀灭悬液中的微生物，也有利于清除根管壁玷污层^[21]。

iRoot BP Plus 的应用为牙髓切断术提供了更多盖髓材料的选择性,可有效促进牙髓愈合^[2]。钙化桥长期被认为是牙髓愈合的重要评估指标,特别是 iRoot BP Plus 的中钙离子成分可参与化学反应,促进钙化桥的形成,生成羟基磷灰石结晶^[2]。i-Root BP Plus 的应用可促进钙化桥形成时间,避免了细胞及血管的远期退化,也避免了细菌的侵袭。不过根管结构的复杂性也是影响磨牙 iRoot BP Plus 牙髓切断术的重要因素之一,比如根管直径变化、根管走向变化等^[24]。特别是根管解剖形态会存在大量不规则区域,常规冲洗技术可导致液体回流无法到达这些区域,冲刷杀菌作用得不到有效发挥,降低了冲洗液与根管壁的接触面积,可影响冲洗效果,导致无法快速形成钙化桥^[25]。本研究显示:超声组术后 12 个月的玷污层分级情况好于对照组;超声组术后 12 个月的不良反应发生率低于对照组,表明超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用能促进清洗玷污层,减少术后不良反应的发生。这一结果与 Căpută PE 等人^[26]的报道一致,从机制上进一步推测分析可知,超声冲洗技术可使冲洗液直接注射至根中、根尖狭窄区域,有利于敞开侧支根管及牙本质小管,也可及时更新此区域的冲洗液,有利于进一步发挥清洁玷污层的作用^[27]。在冲洗中应用超声技术,可发挥热效应、机械效应、生物效应等综合效应,能达到根尖区,有利于玷污层的污垢被充分分解、冲洗排出,也可减少术后不良反应的发生^[28]。超声冲洗可使根管内的冲洗液快速流动,也可增强冲洗液的物理冲刷作用,减少冲洗过程中根管内容物的溢出,从而更有效地发挥清洁根管的作用^[29]。

人体口腔是一种非密闭无菌环境,牙髓切断术具有良好效果,但在切断时发生冠部微渗漏现象,可导致患者口腔内出现细菌感染,影响患者的预后^[30]。iRoot BP Plus 与根尖周接触之后不会产生刺激性,也不会产生致癌、致畸性等不良作用,也有助于根尖病变愈合。本研究显示:超声组术后 12 个月的患牙边缘染色完整性、边缘完整性高于对照组,表明超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用能改善患牙边缘状况。这一结果与 Orozco EIF 等人^[31]的研究结果一致,即超声冲洗可有效减少细菌数量。进一步分析可知,超声冲洗可增强微声流作用,能有效缩短操作时间,增加冲洗液流速,有利于去除根管壁上的牙本质碎屑,从而取得更好的细菌清除作用,达到更好的治疗效果^[32]。本研究也存在一定的不足,设置的组别较少,未进行机制分析,纳入患者数量也较少,将在后续研究中探讨。

总之,超声冲洗技术在磨牙 iRoot BP Plus 牙髓切断术中的应用能改善患牙边缘状况,减少术后不良反应的发生,还可促进钙化桥形成,提高手术成功率。

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