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两种牙体充填材料对乳牙边缘微渗漏及固化效率的体外研究 *

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摘要 目的:比较纳米瓷充填材料和复合树脂充填乳牙 V 类洞边缘微渗漏的影响以及固化效率的差异。**方法:**第一部分为微渗漏实验,选取滞留拔除的上颌乳前牙 20 颗,唇侧制备 V 类洞,随机分为 A、B 两组,分别用 Composan LCM 和 Filtek™ Z350 充填,亚甲基蓝染色处理,24 h 后使用体式显微镜观察,测量染料渗入深度为微渗漏值,每组各选 2 个样本扫描电镜观察充填体与牙体组织间粘结情况。第二部分为显微硬度实验,分别用两种充填材料制作模块各 9 个,记为 A、B 两组,材料模块光固化 24 h 后使用显微硬度仪检测充填材料的固化效率。**结果:**Composan LCM 组微渗漏值明显低于 Filtek™ Z350 组($P < 0.05$);扫描电镜下观察 Filtek™ Z350 组充填材料与牙体组织间可见裂缝,界面参差不齐,有不连续的小断裂,Composan LCM 组界面连续均匀,未见明显裂缝;两组充填材料的固化效率无显著差异($P > 0.05$)。**结论:**纳米瓷充填材料和复合树脂均可用于乳牙龋洞充填,使用纳米瓷充填材料可减少微渗漏。

关键词:纳米瓷有机充填材料;乳牙;微渗漏;固化效率

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Evaluation of Microleakage and Polymerization Efficiency in Primary Teeth with Two Different Restorative Material*

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ABSTRACT Objective: To evaluate the efficiency of Composan LCM and Filtek™ Z350 on the micro-leakage of Class V cavities. **Methods:** Part 1: 20 samples of retained maxillary primary incisors were collected, Class V cavities on the buccal surfaces were prepared and randomly divided into two groups. Group A and group B were filled with Composan LCM and Filtek™ Z350 respectively. All samples were stained for 24 hours after filling and observed by stereomicroscope and scanning electron microscopy. Part 2: Group A to B were filled with Composan LCM and Filtek™ Z350 respectively and light-cured. After 24 hours of light-cured, all the specimens were used the micro-hardness method to detect the curing efficiency. **Results:** The micro-leakage of group B was significantly higher than that of group A ($P < 0.05$). SEM showed that there are visible cracks between the filling materials of group B and the dental tissue, and the interface is uneven with discontinuous small fractures. The interface of group A was continuous and uniform without obvious cracks, there was no significant difference in curing efficiency with different filling materials ($P > 0.05$). **Conclusion:** Composan LCM and Filtek™ Z350 were suitable for primary carious cavities, and using Composan LCM had less micro-leakage than Filtek™ Z350.

Key words: Composan LCM; Primary teeth; Micro-leakage; Curing efficiency

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前言

由于口腔健康意识的欠缺以及儿童特殊的饮食摄入习惯,龋齿一直是儿童最常见的口腔健康问题。及时的修复充填是保留乳牙直至其生理性牙根吸收脱落是乳牙龋齿最理想的治疗方式,有助于维持儿童健康的口腔环境和正常的咀嚼及语言功能,从而促进儿童正常的生长发育^[1]。然而,由于不可避免的紧张焦虑情绪,儿童患者配合程度差,给临床操作治疗增加了难度。

儿童唾液分泌较多且口底较浅,充填操作时可隔湿操作时

间较短,对充填体的边缘封闭性能及机械性能也有更高的要求。本实验将有机瓷纳米充填材料和复合树脂分别应用于乳牙 V 类洞充填,通过染料渗入法和显微硬度法,比较充填体边缘的微渗漏程度及两种充填材料的固化效率,以期临床上选择乳牙充填材料的标准提供参考。

1 材料与方法

1.1 材料与仪器

1.1.1 实验材料 离体牙(选取哈尔滨医科大学口腔医院儿童口腔科,因滞留拔除的上颌乳前牙 20 颗);Composan LCM 有

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机瓷纳米充填材料(Promedica, 德国);Filtek™ Z350XT 通用型纳米树脂(3M ESPE, 美国);Adper Easy One 自酸蚀黏结剂(3M ESPE, 美国);2%亚甲基蓝染料;蒸馏水;生理盐水;透明指甲油(市售);硅橡胶(DMG, 德国)。

1.1.2 实验设备及仪器 光固化灯(3M ESPE, 美国);高速手机(NSK, 日本);金刚砂车针(MANI, 日本);恒温水浴箱(HF90, 中国);冷热循环仪(Hanon, 中国);体视显微镜(Leica, 德国);S3400N 扫描电镜(日立, 日本);全自动显微硬度仪(HVS-1000A, 中国)。

1.2 方法

1.2.1 微渗漏实验 (1)样本的收集与预备:收集新鲜拔除的上颌乳前牙 20 颗,要求牙冠完整,无龋坏,隐裂,无充填体,去除所有软组织和牙面软垢,流水冲洗后,浸于生理盐水中,置于 4℃ 冰箱保存备用。(2)样本的分组与处理:直视下在实验牙唇侧颈部预备规格为 3.0 mm× 2.0 mm× 2.0 mm 的盒状洞形,深达釉牙本质界下 0.5-1.0 mm。制备完成后,冲洗、气枪微风吹干,涂布自酸蚀黏结剂,轻吹至均匀,光照 10 s。将 20 颗实验牙随机分为两组,每组 10 颗。A 组:Composan LCM 有机瓷纳米充填材料充填(CL 组),B 组:Filtek™ Z350XT 通用型纳米树脂充填(Z350 组)。LED 固化灯光源方向垂直于充填体表面,光照时间为 20 秒,充填结束后即刻进行边缘修整,打磨抛光,操作结束后置于生理盐水中备用,于 4℃ 冰箱中储存,以上步骤均由同一实验者完成。(3)染料渗透:将充填后的两组样本置于 0℃~5℃ 和 55℃~60℃ 的水中进行冷热循环,每次浸泡时间 2 min,共交替进行 60 次,冷热循环完成后,将样本吹干,流动树脂封闭根尖,干燥,于充填体周围 1 mm 外均匀涂布透明指甲油。干燥后,再涂布一层。待指甲油完全干燥后,两组各随机选取 8 个样本置于 2%亚甲基蓝溶液中避光浸泡 24 小时,取出实验牙,流动水冲洗,吹干。(4)观察微渗漏:将 16 个样本置于流动水冷却下使用金刚砂片将样本唇舌向剖开,三用气枪吹干表面,去除碎屑,置于体式显微镜下观察窝洞合壁和龈壁微渗漏深度并记录数据,每个标本测量三次,取均值。将两组各 2 个样本进行常规真空干燥、喷金,在扫描电镜下,观察剖面充填物与牙体组织粘结情况。

1.2.2 显微硬度测量 (1)模块制作、分组与处理:自制模具,规格如下:硅橡胶长方体中空状模具(7 mm× 4 mm× 2 mm),分别

采用两种充填材料,共制作材料模块 18 个,分为两组。A 组:Composan LCM 有机瓷纳米充填材料组,B 组:Filtek™ Z350XT 通用型纳米树脂组。两组分别使用同等标准模式固化实验样本 20 秒,固化时确保样本位于光源中心。样本取出后,分别用低温记号笔标记顶底部,放入干燥棕色避光玻璃瓶中,在 37℃ 恒温箱中放置 24 小时。(2)检测固化效率(显微硬度法):将样本从恒温箱取出后,用砂纸打磨,去除毛糙边缘,然后从样本顶部开始,用全自动显微硬度仪,设置间隔组距为 0.25 mm,即每隔 0.25 mm 测量一次显微硬度,每点载荷 1.96 N,停留 15 秒,每个样本测量 25 次,记录数据,最大硬度值的 80%所对应的固化深度即为树脂的固化深度。

1.3 统计学方法

采用 Graphpad Prim 7 绘制统计图;采用 SAS9.3 统计软件进行统计分析,定量资料统计描述采用,组间比较采用独立样本 t 检验,以 P<0.05 为差异有统计学意义。

2 结果

2.1 微渗漏体式显微镜下结果

如图 1 所示,Filtek™ Z350 组换算长度 (1.34 ± 0.33 mm) 明显高于 Composan LCM 组(1.06 ± 0.35 mm),差别有统计学意义($P=0.0113$)。

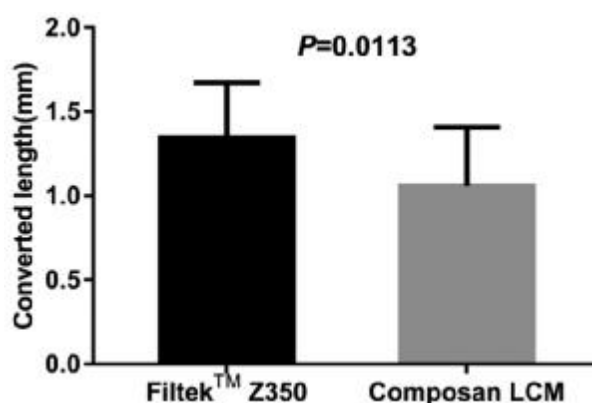


图 1 两组换算长度的比较

Fig.1 Comparison of the converted length between two groups

如图 2 所示,体式显微镜下观察发现,两组均有不同程度的染料渗入,且 Composan LCM 组的染料渗入深度明显较小。

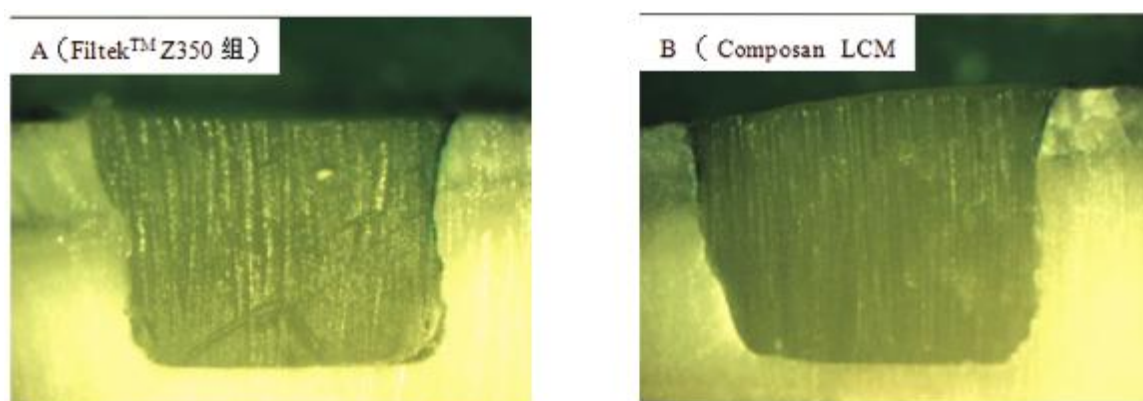


图 2 体式显微镜下微渗漏结果(× 40 倍)

Fig.2 Microleakage photographs under stereomicroscope of two groups (× 40)

A(Filtek™ Z350 group) B(Composan LCM group)

2.2 微渗漏扫描电镜观察结果

如图 3 所示,A 组充填材料与牙体组织间可见裂缝,界面参

差不齐,有不连续的小断裂。B 组界面连续均匀,未见明显裂缝。

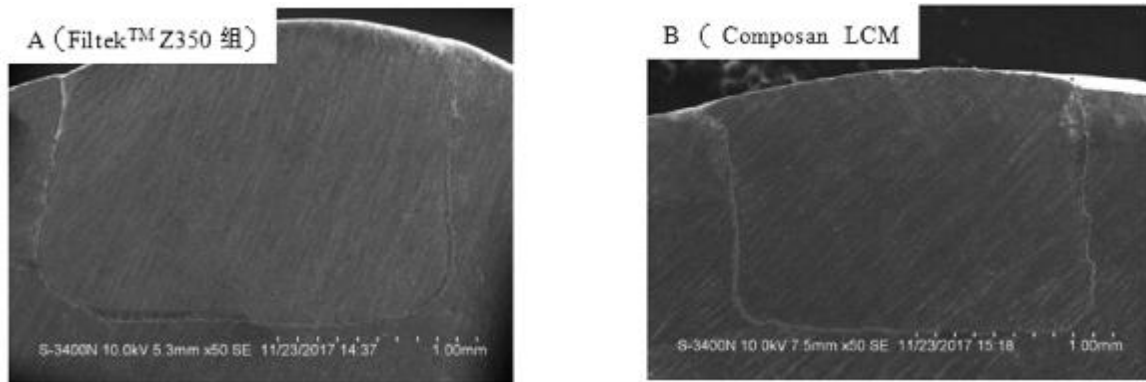


图 3 扫描电镜下微渗漏结果($\times 50$ 倍)

Fig.3 Photographs under SEM of two groups ($\times 50$)

A(Filtek™ Z350 group) B(Composan LCM group)

2.3 显微硬度测量结果

如表 1 所示, 两组固化深度比较差别无统计学意义($P=0.$

1078);Filtek™ Z350 组 80%数值及最大值均低于 Composan LCM 组,差别有统计学意义($P<0.05$)。

表 1 两组显微硬度测得值比较

Table 1 Comparison of the measuring result of microhardness between two groups

Index	Filtek™ Z350 group	Composan LCM group	P-value
Depth at 80% of max.VHN (mm)	2.53 $\pm$ 0.69	2.06 $\pm$ 0.29	0.1078
VHN at 80% of max.VHN(MPa)	50.53 $\pm$ 4.82	59.10 $\pm$ 4.53	0.0026
Max.VHN(MPa)	63.16 $\pm$ 6.02	72.64 $\pm$ 4.17	0.0026

3 讨论

充填材料的边缘封闭性一直都是评估牙体充填材料的重要指标,对于充填体的最大忧虑就是充填体与牙本质界面间的微渗漏。一种具有持久性的牙体充填材料必须保证充填体的完整及边缘密闭性。临床上,不良的充填体边缘封闭会导致充填体周围着色、牙齿敏感甚至继发龋的发生^[2]。评估边缘封闭性最常用最有效的方法是微渗漏实验^[3]。

引起微渗漏的原因之一是牙体硬组织与充填材料的热膨胀系数的不同。口腔环境中的热应力会导致充填材料和牙体组织周期性的膨胀和收缩。当二者的热膨胀系数不同时,其应力就会导致材料与牙体之间缝隙的形成^[4-6]。冷热循环是模仿口腔热应力环境的唯一方法。这个方法遵循以往的微渗漏实验研究方法^[7,8]。研究表明冷热循环进程将引起材料内部的应力,从而导致微渗漏加剧^[9-12]。本研究将离体牙样本用冷热循环来模仿口腔急剧变化的温度环境,来模仿充填体在口腔环境中的长期状态,结果显示纳米瓷充填材料组的微渗漏值明显较小,且在扫描电镜下观察可见纳米瓷材料与牙体组织界面没有发现微裂隙,提示纳米瓷充填材料与牙体组织间达到了很好的衔接。

玻璃离子被作为乳牙理想的充填材料,因其具有很多优势特性,如与牙体组织的直接粘结,良好的生物相容性,以及能够释放氟的抑龋性^[13-15]。玻璃离子的热膨胀系数与牙本质相近,因此玻璃离子充填时的较低收缩使它比复合树脂具有更少的边缘微渗漏^[16-18]。但也有研究表明传统的玻璃离子由于较差的物

理机械性能,长期充填效果并不理想,现已经不建议使用于乳牙^[19]。目前已经有了各种对玻璃离子材料的改进方法,使新型玻璃离子具有理想的临床操作性能和更高的强度^[20,21]。在化学结合过程中,参与结合的分子大小是很重要的因素,通过减小分子大小来提高材料之间的化学结合效果是可行有效的。为了克服玻璃离子的一些缺陷,研究加入一些成分以改进其性能。有研究表明加入生物陶瓷成分可提升玻璃离子的直径和弯曲强度、抗断裂性、粘结强度以及抗压强度等机械性能^[22,23],并可促进脱矿牙本质的再矿化以增强弯曲强度^[24,25]。近几年,研究者们通过将生物活性离子和纳米填料等加入玻璃离子中,改进这种充填材料的物理机械性能,这些成分同时也增强了玻璃离子的氟释放能力和生物活性^[26-28]。本实验中的纳米瓷充填材料即将瓷纳米填料加入玻璃离子中,并加入光固化聚合成分,促进了材料的聚合固化进程,提高了材料的机械性能。

固化效率是光固化充填材料一项非常重要的机械性能和指标,其与充填材料的抗磨损性、体积收缩性、单体渗出量、尺寸稳定性、生物相容性和颜色稳定性等紧密相关,充分的固化是充填材料获得良好机械性能的重要前提,材料只有充分固化,才能够抵御外界环境对它的老化降解。因此,本实验除比较两种充填材料的微渗漏程度外,运用显微硬度法比较不同充填材料的固化效率。结果显示两种充填材料的固化深度没有显著差异,可能是由于充填材料的机械性能主要与其中的无机填料的大小和比例有关,无机填料在材料中所占比例越大,则材料中相应的残留单体数量越少,单体转化率越高^[29]。本实验中,两

种充填材料的填料比例相似,均达到 75%左右,且均为纳米粒子填料,使两种充填材料都具备了较高的固化效率及稳定的机械性能^[30]。

本研究结果显示这两种材料均适合于乳牙龋齿的充填。对于保持健康的儿童口腔,不仅需要良好的口腔卫生习惯和饮食习惯,也需要更有效的儿童口腔治疗。口腔环境是一个动态的环境,目前我们的实验研究还局限于离体环境的研究,一些因素例如唾液以及儿童饮食习惯对充填材料的长期影响的研究尚不足,缺乏长时间的临床观察资料和相应的实验室研究。因此还需要进一步更大样本量的研究,并希望能在真正的口腔环境中去进一步证实这些研究结果。

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