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3D 打印聚醚醚酮在先天性缺牙患者修复中的应用价值 *

王诗维[1] 王金雨[2△] 李 蓉[3] 杨建军[1] 张松梓[1]

（1 西安医学院第一附属医院口腔科 陕西 西安 710077；2 陕西省安康市中医医院口腔科 陕西 安康 725000；
3 西安医学院第一附属医院眼科 陕西 西安 710077）

摘要 目的：探讨 3D 打印聚醚醚酮在先天性缺牙患者修复中的应用价值。**方法：**2013 年 5 月至 2019 年 10 月选择在本院诊治的先天性缺牙患者 72 例，根据随机数字表法把患者分为观察组与对照组各 36 例。对照组给予传统口腔修复治疗，观察组在对照组治疗的基础上给予 3D 打印聚醚醚酮修复治疗，记录与随访两组预后情况。**结果：**所有患者都顺利完成修复，治疗 3 个月观察组的总有效率为 100.0 %，显著高于对照组的 88.9 %(P<0.05)。两组治疗 3 个月的牙龈指数都低于治疗前，观察组也低于对照组(P<0.05)。治疗后 3 个月观察组的感染、刺激痛、出血、修复体脱落等并发症发生率为 5.6 %，显著低于对照组的 27.8 %(P<0.05)。治疗后 3 个月与 4 个月，观察组的美学评分都显著高于对照组(P<0.05)。**结论：**3D 打印聚醚醚酮在先天性缺牙患者修复中的应用能够促进牙周清洁，减少并发症的发生，从而提高临床疗效与美学效果。

关键词：3D 打印；聚醚醚酮；先天性缺牙

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Application Value of 3D Printed Polyetheretherketone in Patients with Congenital Tooth Loss*

WANG Shi-wei[1], WANG Jin-yu[2△], LI Rong[3], YANG Jian-jun[1], ZHANG Song-zi[1]

*(1 Department of Stomatology, the First Affiliated Hospital of Xi'an Medical College, Xi'an, Shaanxi, 710077, China;
2 Department of Stomatology, Ankang Traditional Chinese Medicine Hospital of Shaanxi Province Ankang, Shaanxi, 725000, China;
3 Department of Ophthalmology, the First Affiliated Hospital of Xi'an Medical College, Xi'an, Shaanxi, 710077, China)*

ABSTRACT Objective: To explore the application values of 3D printed polyetheretherketone in the repair of patients with congenital tooth loss. **Methods:** From May 2013 to October 2019, 72 cases of patients with congenital missing teeth were selected for diagnosis and treatment in our hospital were selected. The patients were divided into observation group and control group with 36 cases in each groups accorded to the random number table method. The control group were given traditional oral repair treatment, and the observation group were given 3D printed polyetheretherketone repair treatment on the basis of the treatment of the control group. **Results:** All patients were completed the repair smoothly. The total effective rates of the observation group after treatment for 3 months were 100.0 %, which were significantly higher than that of the control group (88.9 %)(P<0.05). The gingival index of the two groups after treatment for 3 months were lower than that before treatment, and the observation group were lower than that of the control group (P<0.05). The incidence of complications such as infection, irritation, bleeding, implant detachment in the observation group 3 months after treatment was 5.6%, significantly lower than that in the control group, 27.8%. At 3 and 4 months after treatment, the aesthetic score of the observation group was significantly higher than that of the control group (P<0.05). **Conclusion:** The application of 3D printed polyetheretherketone in the restoration of patients with congenital tooth loss can promote periodontal cleaning, reduce the occurrence of complications, and improve the treatment effect and aesthetic effect.

Key words: 3D printing; Polyetheretherketone; Congenital tooth loss

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前言

先天性缺牙主要是由于牙胚在形成过程中未能正常发育并形成，在临床上主要表现为牙列缺损、无牙等[1]。该病不仅影响患者的语言功能和咀嚼功能，也会使患者外貌受损，从而严重影响患者的生活质量[2,3]。口腔修复为先天性缺牙的主要治疗

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作者简介：王诗维(1986-)，女，硕士，主治医师，研究方向：口腔内科，电话：13488335541，E-mail：kqkwsw@126.com

△ 通讯作者：王金雨(1985-)，女，本科，主治医师，研究方向：口腔修复，口腔种植及口腔材料，
电话：18291573986，E-mail：18291573986@163.com

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方法，但是单纯口腔修复治疗很难取得比较好的效果[4]。3D 打印技术在叠加物理层的过程中不会间断，并且将相关材料逐层持续叠加，获得实体 3D 模型。随着医疗技术的提升，该技术在修复领域的应用逐渐增加，其有利于辅助规划手术方案，以及制备个性化修复体，也可缩短生产周期、节约生产成本外，还可以做到准确塑形[5-7]。在骨科领域，使用 3D 打印技术制造的三类骨科植入物已经得到了批准，已成功应用于临床实践，包括骨科手术中辅助器械的制造、骨科模型的构建、特殊骨科植入物的定制等。聚醚醚酮(polyetheretherketone，PEEK)是一种人工合成的高分子材料，具有化学性质稳定、摩擦性能优异、弹性模量高、组织相容性好等特点[8,9]。其能在 250℃高温下保持较高的耐磨性和较低的摩擦系数，可作为一种生物材料应用于临床口腔医学领域[10,11]。并且聚醚醚酮还具有磁共振扫描不产生伪影、放射线透过性高等优点，有利于辅助评价患者的术后恢复情况[12,13]。本文具体探讨了 3D 打印聚醚醚酮在先天性缺牙患者修复中的应用价值，希望为临床上提供一种新型的修复技术与方法。现总结报道如下。

1 资料与方法

1.1 研究对象

2013 年 5 月至 2019 年 10 月选择在本院诊治的先天性缺牙患者 72 例，纳入标准：符合先天性缺牙的诊断标准，病情经过影像学检查确诊；患者签署了知情同意书；患者年龄 16~50 岁，具有手术指征；本院伦理委员会批准了此次研究。排除标准：中途退出研究以及不愿意接受调查的患者；妊娠与哺乳期妇女；既往存在拔牙史者。

根据随机数字表法分为两组，各 36 例，两组的一般资料对比无差异(P>0.05)，见表 1。

表 1 两组一般资料对比

Table 1 Comparison of two sets of general information

Groups	n	Missing part (premolar / medium incisor / side incisor)	Gender(Male/ Female)	Age (years)	BMI (kg/m^2)
Observation group	36	13/13/10	19/17	26.29± 1.48	22.48± 1.00
Control group	36	12/13/11	18/18	26.78± 2.19	22.76± 1.18

1.2 治疗方法

对照组：给予传统口腔修复治疗，采用固定义齿进行修复。拍摄患者口腔与牙齿 CBCT 片等，选择缺失牙的侧牙做基牙，同铸造全冠和金瓷冠。用排龈线压缩牙龈，以硅橡胶印模材料取牙列印模，然后硬石膏灌模型。在模型的预备牙上涂分离剂，制蜡型安插铸道，桥体试合，粘固，清除多余的修复材料。

观察组：在对照组治疗的基础上给予 3D 打印聚醚醚酮修复治疗，具体措施如下：(1)3D 打印聚醚醚酮材料制备：术前行 CBCT 扫描并输出数据，在模型上标记边缘线，使用切削机制作内冠，使用聚醚醚酮(深圳迈普再生医学科技有限公司)进行 3D 打印修复体，消毒备用。(2)术前预防性使用抗生素，麻醉后充分暴露缺牙部位，3D 打印聚醚醚酮可摘局部义齿基牙的固定修复体，以原位嵌入的方式修补缺牙部位并进行固定，处理方法同对照组，保持良好连接状态，低负压引流。

1.3 观察指标

(1)在治疗后 3 个月进行疗效判定：① 前磨牙基本趋于或基本达到中性牙𬌗水平；② 牙齿排列整体并美观，牙𬌗功能良好；③ 前牙覆盖处状态良好；④ 咀嚼功能和语言功能改善至正常；⑤ 修复体具有完整性边缘；⑥ 牙龈健康，无并发病变。治愈：治疗效果符合以上 6 点；显效：治疗效果符合以上 5 点；有效：治疗效果符合以上 4 条；无效：治疗效果符合以上 3 点或不到 3 点[14]。(2)记录两组在治疗后 3 个月出现的感染、刺激痛、出血、修复体脱落等并发症情况。(3)在治疗前与治疗后 3 个月评定患者的牙周指标，牙龈指数(gingival index，GI)0 分 = 牙龈正常，1 分 = 轻度颜色改变及水肿，2 分 = 色红、水肿、探诊出血，3 分 = 红肿明显或有溃疡，有自发出血倾向[5]。(4)在治疗后 3 个月与 4 个月进行修复体美学评价，以近中龈乳头、牙龈颜色、牙龈质地、牙槽嵴缺损、远中龈乳头、龈缘形态、牙龈高度等 7 个项目进行检查评价，采用 "0、1、2" 分别进行评价，分数越高，美学效果越好[6]。

1.4 统计方法

应用 SPSS 19.00，计量数据以($\bar{x}\pm s$)表示，采用 t 检验；计数数据以[n(%)]表示，采用 x^2 分析，检验水准为α=0.05。

2 结果

2.1 疗效对比

所有患者都顺利完成修复，治疗 3 个月观察组的总有效率为 100.0 %，显著高于对照组的 88.9 %(P<0.05)，见表 2。

表 2 两组疗效对比(例，%)

Table 2 Comparison of efficacy between the two groups (n,%)

Groups	n	Excellence	Effective	Invalid	Total effective rate
Observation group	36	34	2	0	36 (100.0)*
Control group	36	26	6	4	32 (88.9)

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

2.2 牙龈指数变化对比

两组治疗 3 个月的牙龈指数都低于治疗前，观察组也低于对照组，对比均有有统计学意义(P<0.05)，见表 3。

表 3 两组牙龈指数变化对比(分)

Table 3 Comparison of gingival index changes between two groups (point)

Groups	n	Before treatment	3 months after treatment
Observation group	36	2.30± 0.15	0.81± 0.09*#
Control group	36	2.32± 0.18	1.33± 0.11*

Note: compare with the same group before treatment, *P<0.05, compared with the control group, #P<0.05.

2.3 并发症情况对比

治疗后 3 个月观察组的感染、刺激痛、出血、修复体脱落等并发症发生率为 5.6 %,显著低于对照组的 27.8 %(P<0.05),见表 4。

表 4 两组治疗后 3 个月的并发症发生情况对比(例,%)

Table 4 Comparison of the occurrence of complications 3 months after treatment between the two groups (n,%)

Groups	n	Infect	Stimulating pain	Haemorrhage	Repairs shedding	Total
Observation group	36	0	1	1	0	2 (5.6)*
Control group	36	2	3	3	2	10(27.8)

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

2.4 美学评分对比

治疗后 3 个月与 4 个月,观察组的美学评分都显著高于对照组,对比有统计学意义(P<0.05),见表 5。

表 5 两组治疗后不同时间点的美学评分对比(分)

Table 5 Comparison of aesthetic scores of two groups at different time points after treatment (points)

Groups	n	3 months after treatment	4 months after treatment
Observation group	36	10.22± 1.00*	12.03± 0.56*
Control group	36	7.34± 0.28	8.76± 0.33

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

3 讨论

先天性缺牙在临床上比较常见,发病部位主为下颌第二前磨牙、上颌侧切牙等[15]。该病的具体发生机制还不明确,多与遗传性因素有关,患者的牙齿功能显著落后于普通人,生活质量都受到严重影响[16]。特别是很多患者缺牙位置的牙槽骨会发生萎缩,邻近牙齿因可形成空隙倾斜甚或牙齿脱落的情况,因而对咀嚼功能、牙髓牙周健康、面容等都有影响,为此需要加强修复治疗。特别是口腔修复治疗能够帮助患者提高患者的口腔功能,更能弥补患者的心理不足[17,18]。不过传统的修复治疗容易受到基牙位置、间隙限制,使得整体修复效果一直不高[19,20]。

本研究显示所有患者都顺利完成修复,治疗 3 个月观察组的总有效率为 100.0 %,显著高于对照组的 88.9 %,与穆苍山[21]等学者的研究类似,该学着将 3D 打印聚醚醚酮修补材料应用于颅骨缺损修补手术中,发现 27 例患者颅骨缺损均修补满意,所有患者行修补术后颅骨外观均得到恢复,对美观度满意,材料安全可靠,疗效确切,表明 3D 打印聚醚醚酮的应用能提高患者的治疗效果。聚醚醚酮具有优良的生物相容性、生物活性和力学性能[22]。相比于传统金属植入物,聚醚醚酮植入物引入具有生物活性的材料,可在植入后可有效减小 " 应力屏蔽效应 "[23]。特别是借助 3D 打印技术精准定制出与患者缺牙部位高度匹配的植入物,因而能提高患者的舒适性。特别是 3D 打印技术因其独特的优势,使得 3D 打印聚醚醚酮具有准确性高、耐用性好、质量轻等优点,也可精准匹配患者的牙齿缺损,从而持续改善患者的预后[24,25]。

胚胎发育学认为先天性缺乏是由于患者的牙齿外胚叶出现了先天性发育障碍,从而影响整体牙齿的发育,多伴随有牙齿畸形[26,27]。聚醚醚酮在剪切速率和粘度之间具有非常强的反向关系,并且也具有软组织工程应用的生物相容性。而 3D 打印技术通过紫外交联的办法,改变了聚醚醚酮的流动性,使其更容易进行 3D 打印建模。本研究显示两组治疗 3 个月的牙龈指数都低于治疗前,观察组也低于对照组。分析其原因为聚醚醚酮具有良好的生物相容性,也能够诱导骨细胞生长,能够让牙周、骨骼产生对应的协调性,并对牙间隙进行调节,可改善牙列整齐度,为口腔种植提供良好的口腔环境[28]。3D 打印聚醚醚酮能够使得使牙齿内外压力保持平衡,有利于邻近牙髓组织恢复活力,从而促进恢复牙周功能[29]。目前国内外还没有类似的研究,但是与杨志强[30]的研究有不同之处,他发现 0.5 mm 厚度的钛合金支架网和 0.6 mm 厚度的钛合金、镁合金、聚醚醚酮支架网的最大等效应力在安全范围内,可满足临床需要。但镁合金支架网的弹性模量与自体骨最为相近, 能引导良好骨愈合,其生物降解性可避免二次手术取出,是口腔引导骨再生较为理想的支架网材料。后续研究需要对比这些材料在 3D 打印造模应用于先天性缺牙优缺点,选择更加适宜的生物材料。

先天性缺牙多与遗传性因素和机体进化因素有关,所以针对该病的治疗需要充分考虑患者的身心特点。临床中 3D 打印

技术发挥了重要的作用,常用于骨科,可辅助进行模型制造、定制骨科植入等,该技术也可融入了术前诊断分析、手术计划和设计等,从而解决骨科中的许多难题。与传统方法比较,3D 打印技术在骨科的应用有操作性强、立体效果强、个性化强的优点。本研究显示治疗后 3 个月观察组的感染、刺激痛、出血、修复体脱落并发症发生率为 5.6 %,显著低于对照组的 27.8 %。治疗后 3 个月与 4 个月, 观察组的美学评分都显著高于对照组。与林柳兰[31]等学者研究类似,发现 3D 打印技术制备个性化聚醚醚酮植入物或假体的应用有良好的治疗效果,提高了治疗后患者的满意度,并发症少,从机制上分析,聚醚醚酮具有良好的机械性能、高温稳定性、优异的耐化学性,其在临床中可以减小应力屏蔽效应及增加边缘骨丢失的风险[32,33]。3D 打印也提高了植入体制作的精度和效率,真正实现个性化的缺牙修补[34]。其也能促进恢复患者的容貌,减轻患者的心理压力,从而减少术后并发症的发生[35,36]。不过本研究也有一定的不足,样本数量过少,且反应预后的指标比较少,为此研究结论可能存在偏倚,将在后续研究中深入分析。

综上所述,3D 打印聚醚醚酮在先天性缺牙患者修复中的应用能够促进牙周清洁,减少并发症的发生,从而提高临床治疗效果与美学效应。

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