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3D 打印技术辅助前侧微创入路手术治疗不稳定型骨盆骨折的临床疗效分析 *

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摘要 目的：探讨 3D 打印技术辅助前侧微创入路手术治疗不稳定型骨盆骨折的临床疗效及安全性。**方法：**选择 2014 年 8 月到 2017 年 2 月在我院诊治的骨盆骨折患者 78 例作为研究对象，按照随机信封抽签原则分为观察组与对照组，每组各 39 例。对照组采用常规 X 线与 CT 进行手术设计，观察组采用 3D 打印技术进行手术设计，两组都给予前侧微创入路手术治疗，比较两组的手术时间、切口长度、骨折愈合时间、术中出血量、术中和术后并发症的发生情况及术后 3 个月的骨盆功能优良率。**结果：**所有患者都完成手术，无术中严重并发症发生，两组手术时间及切口长度对比差异无统计学意义(P>0.05)。对照组的骨折愈合时间、术中出血量显著高于观察组(P<0.05)。观察组术后并发症的发生率(5.1 %)显著低于对照组(25.6 %)(P<0.05)，术后 3 个月的骨盆功能优良率(97.4 %)显著高于对照组(74.4 %)(P<0.05)。**结论：**与常规 X 线与 CT 前侧微创入路手术治疗比较，3D 打印技术辅助前侧微创入路手术治疗不稳定型骨盆骨折可为患者提供安全、有效、个性化的治疗，减少术后并发症的发生，改善患者的骨盆功能。

关键词：3D 打印；前侧微创入路手术；不稳定型骨盆骨折；临床疗效

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Clinical Analysis of 3D Printing Technique Assisted Anterior Minimally Invasive Approach in the Treatment of Unstable Pelvic Fracture*

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ABSTRACT Objective: To investigate the clinical efficacy and security of 3D printing technique assisted anterior minimally invasive approach for unstable pelvic fractures. **Methods:** From August 2014 to February 2017, 78 cases of pelvic fracturespatients pelvic fractures were selected as the research object. All the patients were divided into the observation group and the control group with 39 cases in each group according to the order of admission and the principle of random draw envelope. The control group was given conventional X-ray and CT operation design, the observation group was given the 3D printing technologyoperation design, both groups were given anterior minimally invasive approach surgical treatment. The operation time, incision length, fracture healing time, intraoperative blood loss, intraoperative and postoperative complications and pelvic function rate at 3 months after operation were compared between the two groups. **Results:** All patients completed surgery and there was no serious complications occurred in both groups, the incision length, operation time showed no significant difference between the two groups (P>0.05), the intraoperative blood loss and fracture healing time of observation group were significantly less or shorter than the those of the control group (P<0.05). The incidence of complications such as nail tunnel infection, sacral nerve injury, deep vein thrombosis and wound infection in the observation group at 3 months after operation was 5.1%, which was 25.6% in the control group and was significantly higher than that of the observation group (P<0.05). The excellent and good rates in the observation group and the control group at 3 months after operation were 97.4% and 74.4%, respectively, which was significantly higher in the observation group than that in the control group (P<0.05). **Conclusions:** Compared with the conventional X-ray and CT operation design, the 3D printing technique assisted anterior minimally invasive approach in the treatment of unstable pelvic fracture can provide a safe, effective and personalized for patients, it reduce the incidence of postoperative complications and improve the pelvic function of patients.

Key words: 3D printing; Anterolateral minimally invasive surgery; Unstable pelvic fractures; Clinical efficacy

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前言

骨盆连接脊柱与多数负重运动结构，不仅具有重要的承重作用，还承受着外力，主要有外旋力和内旋力[1,2]。骨盆骨折是一种急危重的损伤，约占全身骨折的 3 %，治疗不当容易导致患者腰骶部疼痛、下肢不等长、骨盆畸形愈合等并发症，严重时甚至会造成患者死亡 [3-5]。不稳定型盆骨骨折多由高能量损伤引起，常伴有严重合并症，且会导致盆骨位移变形，给临床带来治疗带来一定困难。

骨盆骨折治疗的原则是尽早在术中进行精确复位和稳定内固定，因此在没有明显手术禁忌症的情况下进行前侧微创入路手术治疗意义重大[6,7]。由于骨盆结构比较复杂，手术往往易受周围结构组织，手术不可预测风险较高，因而对于手术的精确性要求比较高 [8]。传统影像学方法多采用 X 线进行手术设计，但是存在术中操作风险大、无法进行模拟操作等缺点[9,10]。3D 打印技术是一种现代技术，可以在术前更精确的了解骨折的位置及移位情况，从而更好的制定手术计划[11-13]，但在骨盆骨折应用的比较少见。本研究主要探讨了 3D 打印技术辅助前侧微创入路手术治疗不稳定型骨盆骨折的临床疗效，现报道如下。

1 资料与方法

1.1 研究对象

选择 2014 年 8 月至 2017 年 2 月在我院诊治的骨盆骨折患者 78 例，纳入标准：年龄大于 18 岁(含 18 岁)；患者已签知情同意书；术前影像学判断为不稳定型骨盆骨折，术中得到确诊；术前血液动力学趋于稳定，生命体征平稳，神志清晰；入院至手术时间≤3 周；医院伦理委员会已审核批准。排除标准：合并重大器官疾病者；精神疾病患者；妊娠与哺乳期妇女；术前失血性休克、合并内脏严重损伤患者。根据随机信封抽签原则将所有患者分成观察组、对照组，每组各 39 例，两组患者一般资料对比差异无统计学意义(P>0.05)，见表 1。所有患者均由一组医师进行诊治，医师均由较丰富的骨盆骨折手术处理经验。

表 1 两组患者的一般资料对比

Table 1 Comparison of the general data between two groups

Groups	Amount(n)	Gender (male/female)	Age (year)	BMI (kg/m^2)	Fracture classification (class A/class B /class C)	Admission to operation time (d)	Causes of fracture (car accident injury / fall injury / pressure injury)
Observation group	39	23/16	51.44± 4.24	22.84± 2.14	21/10/8	5.67± 2.34	18/10/11
Control group	39	26/13	51.33± 3.92	22.19± 1.84	23/10/5	5.51± 1.98	19/9/11
t or x^2		0.434	0.113	0.298	0.263	0.189	0.211
P		>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

1.2 手术方法

对照组：采用常规 X 线与 CT 进行手术设计，摄骨盆入口 X 线片、骨盆出口位 X 线片，CT 扫描螺距 1.5，层厚 5.0 mm，层距 1 mm，将扫描数据传送至工作站进行图像处理，选择对手术有参考意义的层面进行摄取图像，全面评估骨折情况及周围解剖结构关系，设计手术策略。

观察组：采用 3D 打印技术进行手术设计，利用三维 CT 重建图像进行 3D 重建，利用激光快速自动成型机快速制作 1:1 等大的骨盆骨折模型，在制作过程中控制激光束逐点、逐线、逐面烧结固化后再叠加，模拟骨盆骨折块手术复位方式、旋转角度、移动距离等。

两组都给予前侧微创入路手术治疗，患者俯卧位，全麻，消毒、铺巾，从两侧髂后上嵴向下沿髂嵴做 5-7 cm 弧形切口 2 个，暴露骶髂关节，对骨折部位进行复位。将已预弯成型的重建钢板穿越位于骶骨后的皮下隧道，安装钢板，以远端指向耻骨联合的方向进行，固定 3 枚左右螺钉。复位与固定满意后冲洗切口，缝合切口并进行无菌包扎。

患者行常规心电监护，手术 1 d 后开始进行关节主被动功能锻炼、下肢肌肉收缩锻炼，抗生素应用 2-3 d，低分子肝素应用 7-14 d。

1.3 观察指标

(1)围手术指标：记录两组的手术时间、手术切口长度、术中出血量、骨折愈合时间等。(2)记录两组术后 3 个月的钉道感染、骶神经损伤、深静脉血栓形成、切口感染等并发症情况。(3)骨盆功能优良率：在术后 3 个月采用 Matta 标准判断优良率，优：步态正常，髋关节活动正常，解剖复位，无疼痛，肢体等长；良：步态正常，髋关节活动正常，复位良好，轻度疼痛；可：髋关节活动轻度受限，复位基本满意，轻、中度疼痛；差：行走困难，髋关节活动受限，复位不满意，疼痛明显。(优 + 良)/ 本组例数× 100.0%= 优良率。

1.4 统计学分析

用 SPSS 20.0 软件进行数据分析，计量资料以($\bar{x}$± s)表示，组间比较采用 t 检验；计数数据以%表示，组间比较采用 x^2 分析，以 P<0.05 表示差异具有统计学意义。

2 结果

2.1 两组围手术指标的对比

所有患者都完成手术，无术中严重并发症发生，两组切口长度、手术时间对比无明显差异(P>0.05)，观察组的术中出血量与骨折愈合时间明显少于对照组(P<0.05)，见表 2。

2.2 两组术后并发症发生情况的对比

观察组术后 3 个月的钉道感染、骶神经损伤、深静脉血栓

形成、切口感染等并发症发生率为 5.1%，对照组为 25.6%，观察组明显低于对照组(P<0.05)，见表 3。

表 2 两组围手术指标的对比($\bar{x}\pm$ s)

Table 2 Comparison of the perioperative indicators between two groups($\bar{x}\pm$ s)

Groups	Amount (n)	Operation time (min)	Intraoperative blood loss (mL)	Cut length (cm)	Fracture healing time (week)
Observation group	39	71.29± 19.53	16.87± 11.44	2.09± 0.91	12.77± 3.11
Control group	39	72.29± 14.22	34.23± 15.3	2.18± 0.35	18.22± 2.45
P		>0.05	<0.05	>0.05	<0.05

表 3 两组术后并发症发生情况的对比(n)

Table 3 Comparison of the incidence of postoperative complications between the two groups(n)

Groups	Amount	Nail infection	Sacral nerve injury	Deep vein thrombosis	Incision infection	Total
Observation group	39	0	0	1	1	2(5.1%)
Control group	39	2	3	3	3	10(25.6%)
P						<0.05

2.3 两组术后 3 个月骨盆功能优良率的对比

观察组与对照组术后 3 个月的骨盆功能优良率分别为 97.4%和 74.4%，观察组的骨盆功能优良率明显高于对照组(P<0.05)，见表 4。

表 4 两组术后 3 个月的骨盆功能优良率对比(n)

Table 4 Comparison of the excellent and good rate of pelvic function at 3 months after treatment between two groups(n)

Groups	Amount (n)	Excellent (n)	Good (n)	Moderate (n)	Poor (n)	Excellent and good rate(%)
Observation group	39	30	8	1	0	97.4%
Control group	39	19	10	6	4	74.4%
P						<0.05

3 讨论

骨盆是人体承重的主要组织器官，骨盆结构坚固且内含有脏器、血管与神经等重要组织，可以起到避免盆腔内脏器受到损害的作用[14-16]。虽然骨盆骨折在临床上发生的几率低于四肢与脊柱骨折，但是病情一般比较危重，死亡率仅次于颅脑伤和胸部损伤[17]。特别是复杂性盆腔骨折常合并粉碎性骨折、多处骨折、邻近软组织及盆腔脏器损伤，骨盆骨折处理难度大，对手术治疗的要求也比较高[18]。

3D 打印技术运用可粘合材料，在数字模型数据的基础上进行逐层打印以获得多维物体模型[19]。在骨科中，3D 打印技术可制作出精度高达 0.1 mm 的 1:1 等比例模型，可直观显示骨折端与周围组织关系[20]，可进行模拟手术，帮助拟定安全、可靠的的手术操作路径。3D 打印技术相对常规影像学图像，直观性更强，从而控制继发性损伤[21]。相关研究表明 3D 打印技术有助于增强医师操作技术水平，规避误伤重大血管、组织，减少术中探查操作，维持术中骨盆力学稳定，减少出血；也可尽可能保护组织器官功能，恢复正常的解剖结构、力学稳定，促进骨折愈合[22,23]。本研究结果显示所有患者都完成手术，无术中严重并发症发生，两组手术时间、切口长度比较无显著差异，而观察组的术中出血量与骨折愈合时间明显少于对照组，也提示 3D 打印技术辅助前侧微创入路手术治疗的创伤更小，有利于患者恢复。

骨盆骨折致死致残率高，一直是临床处理中的重点难点问题。在临床实践中，前侧微创入路手术的作用是给予维持骨折复位和恢复骨盆解剖形态状况，但传统骨盆骨折的手术复位内固定手术是一种技术要求高、创伤大的治疗手段[24,25]。采用 3D 模型打印技术有助于争取足够的治疗时间，可有效降低继发损伤风险，特别是其在模型上模拟骨折复位、预弯钢板、选择合适长度的钢板等，从而使骨盆骨折获得最佳的复位，减少手术对患者的创伤[26,27]。本研究结果显示观察组术后并发症的发生率(5.1%)显著低于对照组(25.6%)，提示应用 3D 打印技术辅助前侧微创入路手术治疗的安全性更高。

骨盆的解剖形态特点及骨折复位质量决定着内固定的效果，前侧微创入路手术可支持骨折复位、恢复骨盆正常形态[28]，能够减小手术切口，更加充分的显露四边体区域，更加充分有效的复位及固定[29]。常规影像学检查虽然可以提供后环结构损伤的详细信息，但不能对骨折碎片进行准确的三维定位[30,31]。本研究结果显示对照组术后 3 个月的骨盆功能优良率(74.4%)显著低于观察组(97.4%)，表明 3D 打印技术的应用能有效改善患者的骨盆功能。

总之，3D 打印技术辅助前侧微创入路手术治疗不稳定型骨盆骨折可为患者提供安全、有效、个性化的治疗，减少术后并

发症的发生,改善患者的骨盆功能。

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