·技术创新·

镜下避开髌板固定儿童胫骨髁间棘骨折△

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摘要：［**目的**］介绍镜下避开髌板固定儿童胫骨髁间棘骨折的手术方法和初步临床结果。［**方法**］取膝关节前内、前外入路，置入关节镜及刨刀清理阻挡滑膜、骨折端内血凝块，予缝合钩横穿前交叉韧带下止点处，引入 PDS 线，利用 PDS 线引入高强线，将高强线引出前内侧切口，牵引高强线复位骨折端，并于胫骨近端前内侧骨骺处寻找安装外排钉最佳位置，予 2.0 mm 克氏针钻孔，C 形臂 X 线机透视确认位置，于克氏针入针点处作 0.3 cm 切口，拔除定位克氏针，于该切口处将高强线引出并将尾线穿入外排钉，将其打入钻好的髌内隧道，再次镜下检查骨折复位情况及前交叉韧带松紧度。［**结果**］所有患者均顺利完成手术，手术时间平均（59.4±1.7）min，术中出血量平均（44.2±2.0）ml，术后 X 线片示骨折对位对线满意。随访时间平均（23.4±10.7）个月。与术前相比，末次随访时，Lysholm 评分 [(34.6±7.9), (94.4±3.5), P<0.001]、IKDC 评分 [(32.3±8.7), (93.2±4.5), P<0.001] 显著增加。［**结论**］镜下外排钉规避髌板固定治疗儿童新鲜胫骨髁间棘骨折是一种微创、安全、有效的术式；外排钉内固定可靠，规避髌板固定可避免损伤髌板，可以早期行功能锻炼。

关键词：关节镜，胫骨髁间棘骨折，儿童，内固定，髌板

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Arthroscopic fixation of tibial intercondylar spine fractures without involving the epiphyseal plate in children // *LIN Lian-yang[1,2], FENG Chao[2], DANG Cui-jiao[2], CHEN Yan[2], DENG Jin[3]. 1. School of Clinical Medicine, Guizhou Medical University, Guiyang, Guizhou 550004, China; 2. Guizhou Hospital of Beijing Jishuitan Hospital, Guiyang, Guizhou 550014, China; 3. Affiliated Hospital, Guizhou Medical University, Guiyang, Guizhou 550004, China*

Abstract: [**Objective**] To introduce the surgical method and preliminary clinical results of arthroscopic fixation of tibial intercondylar spine fractures without involving the epiphyseal plate in children. [**Methods**] As the anteromedial (AM) and anterolateral (AL) portals were made, the arthroscope and instruments were placed to debride the blocking synovium and the blood clot in the fracture fragments. Suture hooks were passed across the lower insertion of the anterior cruciate ligament, with a PDS suture introduced, followed by a high-strength suture introduced, and then the high-strength suture was led out of AM. The fracture fragments were reduced by traction. As optimal location for outer row anchors was determined at the anteromedial epiphysis of the proximal tibia, a 2.0 mm Kirschner wire was drilled, with the position confirmed by fluoroscopy. A 0.3 cm incision was made at the entry point of the Kirschner wire, and then the positioning Kirschner wire was removed. The high-strength suture was transferred out the incision, and fixed in proper fracture reduction with a outer row anchor without involving the epiphyseal plate. The reduction of the fracture and the tightness of the anterior cruciate ligament were examined again. [**Results**] All patients successfully completed the operation, with the average operation time of (59.4±1.7) min, the average intraoperative blood loss of (44.2±2.0) ml. The postoperative X-ray showed that the fracture reduction was satisfactory in all the patients. Compared with those preoperatively, Lysholm scores [(34.6±7.9), (94.4±3.5), P<0.001], IKDC scores [(32.3±8.7), (93.2±4.5), P<0.001] increased significantly at the latest follow-up lasted for a mean of (23.4±10.7) months. [**Conclusion**] This technique is a minimally invasive, safe and effective for fresh tibial intercondylar spine fractures in children. The outer row anchor fixation is reliable to avoid injury of epiphyseal plate, permits early functional exercise.

Key words: arthroscopy, tibial intercondylar spine fracture, children, internal fixation, epiphyseal plate

胫骨髁间棘撕脱性骨折（tibial spine avulsion fractures, TSAFs）在儿童和青少年中并不常见，好发

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年龄为 8~14 岁，年发病率约为 3/100 000 [1]，占所有儿童膝关节损伤的 2%~5% [2]。因为该年龄段骨骼尚未发育成熟，前交叉韧带（anterior cruciate ligament, ACL）胫骨侧止点部位尚未完全骨化，因此软骨成分居多的胫骨髁间棘强度比韧带实质部分小，当 ACL 受到异常应力时更容易发生 TSAFs 而不是韧带损伤 [3~5]。最常见的受伤机制是膝关节的轴移旋转，类似于成人 ACL 损伤的机制；此外，损伤也可能是作用于膝关节的直接创伤或是膝关节过伸的结果 [4, 5]。目前报道的治疗方法较多，常见方法包括关节镜下应用缝线、钢丝、金属螺钉、可吸收螺钉等多种材料进行固定修复，每种材料各有其优势，也有亟待改进之处 [6]；儿童需尽量规避制作胫骨隧道，避免损伤骺板；儿童胫骨髁间棘骨折一般采用 Meyers-McKeever 和 Zaricznyj 分型标准指导治疗方案制定 [7]。统计北京积水潭医院及北京积水潭医院贵州医院于 2019 年 4 月—2023 年 5 月共收治 20 例新鲜胫骨髁间棘撕脱性骨折患儿，术中在全关节镜下给予清理骨折端周围血凝块及嵌入的软组织，给予高强线穿过前交叉韧带胫骨侧止点复位骨折端，采用 1 枚直径 2.9 mm 外排钉将高强线固定于胫骨近端骺内，避免制作胫骨隧道，从而避免损伤骺板，现将手术技术和初步临床结果报告如下。

1 手术技术

1.1 术前准备

术前完善膝关节 X 线片、CT+三维重建、MRI；准备关节镜相关器械、外排钉（直径 2.9 mm，长度 15.5 mm）。

1.2 麻醉与体位

所有患者均采用气管插管全麻，患者取平卧位。

1.3 手术操作

麻醉生效后，常规消毒、铺巾，患侧大腿根部绑止血带并充气，患肢屈膝 90°，触及髌骨下极顺其向下确认髌韧带外侧缘，同时确认膝关节外侧间隙。在关节内外侧间隙近端约 1 cm，髌骨外侧缘位置（髌韧带外缘），此处按压时可以感觉阻力最小，习惯上称“软点”，予尖刀刀刃朝上平行髌韧带朝向股骨髁间窝方向作 0.5 cm 切口，切开关节囊，置入直嵌钝性扩大切口，前外侧置入关节镜鞘套至关节内处及股骨内侧髁内侧缘，随后沿股骨内侧，将鞘套内芯上下分离后拔出（可良好分离滑膜），置入关节镜，冲洗关节腔淤血，关节镜监视予穿刺针定位前内侧入路（入路应位于髌韧带的内侧及内侧半月板前角近端），拔出穿刺针，在此处予尖刀刀刃朝上平行髌韧带朝向股骨髁间窝方向作 0.5 cm 切口，切开关节囊，置入刨刀，清理阻挡滑膜、关节腔内血凝块，进行关节腔内常规检查，注意内外侧半月板是否损伤、关节内是否有股骨髁软骨损伤、前交叉韧带上止点是否损伤，以及膝横韧带是否嵌入骨折端。若有膝横韧带嵌入骨折端给予临时穿 1 根 PDS 线牵引膝横韧带，解除韧带嵌入；予刨刀刨除所有关节内骨软骨碎片，骨折部位需清理所有的纤维或软组织嵌入，予缝合钩横穿前交叉韧带下止点处，引入 PDS 线，利用 PDS 线引入高强线，将高强线引出前内侧切口，刨刀清理胫骨近端内侧骨骺处软组织，在屈膝 45°位，助手做后抽屉动作（便于术者镜下复位骨折端），术者牵引高强线小心复位胫骨髁间棘骨折端，并于胫骨近端前内侧骨骺处寻找安装外排钉最佳位置，予 1 枚 2.0 mm 克氏针经皮垂直骨骺与骺板成 30°~45°角置入骺内（充分利用骺内空间），C 形臂 X 线机透视确认克氏针位置、方向满意，给予等离子标记后，于克氏针入针点处作 0.3 cm 切口，拔除定位克氏针，于该切口处将高强线引出并将尾线穿入外排钉（直径 2.9 mm，长度 15.5 mm），将外排钉打入钻好的骺内隧道，镜下检查骨折复位满意，探钩探查前交叉韧带松紧适宜，剪断多余高强线，退出关节镜，缝合伤口、敷料包扎，给予膝关节伸直位支具固定。

1.3 术后处理

术后伸膝位固定，佩戴支具固定 4 周。术后第 1 d 嘱患者主动进行直腿抬高练习，锻炼股四头肌及踝泵功能，肿胀消退后行推髌活动，术后 4 周开始免负重情况下患膝主动伸屈活动，术后 6~8 周患膝活动基本恢复正常。术后 8 周开始部分负重，12 周完全负重。

2 临床资料

2.1 一般资料

2019 年 4 月—2023 年 5 月共收治 20 例新鲜胫骨髁间棘撕脱性骨折患儿，男 12 例，女 8 例；年龄 7~13 岁，平均（9.3±1.5）岁，受伤至就诊时间为 1~14 d，平均（6.2±1.1）d；按 Meyers-McKeever 和 Zaricznyj 骨折分型标准，II 型 6 例，III 型 13 例，IV 型 1 例。单纯软骨损伤 4 例，软骨及软骨下骨损伤 16 例。

2.2 初步结果

所有患者均顺利完成手术，手术时间平均

（59.4±1.7）min；术中出血量平均（44.2±2.0）ml，住院时间平均（7.3±0.3）d。术后第 2 d X 线片检查提示骨折对位对线满意。患儿均获得随访，随访时间 6~36 个月，平均（23.4±10.7）个月。Lysholm 评分由术前的（34.6±7.9）分显著增加至末次随访的（94.4±3.5）分（P<0.001）；IKDC 评分由术前的（32.3±8.7）分显著增加至末次随访的（93.2±4.5）分（P<0.001）。术后 6~8 周患侧膝关节活动度与对侧无差异。术后 3~6 个月骨折均愈合。末次随访前抽屉试验及 Lachman 试验均呈阴性，双下肢长度无差异，未见膝关节内外翻畸形。

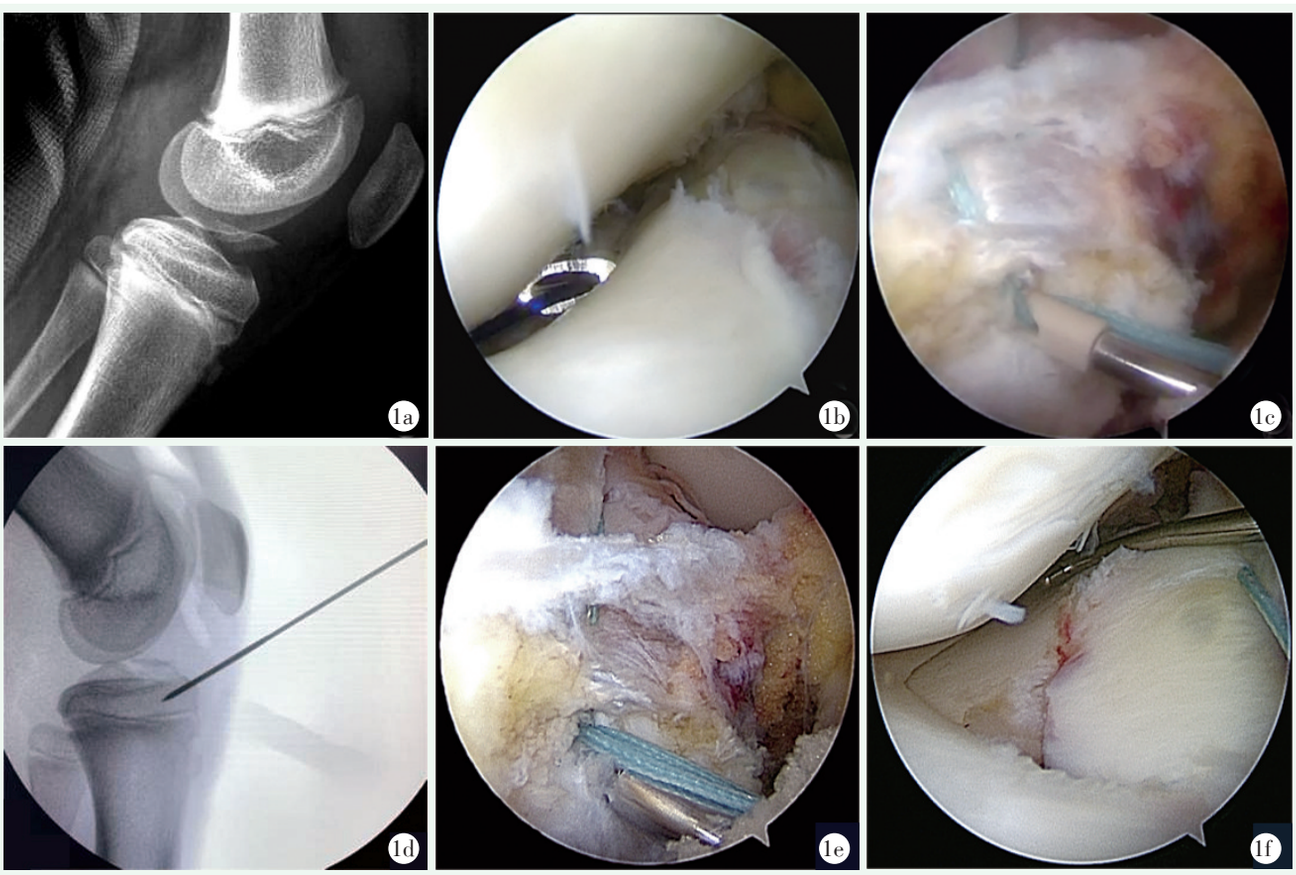

图 1. 患者女性，8 岁。1a: 术前 X 线片示胫骨髁间棘撕脱性骨折；1b: 缝合钩横穿前交叉韧带止点处，引入 PDS 线；1c: 引入高强线牵引复位骨折端后寻找安装外排钉最佳位置；1d: 予 1 枚 2.0 mm 克氏针与髌板成 30°~45°角钻孔；1e: 复位骨折端将外排钉固定于髌内；1f: 检查胫骨髁间棘骨折复位满意，术毕。

Figure 1. A 8-year-old girl. 1a: Preoperative X ray revealed avulsion fracture of tibial intercondylar spine; 1b: The suture hook was passed crosses the anterior cruciate ligament lower insertion to introduces the PDS suture; 1c: After introducing a high-strength suture, reduction of the fracture fragment was conducted by traction of the wire, then find the best location for outer row anchor; 1d: A 2.0 mm Kirschner wire was drilled into the epiphyseal plate at a 30°~45° angle, without involving the epiphyseal plate; 1e: Reducing the fractures by the outer row anchor; 1f: Arthroscopic view of satisfactory reduction of tibial intercondylar spine fractures.

3 讨 论

由于儿童胫骨近端骨骺未闭合，内固定方式选择受到很大限制，选择原则主要包括 3 点：（1）内固定能牢靠固定骨折端、促进骨折愈合：Gans 等[8]系统回顾 26 篇文章 580 例患者，其中 10 例不愈合，均为行保守治疗者，开放和关节镜下固定技术以及螺钉或缝合线固定治疗的患者均愈合。本研究采用张力带原理固定骨折端，将前交叉韧带产生的张力转化为骨折面的压力，能牢靠固定，允许膝关节早期功能锻炼，患者均骨性愈合，术后膝关节活动与健侧一致；（2）避免损伤髌板：国内有许多报道用缝线联合外排铆钉固定治疗胫骨髁间棘骨折，但均在胫骨穿髌板钻孔打骨隧道，将缝线引至髌板以远固定[9~12]。Vargas 等[13]认为穿髌板固定胫骨髁间棘骨折，钻孔或缝线穿过髌板可能对髌板造成损伤，从而导致骨髌早闭；另一种是螺钉固定，但直径 3.0 mm 螺钉无法起到加

压固定、直径更大螺钉会损伤骺板，导致骨骺早闭；对粉碎性骨折或小骨折块骨折患者，螺钉难以固定牢固；同时螺钉为金属物需二次手术取出[14]。本研究选择缝线穿过前交叉韧带与软骨块交点牵引复位骨折端，随后选择直径 2.9 mm、长度 15.5 mm 外排钉将骨块固定于胫骨近端骨骺内，操作简单，不损伤骺板；（3）避免二次手术：选用传统克氏针或螺钉固定需二次取出内固定，并且期间无法行 MRI 检查，而外排钉为可吸收材料，无需二次去除内固定，且不影响后期复查 MRI。

2017 年北美小儿骨科学会（Pediatric Orthopaedic Society of North America, POSNA）专家的调查结果显示，最常见的术后并发症是膝关节纤维化，造成关节纤维化的最重要影响因素是术后制动时间过长[4, 15]。Patel 等[16] 系统回顾分析了 40 例（40 膝）TSAFs 患儿，结果表明，术后制动超过 4 周会使关节纤维化的风险增加 12 倍。本组患儿术后即刻给予长腿支具辅助固定，麻醉消失后，鼓励患儿进行股四头肌及踝泵功能训练，术后 4 周拆除支具，主动循序渐进行无负重膝关节屈伸功能锻炼，未发生膝关节活动受限情况。本研究局限性：（1）样本量少，结果可能存在偏差；（2）Tomasevich 等[17] 发现胫骨髁间棘骨折术后出现患肢过度生长，导致双下肢不等长，本研究因缺乏中长期随访，后期是否出现双下肢不等长、膝关节畸形等并发症无法确定，后期将重点关注这些指数的收集；（3）缺乏量化韧带松弛的指标，无法准确评估韧带是否松弛及松弛程度。

总之，关节镜下外排钉规避骺板固定方式治疗儿童青少年新鲜胫骨髁间棘骨折是一种微创、安全、有效的术式；外排钉内固定可靠，规避骺板固定可避免损伤骺板，可以早期进行功能锻炼。

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