

## · 综述 ·

## Felix IV-A 假体周围骨折：1 例报告和综述

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**摘要:** 全膝关节置换术后 (total knee arthroplasty, TKA) 假体周围骨折已成为一个日益常见和具有挑战性的骨科问题。临床中 TKA 术后胫骨假体周围骨折较股骨远端以及髌骨骨折少见, 胫骨结节骨折合并髌腱损伤则更为罕见, 在文献中很少被描述, 其诊断与治疗充满挑战性。本文介绍了 1 例 74 岁女性患者, 右膝骨关节炎行 TKA 术后 4 年, 因下楼摔伤致右胫骨结节骨折伴髌腱损伤, 骨折类型为 Felix IVA 型。手术采用缝线桥固定骨折, 并联合半腱肌腱环形重建髌腱, 在固定骨折断端的同时修复膝关节伸膝装置。术后 10 个月随访, 患者获得了完全主动的膝关节伸展功能, 无伸膝迟滞。此外, 本文对相关文献进行综述。

**关键词:** 胫骨假体周围骨折, 全膝关节置换术, 髌腱损伤, 半腱肌腱转移

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**Felix type IV-A knee periprosthetic fracture: A case report and literature review** // BU Peng-hui<sup>1</sup>, YANG Zhi<sup>2</sup>, ZHANG Wei-song<sup>2</sup>, HU Shou-ye<sup>2</sup>. 1. Xi'an Medical College, Xi'an 710068, China; 2. Department of Osteonecrosis and Joint Reconstruction, Honghui Hospital, Xi'an Jiaotong University, Xi'an 710054, China

**Abstract:** Periprosthetic fractures after total knee arthroplasty (TKA) have become a common complication, a challenging orthopedic problem. Periprosthetic fractures of the proximal tibia are less common than the distal femoral and patellar fractures, the tibial tubercle fractures combined with patellar tendon injuries are even rarer in clinical practice, which are rarely described in the medical literature, and their diagnosis and treatment remain a challenge. This paper describes a 74-year-old female with Felix type IV-A fracture of the right tibial tubercle with patellar tendon injury caused by a fall 4 years after TKA for right knee osteoarthritis. The fracture was fixed with an suture-bridge, and the patellar tendon was reconstructed with semitendinous tendon transfer. The patient achieved full active knee extension without knee extension retardation 10 months after the revision surgery. In addition, relative literatures were reviewed in this article.

**Key words:** total knee arthroplasty, periprosthetic fracture of the tibia, patellar tendon injury, semitendinous tendon transfer

全膝关节置换术 (total knee arthroplasty, TKA) 后假体周围骨折是全膝关节置换术后发生的股骨、胫骨或髌骨骨折的总称。由于 TKA 数量的增加, 术后假体周围骨折已成为 TKA 手术的一个重要并发症, 并有很高的骨折不愈合和脱位的风险<sup>[1-3]</sup>。胫骨假体周围骨折的发生率较低, 全膝关节置换术后胫骨假体周围骨折的发病率为 0.4%~1.7%<sup>[4, 5]</sup>, 髌韧带损伤的发生率为 0.2%~1%<sup>[6-8]</sup>。髌腱可因胫骨结节或髌骨下极骨折以及腱体损伤而失效, 髌腱损伤会显著影响患者关节功能和生活质量, 临床中不同的治疗策略被用于重建或增强修复, 包括自体移植、同种异体移植、人工韧带等, 但术后并发症发生率较高<sup>[9-11]</sup>。既往文献报道了多种 TKA 术后胫骨假体周围骨折的治

疗方案, 然而, TKA 术后胫骨结节骨折合并髌腱损伤的报道较少。

## 1 病例报告

患者, 女, 74 岁, 身高 160 cm, 体重 50 kg, BMI: 19.5 kg/m<sup>2</sup>, 主诉因“摔伤后右膝疼痛, 活动受限 10 d”于 2022 年 4 月 10 日入院, 患者 4 年前在本院因右膝骨性关节炎行右膝 TKA, 假体采用的是后稳定全膝关节假体 (Zimmer NexGen LPS-Flex 系统)。患者既往有 7 年高血压病史、糖尿病病史, 血压最高可达 180/95 mmHg, 空腹血糖最高 10 mmol/L, 平日口服降压药 (硝苯地平缓释片) 及降糖药

(二甲双胍片)，血压、血糖控制良好。本次入院就诊因下楼时摔伤致右膝关节剧烈疼痛而无法行走。

入院后查体：右股四头肌轻度萎缩，肌力可。膝关节轻度肿胀，浮髌试验阳性，侧方应力试验阴性，膝关节活动范围因疼痛不能查体。影像学检查：右膝胫骨结节骨折（图 1a）。诊断：（1）右胫骨结节骨折；（2）右膝髌腱损伤；（3）右膝关节置换术后；（4）2 型糖尿病；（5）高血压病 3 级（极高危）。完善相关的术前检查，未见绝对手术禁忌证，择期安排手术治疗。

手术步骤：麻醉满意后，取仰卧位。术区消毒、铺巾，上气囊止血带，压力 40 kPa，取膝原手术切口，依次切开皮肤、皮下及深筋膜，暴露髌韧带，探查发现髌腱挛缩，髌韧带自胫骨结节止点处撕裂，探查膝关节假体在位，未见松动迹象。胫骨内侧显露鹅足腱，使用开环取腱器取半腱肌腱，注意保留肌腱胫骨侧止点，修整半腱肌腱的肌肉组织与游离缘后编织备用。复位胫骨结节骨折块后，于胫骨结节两侧打入 2 枚带线外排锚钉（DePuy Synthes, Verasalok），尾线采用 Krackow 缝合法编织髌腱后固定于胫骨对侧<sup>[12]</sup>，见骨折块复位稳定牢靠。分别在髌骨中 1/3、胫骨结节下方制备 4.5 mm 横行骨道，将制备的半腱肌腱游离端自内向外侧穿过髌骨骨道，再将肌腱游离

端由外向内穿过胫骨骨道，拉紧，与半腱肌原止点缝合固定（图 1b）。探查见骨折复位良好，膝关节被动屈曲活动正常。反复冲洗关节腔后关闭伤口。术后右膝关节可调支具固定。术后 X 线片与 CT 检查示：骨折块解剖复位。

术后康复：术后膝关节屈曲最初被限制在 30°，然后在负重的情况下每 2 周升级到 60°和 90°。术后第 1~2 周膝关节被动屈伸锻炼；术后 2~4 周进行右膝关节主动部分负重锻炼、增加活动频次；术后 4~6 周嘱患者下地负重主动功能锻炼；术后 1 个月门诊复查行 X 线检查观察骨折断端愈合情况，并指导患者进一步功能锻炼；术后 10 个月时随访行 X 线片和 CT 观察骨折愈合情况以及髌腱完整性与连续性，行美国膝关节协会评分（Knee Society scale, KSS）评价膝关节功能。

随访：体格检查中，可见右膝关节周围皮肤无红肿、发热及异常渗出物；术后 10 个月，X 线片与 CT 检查右胫骨结节骨折愈合良好，骨折块未发生移位与撕脱（图 1c）。膝关节伸直/屈曲 0°~100°；膝关节伸直、屈曲功能良好，无伸膝迟滞（图 1d, 1e）。髌骨居中，未见髌骨半脱位，下肢末梢循环与皮肤感觉良好。KSS 膝关节功能评分为 90 分。

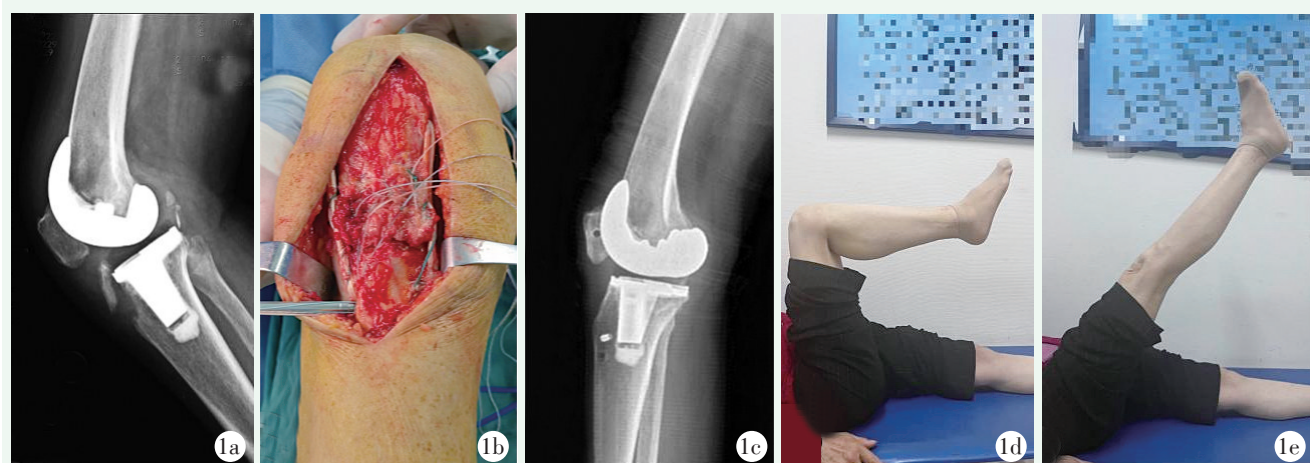


图 1 患者，女，74 岁，Felix IV-A 型膝假体周围骨折。1a: 膝关节矢状位 X 线片示胫骨结节骨折，骨折断端移位，骨折块菲薄；1b: 骨折复位，缝线桥固定，半腱肌腱环形重建髌腱；1c: 术后 10 个月膝关节矢状位 X 线片示胫骨结节骨折块骨愈合；1d, 1e: 术后 10 个月后随访右膝关节活动范围 0°~100°，膝关节屈曲至 90°，直腿抬高、可完全伸直腿。

Figure 1. A 74-year-old female suffered from Felix type IV-A knee periprosthetic fracture. 1a: Sagittal X-ray of the knee shows fracture of the tibial tubercle with displacement of a thin fracture fragment; 1b: Fracture reduction and suture-bridge fixation with patellar tendon; reconstruction with semitendinous tendon transfer; 1c: Radiograph 10 months after surgery showed bony healing of the tibial tubercle fracture; 1d, 1e: The right knee regained a range of motion of 0°~100°, with full extension at straight leg raise 10 months after surgery.

## 2 讨论与文献综述

临床中 TKA 术后胫骨假体周围骨折的发生率远远低于股骨假体周围骨折，治疗困难，文献报道全膝

关节置换术后老年骨质疏松症以及假体的应力遮挡会导致假体周围骨量减少,骨密度降低,同时,胫骨侧先前置入的假体和骨水泥的毒性反应在一定程度上会加速骨溶解,进而影响骨折块复位以及固定,以上因素会导致假体周围骨折愈合不良,骨折骨不连和移位的发生率升高<sup>[13-16]</sup>。关于 TKA 术后胫骨假体周围骨折的分型相对较少, Felix 等<sup>[17, 18]</sup>根据 102 例 TKA 术后胫骨假体周围骨折提出了一种分型,主要分为 4 型: I 型为涉及部分胫骨平台的骨折; II 型骨折累及假体周围的整个胫骨平台; III 型是位于胫骨假体远端下方的骨折; IV 型是涉及胫骨结节骨折,并且每个分型又分为 3 个亚型: A 亚型表示假体稳定、B 亚型表示假体松动、C 亚型表示术中骨折。假体周围骨折的治疗方案通常根据骨折分型、假体的稳定状态以及骨量丢失的严重程度共同参考<sup>[19]</sup>,通常假体稳定且没有移位的骨折可采取保守治疗,包括石膏固定和膝关节不负重 6 周,术后定期复查正侧位 X 线片,判断骨折愈合情况,此治疗方式适用于 IA、IC 类型。对于 II、III 型骨折更多采用闭合复位内固定术、切开复位内固定术<sup>[20]</sup>、LESS 钢板固定术<sup>[21, 22]</sup>、环形外固定器固定术<sup>[23]</sup>、混合内固定器术,但无统一标准。对于 B 亚型有移位的假体周围骨折,通常进行手术翻修,胫骨侧假体使用延长杆,视骨折类型给予钢板内固定术。对于术中导致假体周围骨折(C 亚型),通常采用螺钉、延长杆或者锁定钢板固定,治疗目的保证假体稳定性; IV 型骨折病例报道罕见,胫骨结节骨折通常意味着患者受到某种暴力或者牵拉导致骨折,患者伸膝装置受损,但是通常假体处于稳定状态,多采用石膏、支具固定等保守治疗,还可以采用锚钉固定<sup>[24]</sup>、经骨钻孔缝合或自体腱重建韧带等手术治疗<sup>[25, 26]</sup>。TKA 术后胫骨假体周围骨折的治疗原则:除非患者有明确手术禁忌证,应进行手术治疗,预防并发症,早期康复锻炼,恢复患肢功能。

本文报道的患者为 TKA 术后胫骨结节骨折,为 Felix IVA 型骨折;参考以往的文献,很少见对 Felix IV A 型骨折治疗的报道,临床中可供参考的治疗经验也很少。Platzerr 等<sup>[27]</sup>对 1 例未见明显移位的 Felix IV A 型骨折进行了报道,采用石膏外固定获得了骨折愈合,但患者残留膝关节功能减退。另有文献报道,采用螺钉固定 TKA 翻修术中胫骨结节截骨瓣获得良好临床结果<sup>[28, 29]</sup>。欧亚新等<sup>[26]</sup>对 Felix IV A 型骨折通过锚钉进行固定,用 Krackow 缝合法编织缝合髌韧带重建伸膝装置,通过张力带钢丝进一步加强固定。本文报道的病例,胫骨结节骨折块小,骨折块的

骨量不能为螺钉提供有效的抓持力量,使用螺钉不能实现骨折块的牢靠固定,且术后功能锻炼有再发骨折移位的可能。本例患者选择使用外排锚钉进行固定,术中将骨折块复位后,于胫骨结节两侧打入 2 枚带线外排锚钉,尾线采用 Krackow 缝合法编织缝合髌腱后牢靠固定,在固定骨折块的同时,恢复伸膝装置的完整性,减少骨折块受到股四头肌腱的牵拉力与剪应力,降低了骨块再次撕脱移位的风险,缩短术后支具固定时间,有利于术后膝关节早期康复。术后 10 个月随访,胫骨结节骨折愈合良好。

目前,带线锚钉已广泛应用于治疗韧带损伤以及肌腱止点的撕脱骨折,具有牢固锚定止点、可修复韧带组织等特点<sup>[30, 31]</sup>。对于本病例而言,应用锚钉固定骨折块是因其组织相容性良好,可不予取出,避免再次手术取出内固定装置,降低了假体周围感染的风险。另外,术中尾线采用 Krackow 缝合法编织缝合髌腱,维持髌腱的长度及完整性,保证髌腱强度及张力。既往文献表明, Krackow 缝合法有着良好的抗拉以及抗劈强度,对肌腱血运干扰小,该方法被广泛应用于膝关节韧带修复与重建等手术治疗<sup>[12, 32]</sup>。

膝关节伸膝装置参与关节正常伸膝活动,维持关节稳定性,当患者 TKA 术后发生伸膝装置损伤时,会大幅降低手术效果<sup>[33]</sup>。伸膝装置破坏的诊断依据:膝关节完全丧失伸直功能,包括:伸膝肌群、股四头肌肌腱、髌腱、胫骨结节及其周围附着的韧带损伤<sup>[8, 16, 34]</sup>。TKA 术后伸膝装置损伤发生髌腱损伤的概率为 0.2%~1%。本案例术中探查髌腱存在急性损伤,临床中髌腱出现急性损伤需要巨大冲击力,相当罕见,采用保守治疗和直接缝合修复预后均不佳,再断裂率和关节伸膝迟滞发生率较高<sup>[35, 36]</sup>。目前多采用重建和加强修复的方法治疗,材料包括:合成补片、自体移植物和同种异体移植物<sup>[37]</sup>。与以往文献中报道的使用合成补片技术重建髌腱不同<sup>[38]</sup>,本例患者在髌骨与胫骨结节建立横行骨道,采用自体半腱肌肌腱进行环形重建,并将移植肌腱与髌腱一体化编织固定。笔者认为自体移植物具有失败率低、费用低的优点,并避免了置入异物诱发假体周围感染的风险。

此外,TKA 术后伸膝装置损伤可引起相关的股四头肌激活失败及肌肉萎缩,表现为股四头肌无力<sup>[39, 40]</sup>。为了减少股四头肌无力的发生,改善临床功能,术后应加强股四头肌锻炼。早期在铰链支具有效的外部保护下,嘱患者术后开始行关节被动屈伸锻炼,4~6 周后去除支具开始主动负重下功能锻炼,随

访显示无明显骨折移位及内固定失效的情况发生。术后 10 个月随访,患者获得了完全主动的膝关节伸展功能,无伸膝迟滞,术后 10 个月 ROM 为 0°~100°, KSS 评分 90 分。

综上所述,TKA 术后假体周围胫骨结节骨折合并髌腱损伤在临床中很少见,锚钉止点修复联合半腱肌腱重建髌腱是一种安全可行的选择,可牢靠固定骨折断端,并能重建膝关节伸膝装置,改善临床和关节功能预后。

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