

# 经外踝截骨联合空心钉和肱骨近端锁定钢板倒置固定行胫距跟融合术的疗效观察

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**【摘要】** 目的: 探讨经外踝截骨联合空心钉和肱骨近端锁定钢板倒置固定在胫距跟关节融合的临床疗效。方法: 自 2015 年 6 月至 2018 年 12 月, 采用经外踝截骨联合空心钉和肱骨近端锁定钢板倒置固定行胫距跟融合术患者 15 例, 其中男 10 例, 女 5 例; 年龄 45~72(58.9±6.1) 岁; 病程 2~35(11.9±7.9) 年。术前诊断创伤性关节炎 8 例, Charcot 关节炎 2 例, Charcot-Marie-Tooth(CMT) 2 例, 踝关节结核 1 例, 距骨坏死 1 例, 色素沉着绒毛结节性滑膜炎 1 例。8 例合并单纯内翻畸形, 4 例合并单纯外翻畸形, 2 例合并马蹄内翻畸形, 1 例合并马蹄畸形, 2 例合并中前足内收内旋。采用美国足踝外科协会 (American Orthopaedic Foot and Ankle Society, AOFAS) 踝与后足功能评分及疼痛视觉模拟评分 (visual analogue scale, VAS) 进行临床疗效评价。结果: 14 例患者获得随访, 时间 10~25(16.6±4.3) 个月, 1 例失访, 切口均 I 期愈合, 融合时间术后 15~24(16.8±2.4) 周。1 例合并糖尿病患者骨融合延迟, 通过 I 期再植骨注入富血小板血浆 (platelet-rich plasma, PRP) 后融合。AOFAS 评分由术前 (38.7±3.3) 分提高至术后 (84.5±2.6) 分, VAS 评分由术前 (7.5±1.6) 分降至术后 (1.9±0.3) 分, 差异有统计学意义 ( $P<0.05$ )。结论: 采用经外踝截骨空心螺钉联合肱骨近端锁定钢板倒置固定行胫距跟关节融合术手术操作简便, 融合率高, 且对伴有后足畸形的患者尤其适用。

**【关键词】** 踝关节; 关节炎; 截骨术; 足畸形

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**Clinical outcome of tibiototalcaneal fusion using cannulated screw and humeral proximal locking plate inverted fixation through a lateral transfibular approach** ZHANG De-xiang, ZHONG Xiao, DENG Xiao-dong, XIONG Ming, LI Wen, ZHANG Shao-bing, LI Ya-xing, and ZHANG Hui\*. \*West China Hospital of Sichuan University, Chengdu 610041, Sichuan, China

**ABSTRACT Objective:** To evaluate the clinical outcome of tibiototalcaneal fusion using cannulated screw and humeral proximal locking plate inverted fixation through a lateral transfibular approach. **Methods:** From June 2015 to December 2018, 15 patients underwent a tibiototalcaneal fusion operation using cannulated screw and inverted proximal humerus locking plate through a transfibular approach. There were 10 males and 5 females with the age ranging from 45 to 72 (58.9±6.1) years, and the course of disease ranged from 2 to 35 (11.9±7.9) years. Preoperative diagnosis included 8 cases of post-traumatic arthritis, 2 cases of Charcot arthritis, 2 cases of Charcot-Marie-Tooth (CMT), 1 case of ankle tuberculosis, 1 case of talar necrosis, and 1 case of pigmented villonodular synovitis. Among them, 8 patients were combined with simple varus deformity, 4 patients with simple valgus deformity, 2 patients with equinovarus deformity, 1 patient with equinovarus deformity, 2 patients with adduction and internal rotation of middle and forefoot. American Orthopaedic Foot and Ankle Society (AOFAS) ankle and hindfoot score and the visual analogue scale (VAS) score were used to evaluate the clinical outcome at the last follow-up. **Results:** One lost follow-up and remaining fourteen patients were followed up. The follow-up time ranged from 10 to 25 (16.6±4.3) months. All the 15 patients had primary healing. Fusion time ranged from 15 to 24 (16.8±2.4) weeks after operation. One patient with diabetes experienced delayed union and was successfully treated with secondary bone grafting combined with Platelet-Rich Plasma (PRP) injection. The AOFAS score increased from 38.7±3.3 to 84.5±2.6 ( $P<0.05$ ), and the VAS score decreased from 7.5±1.6 to 1.9±0.3 ( $P<0.05$ ). **Conclusion:** Tibiototalcaneal fusion used cannulated screw and humeral proximal locking plate inverted fixation through a lateral transfibular approach has the advantages of relatively simple technique, high fusion rate, especially for patients with posterior foot deformity, which has satisfactory short-term effects.

**KEYWORDS** Ankle joint; Arthritis; Osteotomy; Foot deformities

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导致踝关节和距下关节病变的疾病众多,Charcot 关节炎,腓骨肌萎缩症(Charcot-Marie-Tooth, CMT),创伤后关节炎,色素沉着绒毛结节性滑膜炎,距骨坏死,关节结核等<sup>[1]</sup>。踝关节合并距下关节病变可引发患者踝关节和后足肿痛,后期甚至出现患足内外翻畸形,导致功能障碍,严重影响患者生活质量<sup>[2]</sup>。非手术治疗方法包括限制或改变运动生活方式、佩戴足踝矫形支具、避免长时间负重、控制体重、口服非甾体镇痛药物等。但对于终末期踝关节伴距下关节病变,非手术治疗方式疗效欠佳,胫距跟关节融合术仍然是手术治疗终末期踝关节伴距下关节病变的金标准。自 2015 年 6 月至 2018 年 12 月,经外踝截骨联合空心钉和肱骨近端锁定钢板倒置固定行胫距跟融合术患者 15 例,现报告如下。

## 1 临床资料

### 1.1 病例选择

纳入标准:采用经外踝截骨入路,并联合使用空心拉力钉和肱骨近端锁定钢板倒置固定的患者;各种原因导致后足疼痛、肿胀的终末期胫距关节和距下关节病变者;影像学检查提示病变累及胫距关节和距下关节;保守治疗半年无效。排除标准:手术区域存在急慢性感染;年龄<16 岁;患肢血管功能严重受损;随访资料不完善。

### 1.2 一般资料

本研究共 15 例(15 足),其中男 10 例,女 5 例;年龄 45~72(58.9±6.1)岁;病程 2~35(11.9±7.9)年。术前诊断:创伤性关节炎 8 例(其中车祸伤导致 2 例,陈旧性 Pilon 骨折 Rüedi-Allgöwer<sup>[3]</sup>分型 III 型,扭伤致踝关节骨折 Lauge-Hansen<sup>[4]</sup>分型旋后外旋 IV 度畸形愈合 3 例,陈旧性距下关节脱位 2 例,高坠伤距骨颈粉碎性骨折 Hawkins<sup>[5]</sup>分型 IV 型 1 例),Charcot 关节炎 2 例,CMT 2 例,踝关节结核 1 例,距骨坏死 1 例,色素沉着绒毛结节性滑膜炎 1 例。术前合并畸形:8 例合并单纯内翻畸形,4 例合并单纯外翻畸形,2 例合并马蹄内翻畸形,1 例合并马蹄畸形,2 例合并中前足内收内旋。手术史:2 例为踝关节骨折(旋后外旋型 IV 度<sup>[4]</sup>)行骨折切开复位内固定术后内固定失效导致踝关节脱位和距骨骨软骨损伤,1 例距骨颈粉碎性骨折(Hawkins IV 型)切开复位内固定术后 2 年发生距骨坏死;2 例 CMT 患足曾在院外行矫形手术失败,其中 1 例因畸形复发而再次入院,1 例因矫形过度导致跟行足而致行走困难。

## 2 治疗方法

### 2.1 术前准备

术前摄踝关节正侧位 X 线片、双下肢全长 X 线片,行 CT 及 MRI 检查,评估患者踝关节及距下关节

受累情况、下肢力线与各关节间隙,以制定手术方案。吸烟者戒烟 2 周,完善术前常规检查排除禁忌证。1 例踝关节结核患者经严格抗痨治疗后接受手术治疗,1 例合并糖尿病患者使用胰岛素控制血糖,待血糖稳定 2 周后手术。

### 2.2 手术方法

术前 30 min 予以头孢唑林 1.0 g 静滴 1 次。采用全麻,联合股神经和坐骨神经阻麻醉减轻术后疼痛。仰卧位,常规大腿根部应用止血带(压力 255 mmHg),做外踝外侧纵行人路长约 10 cm,全层切开至外踝骨质,剥离外踝骨膜,充分暴露距外踝尖 8 cm 处骨质,切断踝关节外侧副韧带、下胫腓前后韧带和骨间韧带,保护腓骨长短肌、腓肠神经和腓浅神经。在距外踝尖 8 cm 处用摆锯截断外踝,将外踝内松质骨制作成骨粒,用生理盐水纱布保持其新鲜。用骨膜剥离器充分松解内侧与后方软组织,用咬骨钳清理踝关节周围骨赘。分别在胫骨远端和距骨上植入 1 枚 2.0 mm 克氏针,用撑开器撑开,充分暴露胫距关节面,去除关节面软骨,暴露软骨下骨,用刮匙刮除囊性变内增生组织;然后在跟骨上置入 1 枚 2.0 mm 克氏针,用同样方法清理距下关节。清理完毕后冲洗关节腔,将关节腔内软骨碎屑彻底清除防止影响融合,松气压止血带,电刀止血,用 2.0 mm 克氏针分别在距骨、胫骨、跟骨关节面均匀钻孔直至骨面渗血。将已取外踝松质骨植于融合关节面,对踝关节内翻同时伴骨缺损严重患者则取髂骨结构性植骨。将踝关节和距下关节复位对合,调整下肢力线,后足外翻 0°~5°,分别用 2 枚 2.0 mm 克氏针维持踝关节和距下关节复位,C 形臂 X 线透视踝关节和距下关节匹配良好,下肢力线恢复满意后,从跟骨后方向距骨体内打入 1 枚空心钉导针,在 C 形臂 X 线辅助下植入 1 枚 6.5 mm 空心拉力螺钉加压固定。用肱骨近端钢板倒置于跟骨、距骨、胫骨外侧壁,固定胫距跟关节。在大多数情况下,跟骨内可置入 4 枚锁定钉,距骨 2~3 枚,胫骨远端双皮质螺钉 4 枚。再次 C 形臂 X 线透视正侧位关节匹配良好,螺钉位置分布合适,轴位确定后足力线佳。冲洗切口,常规放置血浆引流管 1 根,逐层缝合切口,无菌绷带均匀加压包扎前须用无菌棉垫均匀覆盖切口及踝关节周围。在踝关节中立位用“U”形石膏固定。术中联合手术:3 例因马蹄畸形行跟腱点式(经皮微创)延长。2 例合并中前足畸形者,术前中前足畸形程度较轻,经术前与患者沟通后未予 I 期手术矫形,患者负重行走后均自觉症状明显改善,未行 II 期手术矫形。术中植骨:5 例因骨缺损严重取自体髂骨行结构性植骨,其余患者均采用截取外踝骨粒植骨。

### 2.3 术后处理

术后再次予以头孢唑林 1.0 g 静滴 1 次,冰敷并患肢抬高促进肿胀消退。术后第 2 天引流液分层后 ( $\leq 30$  ml) 拔除血浆引流管,同时指导患者小腿三头肌、股四头肌功能锻炼,防止废用性肌萎缩和下肢深静脉血栓形成。术后 14 d 伤口愈合后拆线。通常,患肢使用非负重石膏固定 6~10 周直到骨痂生长可见,此时更换佩戴行走支具,可负重身体重量的 1/4,当影像学提示完全融合可拆除行走支具。但对糖尿病、肥胖、Charcot 关节炎患者石膏固定时间 $>10$  周。

## 3 结果

### 3.1 疗效评价标准

骨性愈合标准:踝关节正侧位 X 线片示关节面 $\geq 75\%$ 骨性接触即为融合<sup>[6]</sup>。采用美国足踝外科协会 (American Orthopaedic Foot and Ankle Society, AOFAS) 踝与后足评分<sup>[7]</sup>进行疗效评价,包括疼痛,功能和自主活动、支撑情况,最大步行距离,地面步行,异常步态,前后活动,后足活动,踝-后足稳定性,足部对线,满分 100 分;其中总分 90~100 分为优,75~89 分为良,50~74 分为可, $<50$  分为差。采用疼痛视觉模拟评分 (visual analogue scale, VAS)<sup>[8]</sup>评价疼痛缓解程度。

### 3.2 治疗结果

本组 14 例获得随访,时间 10~25 (16.6 $\pm$ 4.3) 个月,1 例失访(患者因子女工作变动迁出)。15 例切口均 I 期愈合。1 例术后出现患足外侧麻木,考虑为术中过度牵拉腓肠神经所致,予以口服甲钴胺 0.5 mg,每次 1 片,每日 3 次,术后 6 周患者麻木症状消失。融合时间术后 15~24 (16.8 $\pm$ 2.4) 周。1 例合并糖尿病患者通过 I 期再植骨注入富血小板血浆 (platelet rich plasma, PRP)<sup>[9]</sup>,于术后 8 个月获得骨性融合。AOFAS 评分由术前 (38.7 $\pm$ 3.3) 分提高至术后 (84.5 $\pm$ 2.6) 分 ( $t=39.195, P=0.000$ ),见表 1。VAS 评分由术前 (7.5 $\pm$ 1.6) 分降至术后 (1.9 $\pm$ 0.3) 分 ( $t=12.157, P=0.000$ ),差异有统计学意义 ( $P<0.05$ )。典型病例见图 1。

## 4 讨论

### 4.1 适应证选择

对于同时存在踝与距下关节终末病变的患者,其治疗一直充满挑战。虽然距下关节融合联合踝关节置换可保留患者的踝关节活动度,但其技术要求高,且踝关节假体费用高昂,未在国内普及,远期效果需要长期随访<sup>[10]</sup>。因此,胫距跟关节融合术仍然是治疗终末期踝与距下关节病变的金标准。结合本组病例,笔者认为行胫距跟关节融合的适应证包括:(1)踝关节骨折畸形愈合等创伤性关节炎。

表 1 胫距跟融合术 14 例手术前后 AOFAS 评分比较

( $\bar{x}\pm s$ , 分)

Tab.1 Comparison of AOFAS score of 14 patients undergoing tibiototalcalcaneal fusion before and after surgery ( $\bar{x}\pm s$ , score)

项目	术前	术后
疼痛	20.0 $\pm$ 0.0	40.0 $\pm$ 0.0
功能和自主活动、支撑情况	3.4 $\pm$ 1.4	9.1 $\pm$ 1.4
最大步行距离	2.3 $\pm$ 1.3	4.5 $\pm$ 1.1
地面步行	2.1 $\pm$ 1.4	4.9 $\pm$ 0.5
异常步态	1.4 $\pm$ 1.9	8.0 $\pm$ 0.0
前后活动	1.4 $\pm$ 1.9	0.0 $\pm$ 0.0
后足活动	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0
踝-后足稳定性	8.0 $\pm$ 0.0	8.0 $\pm$ 0.0
足部对线	0.0 $\pm$ 0.0	10.0 $\pm$ 0.0
总分	38.7 $\pm$ 3.3	84.5 $\pm$ 2.6*

注: \*与术前比较,  $t=39.195, P=0.000$

Note: \*Compared with preoperation,  $t=39.195, P=0.000$

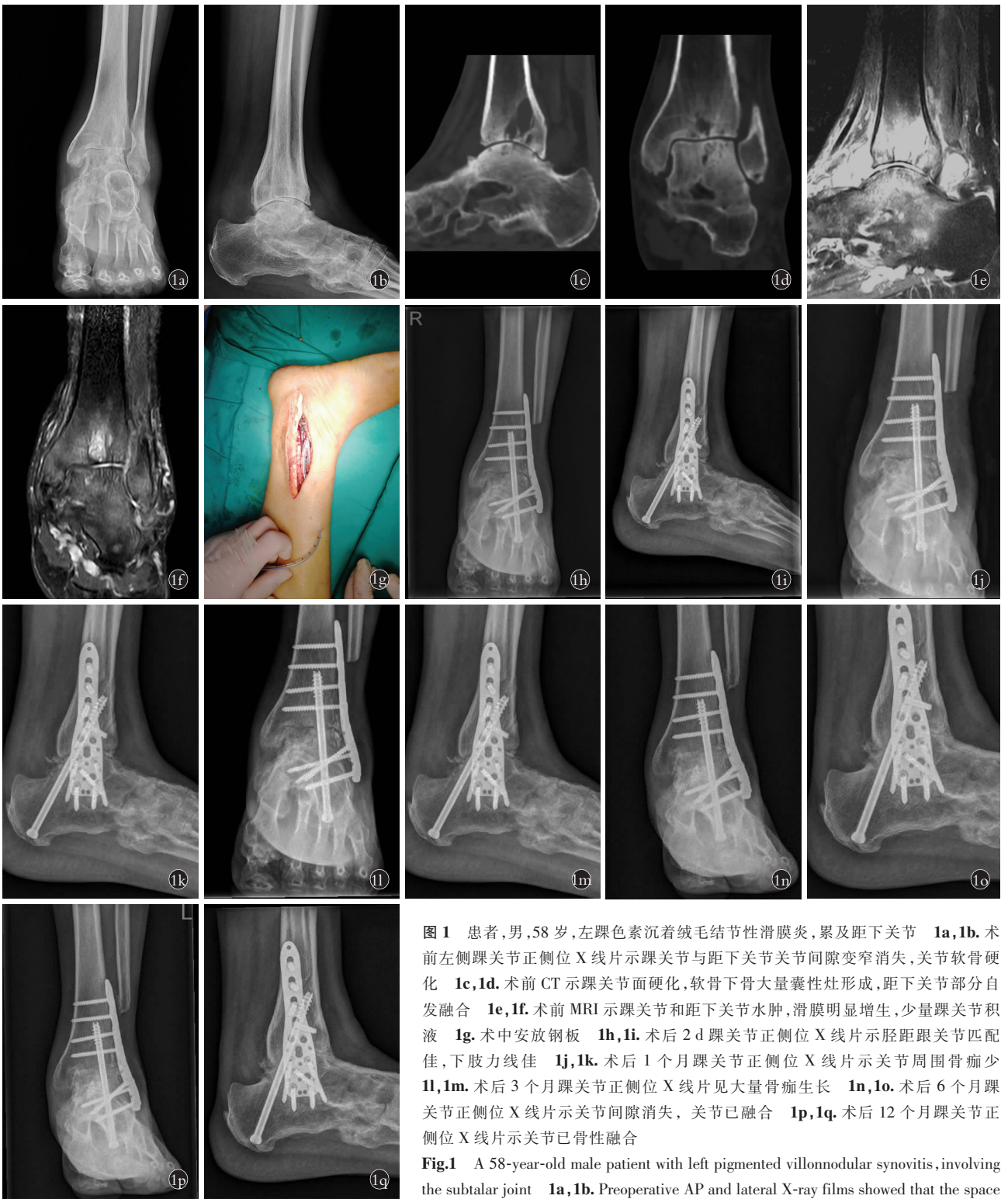
(2)Charcot 关节炎累及后足多关节的。(3)距骨创伤性和原发性坏死。(4)后足先天性和后天性畸形。(5)色素沉着绒毛结节性滑膜炎晚期侵蚀关节软骨。(6)经济困难,不能行距下关节融合联合踝关节置换的患者。对于合并内科基础疾病如糖尿病患者,需血糖控制稳定后方可手术。

### 4.2 手术入路的选择

前方入路具有保留内外侧解剖结构、无须破坏腓骨支撑等优点,但其解剖复杂,且前方软组织覆盖相对较差,并且需同时联合跗骨窦切口清理距下关节面,存在损伤足背动脉及其伴行血管神经风险,而一旦切口感染或皮缘坏死,将很容易造成肌腱外露,后期创口闭合困难<sup>[11]</sup>。鹿军等<sup>[12]</sup>采用经后方跟腱入路行 15 例胫距跟融合术疗效满意,对于内外侧软组织条件差的可选择此入路,但后方入路解剖复杂,手术视野深,暴露有限,且对清理前方关节腔视野不够,而且内置物安放困难。

笔者通过本组病例研究及后期经验认为,与其他入路相比经外侧入路有以下优势:(1)避开前方血管神经肌腱其保护踝关节前方软组织,防止术后切口愈合不良时出现肌腱外露而无法闭合切口。(2)防止经跟腱切口时皮肤坏死跟腱外露。(3)截除外踝后联合撑开器可完全显露踝关节前后关节间隙以及距下关节,有利于关节面处理。(4)对伴有踝关节畸形,特别是内外翻畸形的患者矫形力度更大。(5)截取的外踝可作为植骨源,提高融合率,避免再取髂骨,本研究仅对 5 例踝关节内翻同时伴骨缺损严重患者行





**图 1** 患者,男,58 岁,左踝色素沉着绒毛结节性滑膜炎,累及距下关节 1a,1b. 术前左侧踝关节正侧位 X 线片示踝关节与距下关节间隙变窄消失,关节软骨硬化 1c,1d. 术前 CT 示踝关节面硬化,软骨下骨大量囊性灶形成,距下关节部分自发融合 1e,1f. 术前 MRI 示踝关节和距下关节水肿,滑膜明显增生,少量踝关节积液 1g. 术中安放钢板 1h,1i. 术后 2 d 踝关节正侧位 X 线片示胫距跟关节匹配佳,下肢力线佳 1j,1k. 术后 1 个月踝关节正侧位 X 线片示关节周围骨痂少 1l,1m. 术后 3 个月踝关节正侧位 X 线片见大量骨痂生长 1n,1o. 术后 6 个月踝关节正侧位 X 线片示关节间隙消失,关节已融合 1p,1q. 术后 12 个月踝关节正侧位 X 线片示关节已骨性融合

**Fig.1** A 58-year-old male patient with left pigmented villonodular synovitis, involving the subtalar joint 1a,1b. Preoperative AP and lateral X-ray films showed that the space between the ankle joint and the subtalar joint were narrowed and disappeared, and the articular cartilage was hardened 1c,1d. Preoperative CT scans showed that the ankle joint surface was hardened, a large number of cystic foci were formed in the subchondral bone, and the subtalar joint was spontaneously fused 1e,1f. Preoperative MRI showed edema of the ankle joint and the subtalar joint, obvious synovial hyperplasia, and a small amount of effusion in the ankle joint 1g. Steel plate was placed intraoperatively 1h,1i. Anteroposterior and lateral X-ray films showed that tibiototalcalcaneal was well matched and the lower limb strength line was good 1j,1k. Anteroposterior and lateral X-ray films showed less callus around the joint at 1 month after operation 1l,1m. A large amount of callus growth were seen at anteroposterior and lateral X-ray films at 3 months after operation 1n,1o. Anteroposterior and lateral X-ray films showed the joint space disappeared and the joint were fused at 6 months after operation 1p,1q. Anteroposterior and lateral X-ray films at 12 months after operation showed bone were fused

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取髂骨结构性植骨。(6)与前方切口相比,手术视野均在一切口内,避免再单独做切口暴露距下关节。

### 4.3 内置物选择

用于胫距跟关节融合的固定材料较多,如 Ilizarov 外固定架、空心钉、角钢板及髓内钉等<sup>[13]</sup>。对于软组织情况差、骨缺损多、下肢短缩等不适合内固定患者,使用 Ilizarov 外固定架有一定优势,但其也存在操作复杂、针道感染率高、护理困难、针道松动导致固定不确切等缺陷。空心加压螺钉具有良好的加压效果,软组织包容性要求低,如存在骨缺损或术前下肢力线异常,空心螺钉在加压过程中可能导致踝关节内外翻,且对于严重骨质疏松患者融合加压效果不满意。Zhang 等<sup>[14]</sup>采用髓内钉进行胫距跟融合,其融合率为 95%,但同时报道 25%的患者出现严重并发症。髓内固定技术要求高,操作复杂,髓内钉置入时可产生胫骨劈裂骨折、抗旋螺钉置入困难等诸多并发症<sup>[15]</sup>。采用空心钉和肱骨近端锁定钢板倒置固定的报道尚少。笔者认为,本组病例有较高融合率和低并发症,分析原因如下:(1)6.5 mm 空心拉力螺钉同时固定胫距跟关节,对胫距跟融合端加压的同时还有阻挡防止关节脱位的作用;然后将肱骨近端锁定钢板倒置跟骨、距骨、胫骨外侧壁,固定胫距跟关节。(2)肱骨近端锁定钢板螺钉分部成角交错,具有角稳定性,从侧方多方向把持跟骨、距骨,增强了抗剪切力和抗拔出,能显著增加融合端固定的稳定性,对骨质疏松、踝关节及距下关节内外翻畸形、骨缺损患者起到良好支撑固定作用,为胫距跟关节 I 期融合提供稳定的力学支撑。本研究中除 1 例合并糖尿病的患者外均获 I 期融合,考虑原因系其依从性差,长期血糖控制不佳,且伴骨质疏松所致。

### 4.4 存在不足与改进

本手术方式亦存在切除腓骨后外侧无支撑而导致后期行关节置换困难,偶尔当踝关节内侧间隙有增生骨赘或瘢痕组织妨碍距骨复位时需要联合内侧切口清理内踝关节间隙,对于严重马蹄内翻足患者需辅助内侧切口松解内侧三角韧带或胫后肌腱,远期邻近关节退变等临床问题。同时本研究还存在随访时间较短、无组内随机对照、病例量较小等局限性,还需进一步进行长期大样本研究证实。

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