

· 论著 ·

本文亮点:

- (1) 创新采用经真皮下入路切取的旋髂浅动脉纯皮肤穿支(PSP)皮瓣,皮瓣厚度仅2~3 mm。
- (2) 证实采用经真皮下入路切取的旋髂浅动脉PSP皮瓣修复手足部皮肤软组织缺损,术后皮瓣均成活且其外观、轮廓、颜色及质地良好,是一种安全可行的术式。

Highlights:

- (1) The superficial iliac artery pure skin perforator (PSP) flaps was harvested via subdermal approach innovatively, with the thickness of flaps only 2–3 mm.
- (2) It was confirmed that using the superficial iliac circumflex artery PSP flapsharvested via subdermal approach for repairing skin and soft tissue defects in hands and feet, all flaps survived after surgery, with good appearance, contour, color, and texture, making it a safe and feasible surgery.



经真皮下入路切取旋髂浅动脉PSP皮瓣修复手足部皮肤软组织缺损的临床效果

朱旭伟 周飞亚 丁健 李志杰 张文振 李士

温州医科大学附属第二医院创面修复科,温州 325027

通信作者:李士,Email:Lister@wmu.edu.cn

【摘要】 目的 探讨经真皮下入路切取旋髂浅动脉纯皮肤穿支(PSP)皮瓣修复手足部皮肤软组织缺损的临床安全性和效果。方法 该研究为回顾性病例系列研究。2022年3月—2024年2月,温州医科大学附属第二医院创面修复科收治14例符合入选标准的手足部皮肤软组织缺损患者,共15个创面。清创后创面面积为5.6 cm×1.9 cm~14.0 cm×7.0 cm。术前通过高频超声定位穿支,术中经真皮下入路切取15个旋髂浅动脉纯皮肤穿支皮瓣修复创面,皮瓣切取时间为37~140 min,皮瓣切取面积为5.6 cm×1.9 cm~14.0 cm×7.0 cm,并进行供受区血管吻合。将皮瓣供区创面直接缝合。术后观察皮瓣成活情况。记录术后并发症发生情况。末次随访时,采用利克特5级量表,从整体美学外观、与周围组织的轮廓相似度、与周围组织的颜色相似度、与周围组织的质地相似度4个方面对皮瓣进行评价。结果 15个皮瓣术后均顺利成活。1个皮瓣出现紫斑,经换药后稳定。1个皮瓣发生静脉危象,经探查手术后恢复正常。1例患者供区创面延迟愈合,予以清创换药后1周顺利愈合。末次随访时,皮瓣整体美学外观评分为3.3~5.0分(平均4.5分),与周围组织的轮廓相似度评分为3.7~5.0分(平均4.7分),与周围组织的颜色相似度评分为3.3~5.0分(平均4.5分),与周围组织的质地相似度评分为3.7~5.0分(平均4.8分)。结论 经真皮下入路切取旋髂浅动脉PSP皮瓣修复手足部皮肤软组织缺损,术后皮瓣均成活且其外观、轮廓、颜色及质地良好,是一个安全、可行的手术方式。

【关键词】 穿支皮瓣; 四肢; 纯皮肤穿支; 旋髂浅动脉; 创面修复

基金项目:浙江省基础公益研究计划项目(LY24H110002);温州市科技局基础性科研项目

DOI:10.3760/cma.j.cn501225-20241215-00487

收稿日期 2024-12-15

引用本文:朱旭伟,周飞亚,丁健,等.经真皮下入路切取旋髂浅动脉PSP皮瓣治疗手足部皮肤软组织缺损的临床效果[J].中华烧伤与创面修复杂志,2026,42(5):1-7. DOI:10.3760/cma.j.cn501225-20241215-00487.

Zhu Xuwei,Zhou Feiya,Ding Jian,et al.Clinical effects of harvesting superficial iliac circumflex artery PSP flaps via subdermal approach for repairing skin and soft tissue defects in hands and feet[J].Chin J Burns Wounds,2026,42(5):1-7.DOI:10.3760/cma.j.cn501225-20241215-00487.



(YC20250543)

Clinical effects of harvesting superficial iliac circumflex artery PSP flaps via subdermal approach in repairing skin and soft tissue defects in hands and feet

Zhu Xuwei, Zhou Feiya, Ding Jian, Li Zhijie, Zhang Wenzhen, Li Shi

Department of Wound Repair, the Second Affiliated Hospital of Wenzhou Medical University, Wenzhou 325027, China

Corresponding author: Li Shi, Email: Lister@wmu.edu.cn

【 Abstract 】 Objective To investigate the safety and effects of harvesting superficial iliac circumflex artery pure skin perforator (PSP) flaps via subdermal approach in repairing skin and soft tissue defects in hands and feet. **Methods** This study was a retrospective case series study. From March 2022 to February 2024, 14 patients with 15 skin and soft tissue defect wounds in hands and feet who met the inclusion criteria were admitted to the Department of Wound Repair of the Second Affiliated Hospital of Wenzhou Medical University. After debridement, the wound areas ranged from 5.6 cm×1.9 cm to 14.0 cm×7.0 cm. Before surgery, the perforators were located using high-frequency ultrasound. During surgery, 15 superficial circumflex iliac artery PSP flaps were harvested via the subdermal approach for repairing the wounds. The flap harvesting time ranged from 37 to 140 minutes, and the flap sizes ranged from 5.6 cm×1.9 cm to 14.0 cm×7.0 cm. Vascular anastomosis was performed between the donor and recipient sites. The donor site wounds were closed by direct suturing. After surgery, the survival of flaps was observed, and the occurrence of complications was recorded. At the final follow-up, the 5-point Likert scale was used to evaluate the flaps from four aspects: overall aesthetic appearance, contour similarity to surrounding tissue, color similarity to surrounding tissue, and texture similarity to surrounding tissue. **Results** All 15 flaps survived successfully after surgery. One flap developed purple plaque, which stabilized after dressing changes. One flap developed venous crisis, which alleviated after surgery. One patient experienced delayed healing of the donor site wound, which successfully healed one week after debridement and dressing changes. At the final follow-up, the overall aesthetic appearance score of the flaps ranged from 3.3 to 5.0, with an average of 4.5; the contour similarity to surrounding tissue ranged from 3.7 to 5.0, with an average of 4.7; the color similarity to surrounding tissue ranged from 3.3 to 5.0, with an average of 4.5; the texture similarity to surrounding tissue ranged from 3.7 to 5.0, with an average of 4.8. **Conclusions** Harvesting the superficial iliac circumflex artery PSP flaps via the subdermal approach for repairing skin and soft tissue defects in hands and feet is a safe and feasible surgery as that all the flaps survived after surgery, with favorable aesthetic appearance, contour, color, and texture.

【 Key words 】 Perforator flap; Extremities; Pure skin perforator; Superficial circumflex iliac artery; Wound repair

Fund program: Basic Public Welfare Research Program of Zhejiang Province (LY24H110002); Basic Research Project of Wenzhou Science and Technology Bureau (YC20250543)

近年来,纯皮肤穿支皮瓣技术在超薄皮瓣领域取得了一些进展,适用于四肢浅表部位皮肤软组织缺损的精细重建^[1-7]。该技术通过保留穿入真皮的血管分支,将皮瓣厚度降至约 2 mm,达到了类似全厚皮片的厚度,避免了传统皮瓣中脂肪层厚的问题,又兼具良好的血供。旋髂浅动脉穿支皮瓣是最早应用于临床的纯皮肤穿支皮瓣,因其供区隐蔽且动脉走行于浅筋膜层,逐渐成为修复四肢中小型皮肤软组织缺损的理想皮瓣^[8-11]。早期通常通过“虫蚀法”在显微镜下逐层修薄脂肪,从而获得所需厚度的超薄皮瓣,但该方法费时费力、操作复杂^[12-15]。最新的真皮下入路技术则可直接在真皮下解剖层面切取皮瓣,无须携带脂肪层,可获得符合要求的纯

皮肤穿支皮瓣^[16-19]。Yamamoto 等^[16]的研究显示,通过真皮下入路技术切取皮瓣的平均时间为 27.4 min,同时因解剖层次表浅而减轻了对供区的损伤^[16,20-21]。但是目前关于经真皮下入路切取纯皮肤穿支皮瓣的临床研究很少,国内也鲜见报道,是否是因为手术难度过大而使得该项技术无法进一步推广^[22]。本研究旨在通过回顾性分析,探讨经真皮下入路切取旋髂浅动脉纯皮肤穿支皮瓣修复四肢皮肤软组织缺损的临床效果及安全性。

1 对象与方法

本回顾性病例系列研究符合《赫尔辛基宣言》的基本原则。根据温州医科大学附属第二医院(以

下简称本院)伦理委员会政策,可在不泄露患者身份信息的前提下,对其临床资料进行分析、使用。

1.1 入选标准

纳入标准:(1)手足部皮肤软组织缺损伴神经、肌腱、血管或骨外露者;(2)采用经真皮下入路切取的旋髂浅动脉纯皮肤穿支皮瓣修复皮肤软组织缺损者。排除标准:(1)临床资料不全者;(2)随访时间<6个月者。

1.2 临床资料

2022年3月—2024年2月,本院收治14例符合入选标准的手足部皮肤软组织缺损伴不同程度的肌腱、血管、神经或骨外露的患者,共15个创面(仅1例患者为掌背侧2个创面)。患者中男9例、女5例;年龄6~64岁,平均43.4岁;身体质量指数为16.9~31.1 kg/m²,平均21.6 kg/m²。受伤原因为创伤者11例、烧伤者2例、电烧伤者1例。受伤部位为手部者10例、足部者4例。

1.3 手术方法

所有患者接受经真皮下入路切取的旋髂浅动脉纯皮肤穿支皮瓣修复。

1.3.1 创面准备 对创面进行彻底清创以去除坏死组织,去除肌腱周围的肉芽组织防止粘连,清创后创面面积为5.6 cm×1.9 cm~14.0 cm×7.0 cm。充分止血,预防皮瓣移植后血肿形成^[23]。选取创面周围的知名血管为受区血管,行辅助切口解剖受区血管,确保血管质量后,根据缺损区域大小和形状裁剪样布。

1.3.2 皮瓣设计与切取及转移 术前用18 MHz高频超声探头探查旋髂浅动脉浅支的走行,随后沿旋髂浅动脉浅支走行找到进入真皮的旋髂浅动脉浅支的穿支并做标记^[24-26]。以旋髂浅动脉浅支走行为轴线设计皮瓣,确保穿支位于皮瓣中心位置,以保证充分的血供。使用手术显微镜在2.5倍放大倍数下进行手术,沿设计的皮瓣外侧缘切开,采用细针电刀充分止血。沿真皮下平面逐层分离皮瓣,保护紧贴真皮的小血管,向真皮穿支点剥离,待探查至真皮穿支点后向下解剖,直至旋髂浅动脉。随后切开皮瓣内侧缘,沿真皮下入路解剖,保护穿支,完整游离皮瓣。根据所需蒂部长度向近端游离旋髂浅动脉,无须携带旋髂浅静脉,只需携带旋髂浅动脉浅支的伴行静脉(图1)。将皮瓣供区创面直接缝合。将皮瓣移植于受区创面,取皮钉快速固定皮瓣后即刻吻合血管,缩短皮瓣缺血时间。待血管吻合

完毕后松止血带,观察血运正常后用4-0缝线间断缝合皮瓣周围,拆除固定皮钉,放置引流皮条防止皮下淤血。用无菌纱布包扎,留皮瓣大小观察窗观察皮瓣血运情况。本组患者皮瓣切取面积为5.6 cm×1.9 cm~14.0 cm×7.0 cm,厚度2~3 mm(平均2.6 mm),皮瓣的纯皮肤穿支数量为1~3条(平均1.7条)。皮瓣切取时间为37~140 min(平均68.1 min)。共切取15个旋髂浅动脉纯皮肤穿支皮瓣。其中1例患者分别在同侧切取2个皮瓣,血管蒂分别为旋髂浅动脉的浅支和深支。此外,1例患者由于皮瓣面积较大,保留了旋髂浅动脉的浅支和深支的皮肤穿支,因此该皮瓣包含2个独立的血管蒂,并均进行了吻合。血管蒂长度3.2~7.7 cm(平均5.0 cm),血管蒂动脉直径0.45~1.30 mm(平均0.9 mm)。受区供血动脉为桡动脉者8例、尺动脉者2例、指动脉者1例、胫前动脉者1例、足背动脉者2例及跖动脉者2例。静脉吻合方面,将所有患者旋髂浅动脉的伴行静脉与受区静脉吻合,其中2例患者额外增加了旋髂浅静脉与手背或足背的皮下浅静脉吻合,血管蒂静脉直径0.3~1.3 mm(平均0.8 mm)。所有静脉均采用端端吻合,动脉吻合方式为端端吻合或端侧吻合。

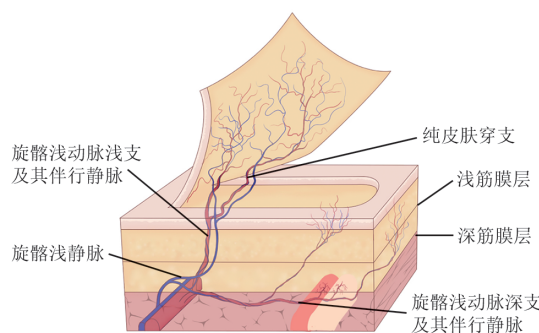


图1 经真皮下入路切取以旋髂浅动脉浅支为蒂的纯皮肤穿支皮瓣的示意图

Figure 1 Diagram of harvesting the pure skin perforator flap pedicled with the superficial branch of superficial circumflex iliac artery via a subdermal approach

1.3.3 术后处理 术后5 d绝对卧床,予以抗感染、抗凝、抗痉挛和镇痛治疗。患肢抬高,表面覆盖毛巾保温。每日观察皮瓣色泽、温度和毛细血管充盈情况,以评估皮瓣成活状况。术后7 d开始适度康复锻炼。术后2周拆线。

1.3.4 观测指标 术后观察皮瓣成活情况。记录术后并发症发生情况。末次随访时,邀请3位本院非手术医师采用利克特5级量表对患者的皮瓣从

整体美学外观、与周围组织的轮廓相似度、与周围组织的颜色相似度、与周围组织的质地相似度 4 个方面进行评价,每个指标评分为 1.0~5.0 分,得分越高表示皮瓣修复效果越佳^[27]。

2 结果

15 个皮瓣术后均顺利成活。其中 1 个皮瓣于术后第 1 天出现紫斑并逐渐扩大,予以换药后于术后第 3 天稳定。1 个皮瓣于术后第 1 天出现静脉危象,予以去除静脉血栓重新吻合后静脉危象缓解。1 例患者术后 2 周供区缝合口裂开,创面延迟愈合,予以清创换药后 1 周顺利愈合。其余患者供受区创面愈合良好,未见供受区创面感染及受区淋巴漏等并发症发生。

患者随访时间为 6~15 个月,平均 8.7 个月。末次随访时,皮瓣整体美学外观评分为 3.3~5.0 分(平均 4.5 分),与周围组织的轮廓相似度评分为 3.7~5.0 分(平均 4.7 分),与周围组织的颜色相似度评分为 3.3~5.0 分(平均 4.5 分),与周围组织的质地相似度评分为 3.7~5.0 分(平均 4.8 分)。

例 1 男,29 岁,身体质量指数为 23.7 kg/m²,因创伤致右手示指远节部分缺失,残端骨、肌腱外露,患者拒绝行手指再造手术。清创后创面大小为 5.6 cm×1.9 cm。于左侧腹股沟区域设计旋髂浅动脉浅支纯皮肤穿支皮瓣,术前行高频超声定位纯皮肤穿支后。术中经真皮下入路切取以旋髂浅动脉浅支为蒂的皮瓣,皮瓣携带 1 条纯皮肤穿支,皮瓣厚 2 mm、大小为 5.6 cm×1.9 cm,切取时间为 37 min,血管蒂长度为 3.2 cm。旋髂浅动脉浅支动脉直径为

0.80 mm,将其与示指尺侧指动脉端端吻合;旋髂浅动脉浅支动脉伴行静脉直径为 0.7 mm,将其与示指掌侧静脉端端吻合。术后皮瓣顺利成活,供受区创面愈合良好,无并发症发生。术后 7 个月(末次随访),皮瓣整体美学外观评分为 4.3 分,与周围组织的轮廓相似度评分为 5.0 分,与周围组织的颜色相似度评分为 3.7 分,与周围组织的质地相似度评分为 3.7 分。图 2。

例 2 男,43 岁,创伤致右手毁损,伴有骨、肌腱外露,急诊入院行清创术,术后创面无感染,创面大小为 14.0 cm×7.0 cm。清创术后 2 周,于左侧腹股沟设计旋髂浅动脉浅支纯皮肤穿支皮瓣修复创面。术前行高频超声定位旋髂浅动脉浅支及纯皮肤穿支走行,术中经真皮下入路切取皮瓣,皮瓣切取面积为 14.0 cm×7.0 cm,皮瓣厚度为 3 mm。术中观察到 2 条纯皮肤穿支,以旋髂浅动脉浅支及深支为蒂,血管蒂长度分别为 4.3 cm 及 5.7 cm,将旋髂浅动脉浅支及深支与受区桡动脉掌浅支的 2 条分支端端吻合,其中旋髂浅动脉浅支动脉的直径为 0.45 mm,其伴行静脉直径为 0.60 mm;旋髂浅动脉深支动脉直径为 0.45 mm,其伴行静脉直径为 0.30 mm。将深支和浅支动脉的伴行静脉与桡动脉掌浅支分支的伴行静脉进行端端吻合。皮瓣携带旋髂浅静脉,直径为 1.00 mm,与受区皮下浅静脉端端吻合。术后皮瓣存活良好。术后 3 周,受区创面愈合良好。术后 6 个月,皮瓣整体美学外观评分为 4.0 分,与周围组织的轮廓相似度评分为 5.0 分,与周围组织的颜色相似度评分为 4.7 分,与周围组织的质地相似度



图 2 经真皮下入路切取以旋髂浅动脉浅支为蒂的纯皮肤穿支皮瓣修复例 1 患者右手示指创面的效果。2A. 术前创面外观;2B. 经真皮下入路显露纯皮肤穿支;2C. 游离纯皮肤穿支;2D. 游离旋髂浅动脉浅支;2E. 皮瓣切取完成后;2F. 术后即刻,皮瓣血运良好;2G. 术后 2 周,皮瓣成活;2H. 术后 6 个月,皮瓣外形良好

Figure 2 Effects of a pure skin perforator flap pedicled with the superficial branch of superficial circumflex iliac artery and harvested via the subdermal approach in repairing a right index finger wound in case one

评分为 5.0 分。见图 3。

3 讨论

日本的 Narushima 等^[8]最早报道将纯皮肤穿支皮瓣用于小儿耳廓后方畸形的重建,与传统的颞浅筋膜瓣+全厚皮片移植相比,带血供的纯皮肤穿支皮瓣移植不存在全厚皮片移植因缺血导致的后期色素沉着的问题^[8]。同时他们还将纯皮肤穿支皮瓣包绕形成管道重建了先天性耳道闭锁患者的外耳道^[28]。随后,他们应用纯皮肤穿支皮瓣成功修复了因血管瘤病变导致全部皮肤切除的手指创面,虽然术后手指的形态无法与再造手指相比,但因皮瓣较薄,使得手指的外形与正常手指并无太大差异^[29-30]。在后续的解剖学研究中,Narushima 等^[13]进一步细化皮瓣的分型,其中最薄的为刃厚皮瓣,其次为全厚皮瓣(纯皮肤穿支皮瓣),而保留全部浅层脂肪层的为薄皮瓣,仅保留真皮下血管网附近的浅层脂肪的为超薄皮瓣。而由保留真皮下血管网的超薄皮瓣向无须保留真皮下血管网的纯皮肤穿支皮瓣的变化得益于 Imanishi 等^[31]对真皮内血管网的解剖学研究,而后有研究者通过 70 MHz 的实时超高频超声进一步验证了真皮内动静脉血管网的存在^[32-34]。与有研究者推崇的经浅筋膜层快速切取以旋髂浅动脉浅支为蒂的薄皮瓣不同,Narushima 及其团队提出的纯皮肤穿支皮瓣是在切取旋髂浅动脉穿支皮瓣后,在显微镜下利用“虫蚀法”从主干血管到真皮层一点点去除脂肪,这无疑会延长手术时间^[28,35-37]。而 Yamamoto 等^[16]在 2021 年报道的经真皮下入路切取

纯皮肤穿支皮瓣克服了这一问题,这一创新的穿支皮瓣手术入路,使髂腹股沟区的皮瓣的厚度由厘米级转变到毫米级,可以说是一个历史性的突破。

Yamamoto 等^[16]建议有淋巴管吻合经验的医师开展纯皮肤穿支皮瓣手术。本研究中所有的纯皮肤穿支皮瓣均由有淋巴静脉吻合经验的同一位高年资显微外科医师完成,术后 15 个皮瓣全部成活,这与 Yamamoto 等^[16]报道的皮瓣成活情况相似。Yamamoto 等^[16]的纯皮肤穿支皮瓣平均切取时间为 27.4 min,另有研究团队的纯皮肤穿支皮瓣平均切取时间为 131.9 min^[1],两者存在较大的差距。本研究中纯皮肤穿支皮瓣平均切取时间为 68.1 min,与日本学者报道的半小时以内的切取时间尚有差距。

纯皮肤穿支皮瓣的一个重要优势是极薄的皮瓣带来的美学修复效果,所以本团队尝试使用 Parrett 等^[27]提出的利克特 5 级量表来评价皮瓣修复结果。在 Parrett 等^[27]的研究中,静脉动脉化皮瓣修复创面后的得分最高,皮瓣整体美学外观平均分为 4.4 分,与周围组织的轮廓相似度平均分为 4.6 分,与周围组织的颜色相似度评分为 4.5 分,与周围组织的质地相似度平均分为 4.3 分,均高于肌皮瓣+皮片移植、筋膜皮瓣和筋膜皮瓣+皮片移植。在本研究中,纯皮肤穿支皮瓣修复创面后,上述 4 个方面的平均分分别为 4.5、4.7、4.5 和 4.8 分,提示纯皮肤穿支皮瓣可能具有美学优势^[27,38]。然而,仍需进一步开展标准化研究,并扩大样本量,以验证纯皮肤穿支皮瓣修复不同创面的效果。纯皮肤穿支皮瓣由于不携带脂肪层,所以可能不太适合覆盖深部组

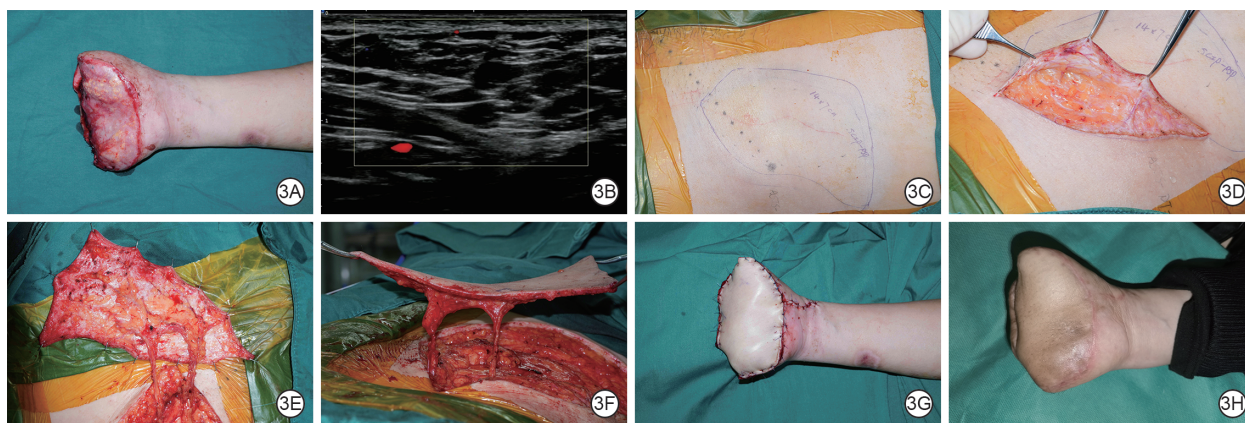


图 3 经真皮下入路切取以旋髂浅动脉浅支和深支为蒂的纯皮肤穿支皮瓣修复例 2 患者右手毁损伤创面的效果。3A. 术前创面外观;3B. 术前用高频超声定位纯皮肤穿支(图上方的红点处);3C. 术前根据创面大小及定位的纯皮肤穿支设计皮瓣;3D. 术中经真皮下入路切取皮瓣,保护纯皮肤穿支;3E. 术中游离皮瓣及纯皮肤穿支后,可见除纯皮肤穿支周围外,其余部位没有脂肪;3F. 游离皮瓣及纯皮肤穿支后从侧面观察皮瓣厚度;3G. 术后即刻可见皮瓣血运良好;3H. 术后 6 个月,皮瓣外观良好

Figure 3 Effects of a pure skin perforator flap pedicled with the superficial and deep branches of the superficial circumflex iliac artery and harvested via the subdermal approach in repairing a destructive wound on the right hand in case two

织缺损。经真皮下入路切取纯皮肤穿支皮瓣是一种较新的皮瓣切取层次,可使脂肪和皮肤分开,可以做到受区缺多少就取多少的效果,无须为了考虑皮瓣厚度而扩大切取范围。术前精准定位穿支入皮点是必不可少的步骤,依靠精准的术前定位,有助于快速找到皮下穿支点,顺利切取整个皮瓣。

纯皮肤穿支皮瓣在四肢的应用主要在于修复功能和美观要求较高的缺损区域,如手足部。这些区域的皮下脂肪很少,运用纯皮肤穿支皮瓣可以有效重塑外形^[29]。与全厚皮片移植相比,纯皮肤穿支皮瓣具有血供明确及能降低色素沉着或色素减退风险的优势。与局部皮瓣不同,纯皮肤穿支皮瓣移植可减少供区瘢痕形成并改善美学外观。在切取过程中,可根据创面情况调整皮瓣携带脂肪情况,例如在肌腱暴露区域选择性地保留一层薄脂肪,可为肌腱滑动提供额外保护并防止肌腱粘连。而在筋膜完整的区域,则无须携带任何多余脂肪进行皮瓣切取,以确保皮瓣的精确分离和制备^[16]。

本研究存在一定的局限性:为回顾性研究且病例数量少,未来的研究应该尝试通过将纯皮肤穿支皮瓣与其他类型的穿支皮瓣对比,来进一步评价经真皮下入路切取纯皮肤穿支皮瓣的优势。

总之,经真皮下入路切取纯皮肤穿支皮瓣修复手足部皮肤软组织缺损虽然有一定的难度,但是一个安全、可行的手术方式,并且受区具有良好的美学效果。

利益冲突 所有作者声明不存在利益冲突

作者贡献声明 朱旭伟、李士:参与手术、研究设计、论文撰写及修改、图片制作、经费支持;周飞亚、李志杰:手术指导、论文修改;丁健:文献查找、论文修改、经费支持;张文振:参与手术、收集病例

参考文献

- [1] Lin Wu ZQ, Bulla A, Aguilera Sáez J, et al. Subdermal dissection technique for pure skin SCIA and ALT perforator flaps in burns and trauma defects: clinical experience[J]. *Microsurgery*, 2024, 44(5): e31189. DOI: 10.1002/micr.31189.
- [2] 韩军涛, 李军, 高晓文, 等. 腹部超薄皮瓣修复小儿手指深度电烧伤创面的效果[J]. *中华烧伤杂志*, 2018, 34(8): 513-515. DOI: 10.3760/cma.j.issn.1009-2587.2018.08.006.
- [3] Barnhill CW, Greyson MA, Iorio ML. Superficial circumflex iliac artery perforator flap reconstruction of the upper extremity[J]. *Hand Clin*, 2024, 40(2): 179-187. DOI: 10.1016/j.hcl.2023.10.001.
- [4] Pereira N, Venegas J, Oñate V, et al. Extremity reconstruction with superficial circumflex iliac artery perforator free flap: refinements and innovations after 101 cases[J]. *J Plast Reconstr Aesthet Surg*, 2023, 85: 1-9. DOI: 10.1016/j.bjps.2023.06.048.
- [5] Hong JP. The superficial circumflex iliac artery perforator flap in lower extremity reconstruction[J]. *Clin Plast Surg*, 2021, 48(2): 225-233. DOI: 10.1016/j.cps.2020.12.005.
- [6] Jung S, Lee S, Eun S. Free flap reconstruction of traumatic skin defects of the entire hand dorsum[J]. *J Clin Med*, 2025, 14(4): 1308. DOI: 10.3390/jcm14041308.
- [7] Chen W, Jian Y, Cheng M, et al. Long-term follow-up of modified shunt-restricted instep arterialized venous flap for reconstruction of hand defects[J]. *Front Med (Lausanne)*, 2025, 12: 1662159. DOI: 10.3389/fmed.2025.1662159.
- [8] Narushima M, Yamasoba T, Iida T, et al. Pure skin perforator flap for microtia and congenital aural atresia using supermicrosurgical techniques[J]. *J Plast Reconstr Aesthet Surg*, 2011, 64(12): 1580-1584. DOI: 10.1016/j.bjps.2011.07.005.
- [9] Tung YC, Chen YK, Lin YS. Reconstruction of posttraumatic distal limb defects with free superficial circumflex iliac artery perforator flap[J]. *Ann Plast Surg*, 2025, 94(3S Suppl 1): S13-S17. DOI: 10.1097/SAP.0000000000004198.
- [10] Kueckelhaus M, Gebur N, Kampshoff D, et al. Initial experience with the superficial circumflex iliac artery perforator (SCIP) flap for extremity reconstruction in Caucasians[J]. *J Plast Reconstr Aesthet Surg*, 2022, 75(1): 118-124. DOI: 10.1016/j.bjps.2021.05.069.
- [11] Yamamoto T, Yamamoto N, Kageyama T, et al. Supermicrosurgery for oncologic reconstructions[J]. *Glob Health Med*, 2020, 2(1): 18-23. DOI: 10.35772/ghm.2019.01019.
- [12] Kimura N, Saitoh M, Hasumi T, et al. Clinical application and refinement of the microdissected thin groin flap transfer operation[J]. *J Plast Reconstr Aesthet Surg*, 2009, 62(11): 1510-1516. DOI: 10.1016/j.bjps.2008.06.039.
- [13] Narushima M, Yamasoba T, Iida T, et al. Pure skin perforator flaps: the anatomical vascularity of the superthin flap[J]. *J Plast Reconstr Surg*, 2018, 142(3): 351e-360e. DOI: 10.1097/PRS.0000000000004698.
- [14] Hong JP, Kwon JG, Suh HP, et al. The evolution of perforator flaps and the future of microsurgery[J]. *JPRAS Open*, 2025, 47: 33-42. DOI: 10.1016/j.jpura.2025.09.016.
- [15] 张丕红. 浅谈薄型穿支皮瓣切取与穿支血管探测和皮瓣血运评估[J]. *中华烧伤与创面修复杂志*, 2023, 39(10): 911-918. DOI: 10.3760/cma.j.cn501225-20230812-00047.
- [16] Yamamoto T, Yamamoto N, Fuse Y, et al. Subdermal dissection for elevation of pure skin perforator flaps and superthin flaps: The dermis as a landmark for the most superficial dissection plane[J]. *J Plast Reconstr Surg*, 2021, 147(3): 470-478. DOI: 10.1097/PRS.0000000000007689.
- [17] Ohki S, Miyazaki T. Fast and thin: subdermal dissection of pure skin perforator flaps in pediatric extremity trauma[J]. *J Plast Reconstr Aesthet Surg*, 2023, 78: 73-74. DOI: 10.1016/j.bjps.2023.01.037.
- [18] Sakai H, Sun JM, Machida T, et al. Dorsal hand reconstruction with large superficial circumflex iliac artery pure skin perforator flap without high-frequency Doppler ultrasound[J]. *J Plast Reconstr Surg Glob Open*, 2026, 14(3): e7580. DOI: 10.1097/GOX.00000000000007580.
- [19] Calabrese S, Innocenti M. Superthin flap harvesting procedure: technical note[J]. *Arch Plast Surg*, 2022, 49(6): 785-786. DOI: 10.1055/s-0042-1758634.
- [20] Zubler C, Constantinescu MA, Lese I, et al. The osteocutaneous superficial circumflex iliac artery (SCIP) flap in extremity reconstruction[J]. *J Hand Microsurg*, 2025, 17(6): 100337. DOI:

- 10.1016/j.jham.2025.100337.
- [21] Innocenti M, Calabrese S, Tanini S, et al. A safer way to harvest a superthin perforator flap[J]. *Plast Reconstr Surg*, 2021, 147(3):466-469. DOI:10.1097/PRS.00000000000007676.
- [22] 王绍钱, 王徽, 贾其余. 膜诱导技术联合游离超薄股前外侧穿支皮瓣修复足踝部创面的临床疗效分析[J]. *解放军医学杂志*, 2025, 50(11): 1407-1413. DOI: 10.11855/j.issn.0577-7402.1121.2025.0716.
- [23] Altiparmak M, Cha HG, Hong JP, et al. Superficial circumflex iliac artery perforator flap as a workhorse flap: systematic review and meta-analysis[J]. *J Reconstr Microsurg*, 2020, 36(8):600-605. DOI:10.1055/s-0040-1713666.
- [24] Malagón P, Miyazaki T, Sakai H, et al. How to perform the preoperative planning of PSP flaps? A practical guide of 5 steps using high-frequency ultrasound[J]. *J Plast Reconstr Aesthet Surg*, 2024, 92: 72-74. DOI: 10.1016/j.bjps.2024.02.072.
- [25] 张文桐, 杨勇, 李峰, 等. 基于彩色多普勒超声定位的分层剥离旋髂浅动脉穿支皮瓣的临床疗效[J]. *中华烧伤与创面修复杂志*, 2025, 41(1): 45-52. DOI: 10.3760/cma.j.cn501225-20240927-00358.
- [26] 赵书明, 刘娜, 刘学亮, 等. 彩色多普勒超声辅助下超薄胸背动脉穿支皮瓣的切取方案及临床应用效果[J]. *中华烧伤与创面修复杂志*, 2024, 40(3): 281-288. DOI: 10.3760/cma.j.cn501225-20231012-00111.
- [27] Parrett BM, Bou-Merhi JS, Buntic RF, et al. Refining outcomes in dorsal hand coverage: consideration of aesthetics and donor-site morbidity[J]. *Plast Reconstr Surg*, 2010, 126(5): 1630-1638. DOI:10.1097/PRS.0b013e3181ef8ea3.
- [28] Narushima M, Yamasoba T, Iida T, et al. Supermicrosurgical reconstruction for congenital aural atresia using a pure skin perforator flap: concept and long-term results[J]. *Plast Reconstr Surg*, 2013, 131(6): 1359-1366. DOI: 10.1097/PRS.0b013e31828bd466.
- [29] Narushima M, Iida T, Kaji N, et al. Superficial circumflex iliac artery pure skin perforator-based superthin flap for hand and finger reconstruction[J]. *J Plast Reconstr Aesthet Surg*, 2016, 69(6): 827-834. DOI: 10.1016/j.bjps.2016.03.005.
- [30] Jain NS, Bingham E, Goldberg M. The superficial circumflex iliac artery perforator flap for devastating hand injuries in obese patients[J]. *Ann Plast Surg*, 2023, 91(4): 441-445. DOI: 10.1097/SAP.0000000000003644.
- [31] Imanishi N, Nakajima H, Minabe T, et al. Angiographic study of the subdermal plexus: a preliminary report[J]. *Scand J Plast Reconstr Surg Hand Surg*, 2000, 34(2): 113-116. DOI: 10.1080/02844310050159954.
- [32] Imanishi N, Kishi K, Chang H, et al. Three-dimensional venous anatomy of the dermis observed using stereography[J]. *J Anat*, 2008, 212(5): 669-673. DOI: 10.1111/j.1469-7580.2008.00890.x.
- [33] Yoshimatsu H, Hayashi A, Yamamoto T, et al. Visualization of the "intradermal plexus" using ultrasonography in the dermis flap: a step beyond perforator flaps[J]. *Plast Reconstr Surg Glob Open*, 2019, 7(11): e2411. DOI: 10.1097/GOX.0000000000002411.
- [34] Zhang T, Wu X, Jiang L, et al. Type 3A free anterolateral thigh chimeric flap based on the Zunyi classification for reconstructing diabetic foot wounds[J]. *Front Surg*, 2025, 12: 1679998. DOI: 10.3389/fsurg.2025.1679998.
- [35] Goh TLH, Park SW, Cho JY, et al. The search for the ideal thin skin flap: superficial circumflex iliac artery perforator flap--a review of 210 cases[J]. *Plast Reconstr Surg*, 2015, 135(2): 592-601. DOI: 10.1097/PRS.0000000000000951.
- [36] Koshima I, Nanba Y, Tsutsui T, et al. Superficial circumflex iliac artery perforator flap for reconstruction of limb defects[J]. *Plast Reconstr Surg*, 2004, 113(1): 233-240. DOI: 10.1097/01.PRS.0000095948.03605.20.
- [37] Song CT, Bhogsha S, Chu S, et al. Review of the superficial circumflex iliac artery perforator flap: recommendations to the approach[J]. *Australas J Plast Surg*, 2020, 3(2): 20-29. DOI: 10.34239/ajops.v3n2.193.
- [38] Hattori Y, Harima M, Yamashita S, et al. Superthin thoracodorsal artery perforator flap for the reconstruction of palmar burn contracture[J]. *Plast Reconstr Surg Glob Open*, 2020, 8(3): e2695. DOI: 10.1097/GOX.0000000000002695.