

· 临床研究 ·

复合骨皮瓣移植联合骨延长修复下肢烧伤伴软组织并骨缺损

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【摘要】 目的: 比较传统腓骨皮瓣联合自体骨移植与复合骨皮瓣移植联合骨延长长期修复治疗下肢烧伤致严重软组织并骨缺损的疗效。**方法:** 回顾分析 2015 年 3 月至 2018 年 1 月下肢烧伤致严重软组织并骨缺损患者 68 例, 依据治疗方案分为对照组 34 例与研究组 34 例。所有患者存在不同程度软组织及骨组织缺损, 研究组 34 例采取复合骨皮瓣移植联合骨延长长期修复治疗, 男 22 例, 女 12 例; 年龄 32~46(39.18±6.01) 岁; 受伤至治疗时间(16.69±5.11) h; 致伤原因: 爆炸伤 28 例, 火器烧伤 6 例; 骨缺损长度(12.10±2.34) cm; 左侧 16 例, 右侧 18 例。对照组 34 例采取腓骨皮瓣联合自体骨移植治疗, 男 24 例, 女 10 例; 年龄 31~47(38.93±5.81) 岁; 受伤至治疗时间(17.10±5.63) h; 爆炸伤 30 例, 火器烧伤 4 例; 骨缺损长度(11.96±2.51) cm; 左侧 19 例, 右侧 15 例。所有患者随访 6 个月, 记录两组术前及术后 3、6 个月肢体功能 Fugl-Meyer 分值(FMA), 术后 6 个月的治疗满意度、疗效和并发症。**结果:** 肢体功能: 术前两组 FMA 分值间差异无统计学意义($P>0.05$), 术后 3、6 个月两组 FMA 分值较术前增高($P<0.05$), 且研究组高于对照组($P<0.05$)。术后 6 个月疗效: 研究组治疗优良率(94.12%)高于对照组(76.47%)($P<0.05$)。术后 6 个月患者治疗满意度: 研究组治疗满意度(94.12%)高于对照组(76.47%)($P<0.05$)。并发症: 研究组并发症发生率(14.71%), 对照组(26.47%), 差异无统计学意义($P>0.05$)。**结论:** 联合采取复合骨皮瓣移植及骨延长长期修复治疗下肢烧伤致严重软组织并骨缺损, 可取得良好治疗效果, 改善患者肢体功能, 治疗满意度较高, 且具有一定安全性。

【关键词】 外科皮瓣; 骨延长术; 下肢; 烧伤; 软组织损伤

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Composite bone and skin flap transplantation combined with bone lengthening for repairing lower limb burn with soft tissue and bone defect JIN Jie. Zhejiang Tongde Hospital, Hangzhou 310000, Zhejiang, China

ABSTRACT Objective: To compare the effect of traditional fibula flap combined with allogeneic bone transplantation and composite bone flap transplantation combined with bone lengthening in staged repair of severe soft tissue and bone defect caused by lower limb burn. **Methods:** Total 68 patients with severe soft tissue and bone defect caused by lower limb burn from March 2015 to January 2018 were retrospectively analyzed, and they were divided into control group (34 cases) and study group (34 cases) according to the treatment plan. All patients had different degrees of soft tissue and bone tissue defects. In the study group, 34 patients were treated with composite bone flap transplantation combined with bone lengthening. There were 22 males and 12 females; the age ranged from 32 to 46 (39.18±6.01) years; the time from injury to treatment was (16.69±5.11) h; 28 cases were caused by explosion injury and 6 cases were caused by firearm burn; the length of bone defect was (12.10±2.34) cm; and 16 cases were on the left side of affected limb 18 cases were on the right side. In the control group, there were 24 males and 10 females, aged 31 to 47 (38.93±5.81) years; the time from injury to treatment was (17.10±5.63) h; the causes of injury were explosive injury in 30 cases and firearm burn in 4 cases; the length of bone defect was (11.96±2.51) cm; 19 cases were on the left side and 15 cases on the right side. All patients were followed up for 6 months. The FMA scores before operation and 3 and 6 months after operation, treatment satisfaction, curative effect and complications of the two groups were recorded. **Results:** Limb function; there was no significant difference in FMA scores between the two groups before operation ($P>0.05$), and the FMA scores of the two groups were higher than those before operation 3 and 6 months after operation ($P<0.05$), and the FMA scores of the study group were higher than those of the control group ($P<0.05$). At 6 months after operation; the excellent and good rate of the study group (94.12%) was higher than that of the control group (76.47%) ($P<0.05$), the treatment satisfaction of the study group (94.12%) was higher than that of the control group (76.47%) ($P<0.05$). Complications; the incidence of complications in the study group (14.71%) was higher than that in the control group (26.47%) ($P>0.05$). **Conclusion:** the combined use of composite bone flap transplantation and bone lengthening staged repair in the treatment of severe soft tissue and bone defect caused by lower limb burn can achieve good therapeutic effect, improve limb function, and have high treatment satisfaction and certain safety.

KEYWORDS Surgical flaps; Bone lengthening; Lower extremity; Burns; Soft tissue injuries

重度烧伤(一氧化碳中毒烧伤、高压电烧伤)所致下肢开放性粉碎性骨折、骨坏死具有较高发病率,且患者多伴有广泛长段骨坏死、软组织缺损,重建、修复难度较大^[1-2]。同时,若下肢烧伤致严重软组织并骨缺损患者未及时得到有效干预,则可能会导致重度残疾,对患者身心健康及躯体功能造成极大影响^[3]。此外,下肢烧伤致严重软组织并骨缺损临床治疗不仅需重建骨缺损,且应给予必要的软组织缺损修复处理。既往临床多是采取带血管蒂腓骨移植等措施对患者实施治疗,可取得一定效果,但治疗用时较长、过程复杂,且术后畸形、骨不愈合、感染等并发症发生风险较高,不利于预后改善^[4-5]。近年来,复合骨皮瓣移植及骨延长分期修复技术在下肢伤所致缺损中的应用价值得到普遍重视,但关于两者联合治疗效果的系统性研究较少。基于此,本研究选取我院 2015 年 3 月至 2018 年 1 月 68 例下肢烧伤致严重软组织并骨缺损患者,探讨复合骨皮瓣移植联合骨延长分期修复效果,以期为下肢烧伤致严重软组织并骨缺损的临床治疗提供新的思路及参考价值。

1 资料与方法

1.1 病例选择

纳入标准:年龄<60 岁;骨缺损长度 7.3~17.1 cm,软组织缺损面积 39.4~204.2 cm²;生命体征平稳;单侧肢体受损。排除标准:合并其他肢体骨折者;合并全身性感染者;合并血液系统、内分泌系统病者;合并良恶性肿瘤者;合并骨肿瘤及骨髓炎者;合并肝肾等脏器器质性病变者;合并心脑血管病者。

1.2 一般资料与分组

回顾分析我院下肢烧伤致严重软组织并骨缺损患者 68 例,根据治疗方案分为对照组与研究组,每组 34 例,两组性别、年龄、受伤至治疗时间、致伤原因、伤侧骨缺损长度等术前一般资料差异有统计学意义,具有可比性($P>0.05$),见表 1。

1.3 治疗方法

1.3.1 研究组 采取复合骨皮瓣移植联合骨延长

分期修复治疗。清除内固定物、感染死骨、感染肉芽组织、坏死皮肤;参照缺损形状及面积,于髂腹处设计髂骨皮瓣,自股动脉腹股沟搏动点内侧 1~2 cm 起,于腹股沟韧带上约 2 cm 朝髂前上棘弧形做与腹股沟韧带平行的切口;沿预设切口线,做腹股沟切口,可见腹外斜肌腱膜,腹股沟韧带上 2 cm,与腹股沟韧带平行剖开腹外斜肌腱膜,沿腹股沟韧带分离腹横肌、腹内斜肌,向上牵开;腹横筋膜剖开,髂外动脉前外侧游离旋髂深动脉,显露旋髂深动脉与伴行静脉血管蒂腹股沟段;旋髂深血管于髂前上棘内 2 cm 结扎粗大腹壁肌,髂前上棘处自血管前方跨过,将其切断,髂骨皮瓣游离后缝合处理;沿皮瓣上切口线剖开至腹外斜肌,深筋膜和腹外斜肌腱膜间朝下掀开皮瓣,与髂嵴平行剖开腹横肌、腹内斜肌、腹外斜肌,与髂嵴相连的肌袖保留 1 cm;沿皮瓣下切口线剖开,皮瓣掀起至髂嵴外侧,贴附髂骨离断阔筋膜张肌、臀大肌起点,剥离骨膜至预设髂骨瓣平面,切取髂骨瓣,参照患者下肢缺损进行移植:移植于胫骨 15 例、移植于股骨 19 例,吻合血管。随访 6~8 个月,待骨皮瓣成活、创面愈合,实施骨延长,外固定架与石膏托拆除,选取适宜骨延长外固定架,明确远近端骨段对线对位良好,正侧位透视延长滑杆平行于骨干解剖轴,选取干骺处截骨,作胫骨或股骨前方向切口,骨膜纵向剖开,剥离骨膜,显露胫骨或股骨周径前外约 1/4,于预设截骨水平处采取钻头(直径 3.2 mm)间断性钻孔,并穿透双侧皮质,以骨刀凿断各孔间骨皮质,顺时针旋转加压牵拉螺栓闭合截骨端间隙,延长骨段夹钳拧紧、固定,骨膜缝合,止血、闭合切口;截骨后约 2 周牵拉截骨段,朝骨缺损侧延长中央骨段(每天 4 次,每次 0.25 mm),间隔 6 h 延长 1 次,若骨延长>4 cm,则每周减少牵拉 1~2 d;根据患者具体恢复情况指导其进行术后康复训练。

1.3.2 对照组 采取腓骨皮瓣联合异体骨移植,清除内固定物、感染死骨、感染肉芽组织、坏死皮肤,参照骨缺损长度、软组织缺损面积预设腓骨皮瓣,受损

表 1 两组下肢烧伤致严重软组织并骨缺损患者一般资料比较

Tab.1 Comparison of general information of two groups of patients with severe soft tissue and bone defect caused by lower limb burn

组别	例数	性别(例)		年龄 ($\bar{x}\pm s$,岁)	致伤原因(例)		受伤至治疗时间 ($\bar{x}\pm s$,h)	骨缺损长度 ($\bar{x}\pm s$,cm)	伤侧(例)	
		男	女		爆炸伤	火器烧伤			左侧	右侧
研究组	34	22	12	39.18±6.01	28	6	16.69±5.11	12.10±2.34	16	18
对照组	34	24	10	38.93±5.81	30	4	17.10±5.63	11.96±2.51	19	15
检验值		$\chi^2=0.269$		$t=0.174$	$\chi^2=0.469$		$t=0.314$	$t=0.238$	$\chi^2=0.530$	
P 值		0.604		0.862	0.494		0.754	0.813	0.467	

区探查、分离备用血管，剖开皮瓣后缘，参照患者下肢缺损进行移植：移植于胫骨 18 例、移植于股骨 16 例，皮肤及深筋膜切透，沿肌肉表面朝前方实施锐性分离处理，深层组织剖开，显露腓总神经、腓静脉及动脉，游离至后肌间隔，深筋膜下游离向外侧腓骨，腓骨止点保留腓骨短、长肌薄层后切断，显露腓骨前外侧、后侧，于腓骨周边保留于 1 cm 肌袖；预设冻干异体骨开槽，腓骨植入异体骨，构建为复合移植体，防止血管蒂、腓骨表面肌袖遭受压迫，植入缺损处，固定。术后干预同研究组。

1.4 观察项目与方法

两组术前及术后 3、6 个月肢体功能，依据 Fugl-Meyer 量表(FMA)评估，共 34 分，分值越高肢体功能越好^[6]。术后 6 个月统计两组患者对治疗的主观满意度以主观评估，分为非常满意、满意、不满意，[(非常满意+满意)/总例数]×100%=治疗满意度。记录两组并发症发生情况。根据胡居正等^[7]临床评价标准：优，疼痛等症状消失，无局部压痛感，关节可正常活动，未出现畸形，可对抗力量，肢体缩短不足 1 cm；良，创面愈合，关节活动度≥80°，偶尔出现疼痛感，存在轻度畸形，肢体缩短为 1~2 cm；可，创面愈合，但存在明显疼痛感，对抗力量较弱，关节活动度<80°，肢体缩短为 2~3 cm；差，创面愈合不良，存在强烈疼痛感，关节难以正常活动，存在明显跛行，肢体缩短>3 cm；治疗优良率=[(优+良)/总例数]×100%。

1.5 统计学处理

采用 SPSS 25.0 软件进行统计分析，定量资料(肢体功能评分)以均数±标准差($\bar{x}\pm s$)表示，采用配对 *t* 检验；计数资料(治疗优良率、治疗满意度、并发症)采用 χ^2 检验；以 *P*<0.05 为差异有统计学意义。

2 结果

两组患者术前后肢体功能 FMA 评分结果见表 2，术前两组 Fugl-Meyer 分值差异无统计学意义(*P*>0.05)，术后 3、6 个月两组 FMA 分值较术前明显增高(*P*<0.05)，且研究组高于对照组(*P*<0.05)。两组患者术后随访 6 个月时，研究组患者对治疗的主观满意度(94.12%)明显高于对照组(76.47%)(*P*<0.05)，见表 3。两组术后 6 个月疗效结果见表 4，研究组优良率(94.12%)明显高于对照组(76.47%)(*P*<0.05)，见表 4。两组患者术后并发症发生见表 5，研究组并发症发生率 14.71%，对照组 26.47%，但两组比较差异无统计学意义(*P*>0.05)。

3 讨论

下肢烧伤所致严重软组织并骨缺损危害较大，且感染及创伤等所致骨缺损，极易因血管挫伤、瘢痕

表 2 两组下肢烧伤致严重软组织并骨缺损患者术前后肢体功能 Fugl-Meyer 分值比较($\bar{x}\pm s$,分)

Tab.2 Comparison of Fugl Meyer scores of limb function of patients with severe soft tissue and bone defect caused by lower limb burn between two groups before and after operation($\bar{x}\pm s$, score)

组别	例数	术前	术后 3 个月	术后 6 个月
研究组	34	15.13±2.20	23.79±2.11 ^a	29.15±2.53 ^a
对照组	34	14.78±2.02	19.91±1.98 ^a	25.06±2.34 ^a
<i>t</i> 值		0.683	7.819	6.920
<i>P</i> 值		0.497	<0.001	<0.001

注：与同组术前比较，^a*P*<0.05

Note: Compared with the group before operation, ^a*P*<0.05

表 3 两组下肢烧伤致严重软组织并骨缺损患者治疗主观满意度比较[例(%)]

Tab.3 Comparison of subjective satisfaction between two groups of patients with severe soft tissue and bone defect caused by lower limb burn[cases (%)]

组别	例数	非常满意	满意	不满意	总满意度
研究组	34	27(79.41)	5(14.71)	2(5.88)	32(94.12)*
对照组	34	17(50.00)	9(26.47)	8(23.53)	26(76.47)

注：与对照组比较，* $\chi^2=4.221$, *P*=0.040

Note: Compared with control group, * $\chi^2=4.221$, *P*=0.040

表 4 两组下肢烧伤致严重软组织并骨缺损患者术后疗效比较[例(%)]

Tab.4 Comparison of postoperative efficacy between two groups of patients with severe soft tissue and bone defect caused by lower limb burn[case (%)]

组别	例数	优	良	可	差	优良率
研究组	34	25(73.53)	7(20.59)	2(5.88)	0(0.00)	32(94.12)*
对照组	34	19(55.88)	7(20.59)	7(20.59)	1(2.94)	26(76.47)

注：与对照组比较，* $\chi^2=4.221$, *P*=0.040

Note: Compared with control group, * $\chi^2=4.221$, *P*=0.040

增生、动静脉局部血管缺损等影响机体功能康复^[8-9]。

3.1 治疗现状

针对下肢烧伤致严重软组织并骨缺损，其治疗原则主要在于有效清创，并选取血运丰富皮瓣进行缺损修复，控制创面感染情况，待皮瓣成活及创面良好愈合后实施截骨术、骨延长分期修复治疗。Masquelet 技术、带血管蒂自体腓骨移植等均为临床治疗骨缺损的常用措施，但均存在一定弊端，如 Masquelet 技术安全性高、操作简单，且对受区要求较低，但需二次手术治疗，加之自体松质骨来源较

表 5 两组下肢烧伤致严重软组织并骨缺损患者术后并发症比较[例(%)]

Tab.5 Comparison of postoperative complications between two groups in patients with severe soft tissue and bone defect caused by lower limb burn[cases(%)]

组别	例数	感染	畸形愈合	血肿	血管危象	骨不愈合	总发生率
研究组	34	2(5.88)	0(0.00)	2(5.88)	0(0.00)	1(2.94)	5(14.71)*
对照组	34	2(5.88)	1(2.94)	3(8.82)	2(5.88)	1(2.94)	9(26.47)

注:与对照组比较, * $\chi^2=1.439, P=0.230$

Note: Compared with control group, * $\chi^2=1.439, P=0.230$

少,故临床应用存在一定局限性;带血管蒂自体腓骨移植要求受区无感染、皮肤组织完整,且骨愈合前无法长时间负重^[10-11]。此外,若患者同时发生软组织并骨缺损,则如何有效修复软组织即成为影响骨缺损治疗效果的重要前提。随临床研究深入发现,联合实施皮瓣移植术及骨延长分期修复术可有效避免瘢痕形成、骨延长难以愈合、血管危象及神经麻痹等并发症发生^[12]。同时,待皮瓣移植成活后,可显著增多受区血运、强化局部抗感染能力,最大程度降低骨髓炎、继发性坏死、截肢等风险。

3.2 复合骨皮瓣移植及骨延长分期修复治疗价值

沈余明等^[13]研究发现,烧伤后下肢严重软组织与骨缺损患者联合采取组织瓣移植及骨延长技术分期治疗后,其骨缺损均得到有效修复,下肢功能良好恢复,且未见骨髓炎、神经及血管损伤等并发症发生。张旭等^[14]联合皮瓣移植术及骨转移技术对小腿骨与软组织缺损实施治疗后发现,患者骨愈合率可达 100%。Sia 等^[15]采取背阔肌锯齿状前肋游离皮瓣修复治疗下肢广泛性软组织缺损伴骨缺损,也发现所有患者皮瓣均存活,且实现骨愈合。本研究结果显示,治疗后研究组 FMA 分值高于对照组,治疗优良率优于对照组,与上述研究结果具有一致性,且研究组治疗满意度较高($P<0.05$),而并发症发生率低于对照组,但组间比较无显著差异,表明联合复合骨皮瓣移植及骨延长分期修复治疗下肢烧伤致严重软组织并骨缺损,在改善患者肢体功能、提高治疗效果方面具有显著优势,患者对手术治疗效果满意度较高。分析其原因主要在于:吻合血管髂骨皮瓣移植属活骨,可提供良好血供,无须爬行代替,能为创面及骨皮瓣愈合提供良好条件,缩短愈合时长,并有效降低单纯植骨术后植骨吸收及骨不连等发生风险。同时,旋髂深血管外径较粗,解剖恒定,于髂嵴处分出髂嵴支能直接滋养髂骨,加之髂骨具备良好成骨性能,主要由富含红骨髓的骨小梁所构成,骨诱导作用突出,可有效促进成骨及骨质愈合^[16-17]。而联合骨延长技术可将健康骨运输至缺损部位,并于运输期间促使新骨形成,以此实现骨缺损治疗目标,适用于长段骨

缺损修复治疗。

3.3 复合骨皮瓣移植及骨延长分期修复注意事项

此外,为保证复合骨皮瓣移植及骨延长分期修复治疗效果及安全性,研究认为实际治疗期间应注意:实施旋髂深血管解剖处理时,应有效保护股外侧皮神经,而游离髂骨皮瓣时应保护血管蒂旁肌袖,防止损伤小分支影响皮瓣及骨瓣血供。同时,骨延长对接端断端存在间隙影响愈合时,需及时清理断端软组织、去皮质化,防止骨局部不愈合、畸形愈合、拆除外固定支架时局部发生骨折。

综上所述,联合采取复合骨皮瓣移植及骨延长分期修复治疗下肢烧伤致严重软组织并骨缺损,可取得良好治疗效果,改善患者肢体功能,治疗满意度较高,且具有一定安全性。

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