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Comparison of outcomes between early and delayed weight bearing following lower limb free flaps: an 18-month single-center study

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How to cite this article: Al-Khalil M, Roman M, Emam A, Marsden N. Comparison of outcomes between early and delayed weight bearing following lower limb free flaps: an 18-month single-center study. *Plast Aesthet Res* 2023;10:15. <https://dx.doi.org/10.20517/2347-9264.2022.102>

Received: 1 Sep 2022 **First Decision:** 8 Mar 2023 **Revised:** 2 Apr 2023 **Accepted:** 15 Apr 2023 **Published:** 24 Apr 2023

Academic Editors: Marten Basta, Christopher Bibbo **Copy Editor:** Yanbing Bai **Production Editor:** Yanbing Bai

Abstract

Aim: Post-operative protocols following lower limb free flap surgery are not well defined, with a lack of consensus in the literature around limb dependency and weight bearing. The aim was to compare the complication rate for lower limb free flaps before and after the introduction of an enhanced lower limb free flap protocol with earlier dangling (day 3 vs. day 4) and weight bearing (day 5 vs. day 14) post lower limb free flap surgery.

Methods: All lower limb free flaps between June 2020-January 2022 were identified from a departmental flap database. Patient data were collected from the comprehensive lower limb free flap database, medical notes, and electronic records. Patients prescribed an extended non-weight-bearing period due to the method of bone fixation were excluded.

Results: A total of 37 patients, 15 pre- and 22 post-enhanced protocol, were identified for comparison. The mean age was 43 (17-72) with a M:F of 3:1. There was no difference in the type of flap reconstruction between groups, with the anterolateral thigh flap being the most common in both groups. No differences were identified in the number of complications related to dependency/weight bearing before and after the introduction of the enhanced protocol, with the mean length of stay reduced from 12.1 to 10.6 days ($P = 0.34$).



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Conclusion: The new enhanced protocol remains the standard of care in our unit, as we demonstrated a reduction in length of stay with no difference in complication rates following early weight bearing after lower limb free flap surgery.

Keywords: Lower limb reconstruction, free flap, free tissue transfer, weight bearing, post-operative complications

INTRODUCTION

Free tissue transfer is now a widely prevalent technique that may be employed to reconstruct complex defects of the lower limb resulting from trauma, infection, or other aetiologies. Free flap reconstruction constitutes major surgery and complication rates as high as 40% have been reported with complete flap loss rates of approximately 3%-8.5%^[1].

The aim of free flap reconstruction is to restore form and function to the affected limb and provide lasting coverage to the defect. As such, a key complication of surgery to be avoided is flap loss. The first few days following surgery are the time when a flap is most at risk, with the majority of cases of flap loss occurring within the first 48 hours^[2]. These first days are, therefore, justifiably a time of close monitoring and considerable caution. An important consideration for the post-operative management of lower limb free flap patients is the best time from which to allow patients to bear weight on their operated leg. It has been well established in surgical patients in general that prolonged periods of immobilisation are associated with multiple complications including an increased risk of venous thromboembolism and physical deconditioning^[3,4]. In addition, many lower limb free flaps are performed due to trauma, and there is evidence that early weight bearing can help fracture healing for certain fracture patterns without an increase in complications^[5,6]. However, there remains a lack of consensus over when is the correct time to introduce weight bearing, mainly due to uncertainty on its possible effect on flap loss^[1,7]. It has been suggested that the lack of consensus on the correct time to start weight bearing may be related to the fact that there are multiple factors that determine when a patient may begin mobilising^[8]. For example, there may be constraints imposed by the method of bone fixation or other injuries the patient may have sustained. In our unit and in the United Kingdom as a whole, standards for the management of open fractures are published by the British Orthopaedic Association (BOA) and the British Association of Plastic, Reconstructive and Aesthetic Surgeons (BAPRAS)^[9]. This set of standards, last updated in 2020, provides a structured and detailed set of requirements for the management of open lower limb fractures but does not make recommendations on weight bearing after free flap reconstruction.

In April 2021, The Welsh Centre for Burns and Plastic Surgery adopted an enhanced recovery protocol (a copy is provided in the supplementary materials section) to guide the post-operative management of patients having lower limb free-flap surgery. This involved dangling from day three and weight bearing from day five after surgery. Prior to the introduction of the enhanced protocol, dangling began from day four and weight bearing from day 14. There are no formal established care standards for dangling and weight bearing, but this document was informed by a recommended published protocol following a survey of UK units^[10]. The aim of introducing this protocol was to standardise post-operative care, enhance recovery and reduce post-operative complications.

This study aimed to identify whether the introduction of an early weight-bearing protocol had any impact on post-operative complications or length of hospital stay following lower limb free flap surgery.

METHODS

Details of all free flaps performed at the Welsh Centre for Burns and Plastic Surgery, including post-operative complications, are entered prospectively into a departmental database by the senior authors. All patients who underwent lower limb free flap surgery between June 2020 and January 2022 were identified and screened against the following exclusion criterion: any patients who had an extended non-weight bearing requirement at the time of free flap surgery (for example due to an ankle fracture or specific orthopaedic requirement) were excluded as they would not be able to take part in weight bearing at the standard times (day 14 pre-protocol or day five post-protocol). This information was gleaned from the operation note. Information on complications was identified directly from the departmental database, as well as by screening all clinic letters, operation notes, and clinical documents. Intra-operative or immediate/very early complications, such as a flap necessitating returning to theatre within a few hours of the original surgery, were excluded because these cannot be attributed to the patient's weight-bearing status.

Our objective was to identify all patients undergoing lower limb free flap surgery before and after the implementation of the enhanced recovery protocol and to compare their complication rates. Our primary outcome measure was flap loss at the point of discharge from hospital. Secondary outcomes were other complications and the length of stay.

This work was classified as quality improvement rather than research and involved no patient intervention and so ethical approval was not indicated in accordance with UK Health Research Authority guidelines^[11].

RESULTS

In total, 121 lower limb free flaps were performed between June 2020 and January 2022, with 108 (89%) for acute lower limb trauma and 13 for fracture-related infection (FRI) (11%). Prior to the introduction of the enhanced protocol, there were 53 free flaps, and 55 flaps post the introduction of the enhanced protocol, which met the inclusion criteria of being prescribed full weight bearing from an orthopaedic perspective. In total, 37 patients were identified that met the inclusion/exclusion criteria (15 pre-protocol and 22 post-protocol). The patient mean age was 43 (17 to 72) years, with a 3:1 male-to-female ratio. The most common free flap performed was the anterolateral thigh flap (ALT) in both groups. Of the 37 patients who met inclusion criteria, 32 had suffered an acute open fracture, with the remaining 5 cases requiring soft tissue coverage for fracture-related infection. Further details, including information on fracture configuration, are displayed in [Table 1]. Of the 32 patients with open fractures, the method of fixation was intramedullary nailing in 31 cases, with one patient (in the post-protocol group) having a Taylor Spatial Frame fitted. In 3 patients (1 pre-protocol and 2 post-protocol), there was a requirement for partial weight bearing, whereas the remaining patients were allowed to fully weight bear when deemed appropriate from a soft tissue perspective.

Of note, there was no significant difference identified in either major or minor complications after the enhanced recovery protocol was introduced. Two flaps were lost, one before and one after the protocol was introduced. The first (pre-enhanced protocol) was a 58-year-old patient with multiple medical comorbidities with an open fracture of the distal tibia treated with intramedullary nailing and a free gracilis flap. This failed on day 7 secondary to arterial insufficiency after transfer to another unit. The second (post-enhanced-protocol) was a 17-year-old with a high-energy mid-shaft open tibial fracture, who had a gracilis flap that failed on day 4 secondary to arterial thrombosis. Interestingly, the one patient who suffered a VTE (PE) complication was in the pre-enhanced protocol group. There was a decrease in the total length of stay from 12.1 to 10.6 days ($P = 0.34$) and in the length of stay after free flap surgery from 8.0 to 7.1 days.

Table 1. Outcomes before and after the introduction of the enhanced recovery protocol

	Pre-enhanced protocol	Post-enhanced protocol
<i>N</i>	15	22
Age (years)	44 (22-64)	42 (17-72)
Sex (M:F)	2:1	3.6:1
Flap type		
-ALT	10	16
-Gracilis	4	5
-MSAP	1	1
Fracture configuration		
-Mid-shaft	4	5
-Distal third	7	12
-Segmental	1	3
-FRI	3	2
Minor complications (superficial infection, wound dehiscence, minor flap necrosis)	2	3
Major Complication	2 (1 flap loss, 1 pulmonary embolus)	2 (1 flap loss, 1 deep infection)
Total L.O.S (days)	12.1	10.6
L.O.S post fix and flap (days)	8.0	7.1

ALT: Anterolateral thigh; MSAP: medial sural artery perforator; L.O.S: length of stay.

DISCUSSION

A key aim of perioperative care in patients undergoing lower limb reconstruction is preventing flap loss. Causes of flap loss are varied, with patient factors, anastomosis-related factors and post-operative care among many possible important elements^[12,13]. Venous thrombosis has been identified as the most common cause of lower limb free flap failure and venous congestion is an important problem that can lead to flap failure^[14,15]. Free flaps applied to the lower limbs may be especially prone to venous congestion due to their dependent position, leading to increased oedema, reduced perfusion pressure, compression of the vascular pedicle, and, ultimately, loss of the flap^[16-18]. It has also been reported that lower limb free flaps may be at increased risk of venous congestion compared to free flaps applied elsewhere in the body, even when the limb is kept elevated^[19]. In light of concerns around venous congestion, the best time from which to permit weight bearing is uncertain, and many centres have introduced “dangling protocols”, the aim of which is to introduce gravitational dependency gradually to allow adaptive physiological responses to take place and reduce the risk of flap loss^[20]. Systematic reviews have shown that early dangling appears to be safe and may lead to reduced length of stay^[1,7]. However, a wide variability in practice has been demonstrated in multiple countries, and there is no consensus over the best time to introduce dangling, with even less evidence for weight bearing^[1,20,21]. A systematic review of dangling regimes published in 2017 stated that, traditionally, dangling begins on around day 5 but concludes that dangling may be safe from as early as day 3^[22]. Flap oedema and pressure on the vascular anastomosis are cited as potential concerns against dangling earlier than this. If it is the case that dangling is beneficial in training a flap for weight bearing, then it would follow that permitting earlier dangling could pave the way for earlier weight bearing. It could also be argued that the theoretical concerns regarding potential risks from early dangling may also apply to early weight bearing as both involve dependency. However, for the timing of both dangling and weight bearing, there is no established consensus on what is best practice, and a substantial amount of the evidence available is limited by study heterogeneity and a lack of randomized controlled trials^[22].

Reviewing the literature on post-operative management of lower-limb free flap patients, there appears to be a paucity of studies on the effect of weight bearing. The two largest relevant systematic reviews to date have instead focused on dangling^[1,7]. The reasons for this are uncertain. Given the concerns around gravitational dependency on lower limb free flaps, it may be the case that efforts have focused on the effects of gradually introducing dependency through dangling, including through an open multicentre randomised controlled trial (RCT)^[21]. Dangling protocols vary widely in their length and their level of detail and prescriptiveness, with dangling regimes varying in length from as little as 1-2 days to as long as 12 days^[1,7]. Some units have made their dangling protocols public and shown encouraging results that early weight-bearing protocols can improve standardization of care and reduce hospital stay without an increase in complications^[23]. Other research efforts have examined the use of techniques such as compression dressings and tilt-tables to help “train” the flap to the conditions experienced in dependency^[1,24]. The cumulative effect of this is that there is no consensus on the correct time to start weight bearing, although there is a consensus that prolonged bed rest is harmful and that early dangling is likely to be safe. Overall, there remains a lack of high-quality evidence on the post-operative management of lower limb free flaps and the relationship between weight-bearing status and complications and future well-designed RCT’S are required to guide best practice^[1,7]. We have demonstrated that an early dangling and weight-bearing protocol was introduced without leading to an increase in recordable complications following lower limb free flap surgery. The introduction of early weight bearing is part of an effort to enhance the recovery of patients who have undergone significant physical and emotional trauma and to help them regain a semblance of normality sooner. Many cases of lower-limb free flaps are performed following trauma, and it has been demonstrated that for some lower limb fracture patterns such as tibial shaft fractures treated with intramedullary nailing, early weight bearing is associated with improved healing without an increase in complications^[5,6]. It has certainly been demonstrated in the wider surgical sphere that prolonged bed rest is associated with poorer outcomes and an increased number of medical complications^[3]. Notwithstanding this, the authors acknowledge that this study carries multiple limitations. The number of patients presented here is small; thus, we have not demonstrated statistical significance in the measured reduction of length of stay. In addition, it is difficult to attribute complications specifically to a patient’s weight-bearing status. Interestingly, both of the flap failures in our series were beyond the initiation of the early dangling/weight bearing and therefore are unlikely related, although this cannot be proven. Dangling from day three and weight bearing from day five are just two components of multiple care standards introduced in our lower limb free flap enhanced protocol, a copy of which is provided in the supplementary materials. Close monitoring of both the flap and overall patient will all play a part in achieving positive outcomes. During the post-operative period covered by our protocol, the patient and flap are monitored regularly by both nursing and medical staff. The flap is regularly monitored for changes in appearance, doppler signal, and capillary refill by specially trained nurses at intervals specified by the protocol. Any concerning features are escalated to the surgical team for review. Patients in our unit undergoing lower limb reconstructive surgery receive venous thromboembolism prophylaxis with Low Molecular Weight Heparin (LMWH) as specified by our protocol. This is generally stopped on discharge unless the patient is non-weight bearing or there is a requirement for extended thromboprophylaxis from the orthopaedic team for joint immobilization in a cast. It is well established that lower limb trauma and orthopaedic surgery are high-risk for venous thromboembolism and extended chemoprophylaxis may be indicated^[25,26].

Our results suggest that the introduction of an enhanced recovery protocol with weight bearing at day 5 is not associated with an increase in complications. This is in line with the results from published systematic reviews^[1,7]. However, there remains a lack of high-quality evidence in this area, and a randomised controlled trial would be needed to help determine this more definitively. Dangling from day three and weight bearing from day 5 remains the standard of care within our unit as part of an enhanced recovery protocol that aims to optimise patient recovery following lower limb free flap surgery.

DECLARATIONS

Authors' contributions

Made substantial contributions to data acquisition, analysis and interpretation, literature review, and manuscript preparation: Al-Khalil M

Made substantial contributions to data acquisition, analysis, and interpretation: Roman M

Made substantial contributions to the conception and design of the study, data acquisition and analysis, and manuscript preparation: Emam A, Marsden N

Availability of data and materials

Requests for data may be made to our corresponding author.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

This work was classified as quality improvement rather than research and involved no patient intervention and so ethical approval was not indicated in accordance with UK Health Research Authority guidelines.

Consent for publication

Informed consent from patients has been obtained.

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