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The Sagittal Incision in Transtibial Amputation-Including the Postoperative Treatment

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Abstract

Objective: The aim of this article is to describe a standardized surgical technique related to transtibial amputation.

Over the last decades, a standardized method of performing sagittal incision in transtibial amputation and using a standardized postoperative plan has been established in Sweden. This is due to the increased use of gel liners in compression therapy and prosthetic fitting, which is discovering the benefits of the position of the scar and the shape of the limb compared with the traditional long posterior flab technique. In a recent report from Sweden, the transtibial sagittal flap incision technique resulted in 20 fewer days (median) until the first prosthetic fitting as compared to the traditional incision.

In general, the rate of wound healing has been seen as the main outcome, irrespective of the kind of postoperative treatment strategy used. Studies have seen new options related to postoperative treatment to affect the outcome. This sagittal operation technique has been learned by doing, and despite its popularity in Sweden, descriptive standardized instruction has been missing.

This paper's method and process description can support education, guidance, and a good start in rehabilitation after limb amputation.

Keywords: Transtibial amputation; Surgical technique; Postoperative treatment

Introduction

The rate of scientific evidence related to the treatment and outcome of Lower Limb Amputation (LLA) due to vascular disease is generally low in patients with Peripheral Arterial Diseases (PAD) [1]. The level of amputation (*e.g.*, preserving the knee joint) is often considered the main factor in the patient's ability to reestablish their functional mobility [2]. Specifically, it can enable the elderly patient to walk with prosthesis instead of being primarily a wheelchair user [3]. Also, given the high risk of a later contralateral amputation in this population, focusing on the patient's function and mobility is essential to reduce that risk [4]. The most widely used incision technique in Transtibial Amputation (TTA) is the Long Posterior Flap (LPF) technique, often referred to as the Burgess technique, developed in the 50s [5]. Although the wound area created after a TTA is one of the largest in a routine operation, the choice of incision technique alone has, in a Cochrane review, shown no effect on the healing rate [6]. However, in a recent report from the SwedAmp register, the Tanstibial Sagittal Flap incision technique (SF) resulted in 20 fewer days (median) until the first prosthetic fitting as compared to an LPF incision [7]. This indicates that the choice of incision technique in TTAs can affect the following postoperative treatment. The LPF technique includes the often-seen bulbous limb shape [8], featuring an incision scar directly over a distal affected bone area [9], and the effect on the limb length and the length of the posterior muscles flap. These features could be questioned today [10]. All these factors can affect the pathway to prosthetic fitting and better function/mobility.

The SF incision technique was revived by the orthopedic surgeon B. M. Person at Lund University Hospital in the late 60s and popularized as the primary TTA technique in the southern part of Sweden throughout the 70s. The SF is less apt to become necrotic in dysvascular cases for two reasons. The first is that the placement of flaps medially and laterally automatically reduces the amount of poorly vascularized anterior skin left. The second reason is that the resultant flaps are widely based and very short, thus enhancing their viability. Persson also stated that a side-to-side

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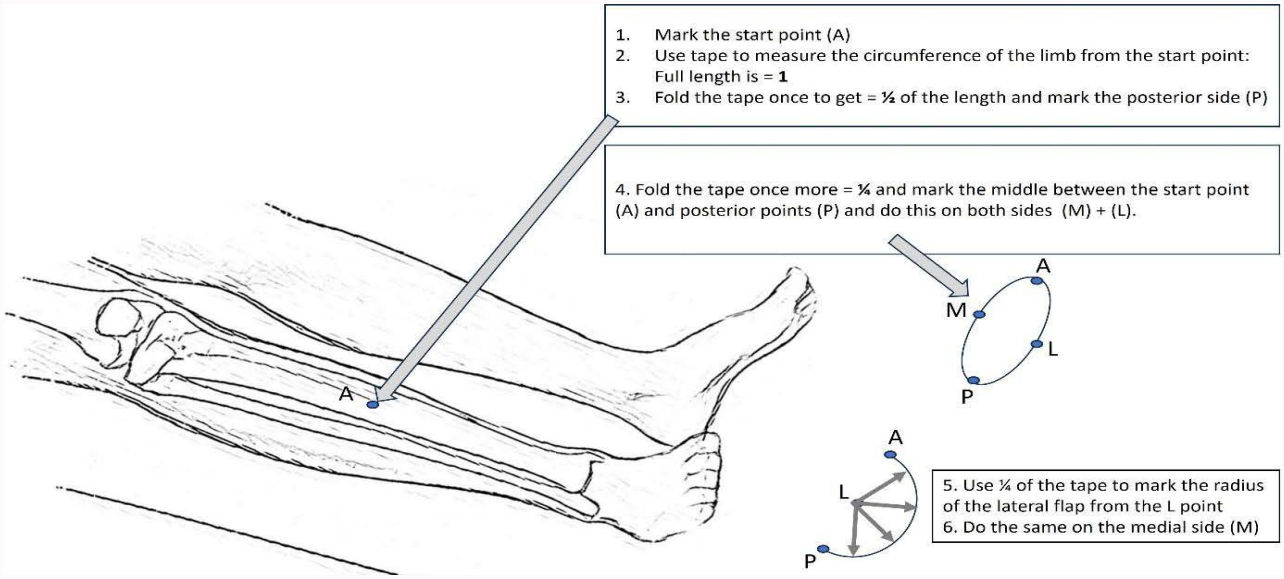

Figure 1: Schematic picture of the drawings on the leg prior to incision.

myoplasty covers the bone better and provides good spontaneous drainage [11].

The SF incision technique has increased in popularity among surgeons who perform TTAs in Sweden, where nearly 80% of all TTAs were reported in 2022 as SF [7]. The benefits of this incision technique were emphasized in the 90s due to the position of the scar, especially when it comes to using modern liner material in both postoperative compression treatment [12] and later prosthetic fitting [13]. Connecting the incision method with the postoperative treatment is of paramount importance if the goal is to regain the patient's walking ability [14].

This operation technique has been learned by doing, and despite its popularity in Sweden, descriptive standardized instruction has been missing. This article describes the incision in practice and the following postoperative treatment pathway, thus contributing to a more standardized approach [15].

Material and Method

The method is divided into parts that potentially can affect the outcome:

The length of the residual limb

In the second edition of Atlas of Amputation and Limb Deficiencies, Professor John H Bowker summarized that "there is no longer an ideal length or site of amputation." In dysvascular cases with an absent popliteal pulse, amputation in the proximal half of the leg would seem reasonable, with a bony level as distal as the junction of the proximal and middle thirds. In cases with good blood flow to the ankle, bone length at the junction of the middle and distal thirds will provide a very functional residual limb. Modern prosthetic components can be easily matched to these more distal levels [16].

Additionally, in the latest and the 5th Edition of the Atlas, published in 2024, J. R. Ficke stated: ["The ideal length of the residual limb is at least 12 cm distal to the knee joint line, and at least 25 cm above the plantar heel pad at a level of where sufficient gastrocnemius muscle can effectively serve as padding by way of a myodesis"] [6].

Bowker's view can be considered the preferred one by the prosthetists, both regarding the length and his view on the build height of the prosthetic feet, taking into account Ficke's concern about having sufficient gastrocnemius muscle to pad the distal end effectively, as a more distal choice can compromise the healing potential in PAD patients.

The incision plan

A planned incision level should be preoperatively drawn on the skin. The flaps are designed as semicircles with radius = 1/4 of the circumference of the leg (Figure 1).

The intersection of the lines shall be approximately 1 cm to 2 cm laterally to the anterior crest of the tibia and 1 cm distal to the planned level of the tibia cut (Figure 2). The level of the cut is dependent on the quality of the skin and the circulation of the leg.

The incisions of the skin and fascia are done perpendicularly without dissection between the layers. The muscles are divided obliquely in the proximal direction. The flaps then become smoother. The tibial vessels are found by following the anterior intermuscular septum to the Fibula and then following the interosseal septum. The vessels are ligated. The deep peroneal nerve is freed, gently stretched, and divided high with a knife or electrocautery. For osteotomy of the tibia, the sawing is done with an oscillating saw. The anterior third of the sawing should tilt 45 in the cranial direction. The edges are carefully rounded with a file. The Fibula is divided higher than the tibia (approx. 1 cm), preferably with a saw, and at an angle of 45° in the lateral direction. To facilitate further work, it may be worthwhile to saw off the tibia once more, about 5 cm more distally, and remove the middle piece. The muscles of the deep posterior compartment are divided. The posterior tibial vessels and the peroneal vessels are freed and ligated. The tibial nerve is freed higher up and divided (scalpel or electrocautery). Then, the remaining muscles are divided so the flaps are thinned towards the fascial edge.

The closure

The residuum is formed by adapting the fascial edges with an absorbable suture. The skin is closed with single skin sutures. Surgical

Figure 2: Incision flaps marked.

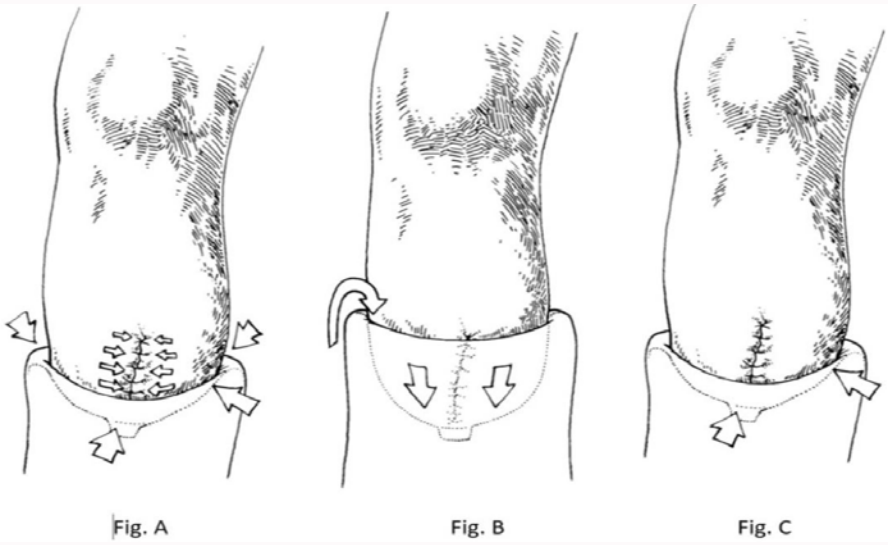

Figure 3: The function of the postoperative liner. A) It stretches the soft tissue in a forward direction. This helps to keep the wound closed. B) The compression of the wound surfaces along the suture lines. C) An even compression decreases proximally because of the decreasing thickness of the liner walls. The geometry of the liner automatically generates this.

clamps instead of sutures are not recommended, nor are drains if not really necessary. The reason for this is that many of these elderly patients have vulnerable skin and a higher risk of infection after surgery. Infections affect the healing time and can lead to revision/reamputation [17].

The dressing

The use of rigid dressing after lower limb amputation has been evaluated in more than 350 articles, including three systematic reviews [18-20]. Rigid and semi-rigid dressings have been reported to have advantages associated with better wound healing and volume control, protection against injury during falls, lower risk of knee contracture, reduced time in hospital, and reduced time to prosthetic fitting. Despite the reported advantages of rigid dressings, the most widely used type following transtibial amputation is still the soft dressing [21]. Finally, it protects against injuries related to falls, and lowers the risk of knee contracture. There are studies that show a reduction in time in the hospital and a reduction in time to prosthetic fitting [21]. These features can enhance the process of early prosthetic fitting.

The volume that the limb has after the amputation and before the application of the rigid dressing in the operation theater already includes oedema that is a consequence of the surgery but also needed to promote healing. The correctly applied rigid dressing shouldn't apply any pressure but should counteract additional edema. However, an elevated internal pressure could indicate uncontrolled infection which can create problems with a non-removable rigid dressing. Removable rigid dressing could be a more practical alternative [21].

Compression treatment

A postoperative compression silicone liner [21] is a standard treatment in most clinics in Sweden [7]. The liner treatment is recommended to start after removing the rigid dressing (5 to 7 days after the amputation). The liner size is selected after taking a circumferential measurement 4 cm from the distal end of the residuum. The compression treatment is applied twice daily (morning and afternoon). The duration of each application period is gradually increased from 1 h to 4 h (by 1 hour each day) or until the patient can apply the liner and decide how much more they can use it daily. During the day when not using the liner, and at night, a soft stockinette is used. When the patient needs to stand up or be

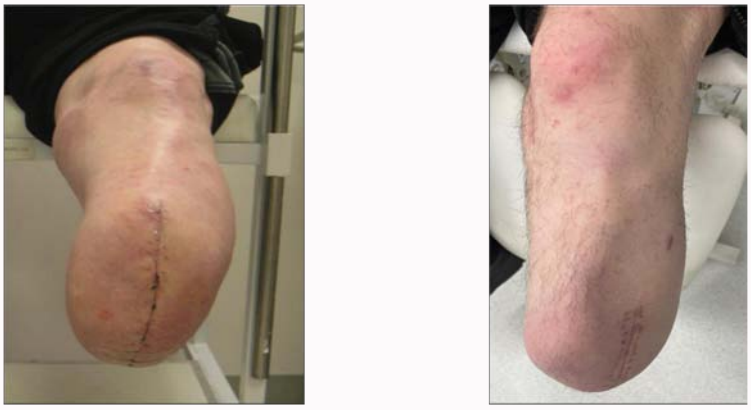

Figure 4: On the left the sagittal location of the scar and on the right a more skewed placement of a healed scar.

mobilized, it is recommended to apply the liner to prevent increasing edema from developing. The size of the liner is changed when necessary to maintain continuous compression. The time of use and the circumferential measurements are recorded [14].

The silicone postop liner is an advantageous alternative to traditional residual limb management. The same compression level is achieved regardless of who applies the liner [14]. In conventional care, the compression and the quality of the soft bandage can vary, depending on the individual who performs the treatment [22].

As stated above, the main benefit of the SF incision compared with the LPF technique is the placement of the incision scar and the minimal risk of ending up with the traditional bulbous form. The benefit of the scar position is further capitalized on the following compression therapy with a silicone postop liner: When the liner is turned inside out, this inversion stretches the material on the inside. The surface tension of the silicone in contact with the skin helps to invaginate the soft tissues of the residual limb into the liner.

Three objectives are achieved in this phase (Figure 3): Compared with traditional treatment, the improved effects of using a silicone compression liner on scar tissue are pronounced (Figure 4), and a similar effect is observed as with general scar tissue treatment using silicone gel [23]. Scar tissue treatment with a silicone liner allows for a period of adaption, later included as a part of modern prosthetic technology (*e.g.*, liner and vacuum suspension). The need to adapt regards the skin adaption to the new environment, *e.g.*, in terms of perspiration, but also the patient's ability to correctly don and doff a liner and take care of the affected skin.

Conclusion

Over the last decades, a standardized method of performing SI in TTAs and using a standardized postoperative plan has been established in Sweden. This paper's method and process description can support education, guidance, and a good start in rehabilitation after limb amputation.

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