〈 Techniques in Foot and Ankle Surgery 〉

Use of a Continuous External Tissue Expander in Total Ankle Arthroplasty

A Novel Augment to Wound Closure

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Abstract: *Despite major improvements in surgical technique and implant designs in total ankle arthroplasty (TAA), wound healing complications are still commonly encountered. Not only do these problems delay postoperative recovery and threaten functional outcomes, they also carry an increased risk of progression to deep wound infection, which can jeopardize ultimate retention of the implant. In an effort to reduce the high frequency of wound-related complications after TAA, we have incorporated the use of continuous external tissue expansion (CETE) to augment our closures of the anterior ankle incision. CETE is an innovative technique that is currently being used to aid in the rapid closure of acute and chronic full thickness soft tissue defects, including fasciotomy wounds, high grade open fractures, and chronic foot ulcers. By exploiting the viscoelastic properties of the skin, this technique not only facilitates wound edge approximation of full thickness defects, it also helps take tension off tenuous incisions, thus allowing them to heal and reducing the chance for wound dehiscence. This is the first description of the use of an external tissue expander for the prevention of wound healing complications in the setting of TAA. Since introducing CETE to the closure of our TAA incisions, we have seen a decrease in the number of postoperative wound complications and time to wound healing. Based on our experience, we believe that the use of CETE for the prophylactic management of tenuous surgical incisions, specifically those used in the anterior approach to the ankle during TAA, is both safe and efficacious.*

Levels of Evidence: *Level V: Technique tip*

Keywords: postoperative wound complication; anterior ankle approach; ankle arthroplasty; external tissue expansion; surgical dehiscence

Total ankle arthroplasty (TAA) has been increasingly used in recent years as an alternative to arthrodesis for the surgical management of end-stage ankle arthritis. This growing trend is attributed to improved implant design, surgeon training, and clinical outcomes.[1-4] Despite these advancements, the frequency of complications in TAA remains high.[5] In particular, wound healing

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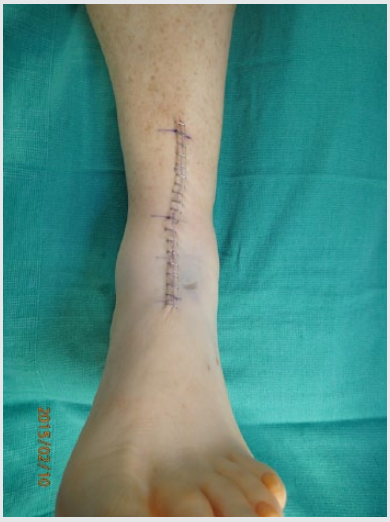
complications after TAA through an anterior approach has been reported to occur in up to 28% of cases.[5-7] Management of delayed healing or superficial breakdown of a TAA incision requires prolonged postoperative immobilization, which can lead to scar formation and in effect, decreased functional outcomes. While wound healing problems after TAA are generally classified as minor complications, they have the potential to become disastrous, as the risk for deep infection is increased and retention of the implant is jeopardized.[8]

Continuous external tissue expansion (CETE) is an innovative technique developed by plastic surgeons to aid in the rapid closure of acute and chronic full thickness wounds. By exploiting the viscoelastic properties of the skin, this technique facilitates both wound edge approximation of full thickness defects as well as reduction of tension on tenuous wound closures.[9] It works by gently expanding skin on the subcutaneous planes through a continuous controlled pulling force on the nontraumatized skin adjacent to the wound or incision. This technique has served as a safe and viable alternative to skin flaps and skin grafting in the field of plastic surgery. More recently, the technique has been shown to be efficacious by extremity surgeons in the management of fasciotomy wounds, open fractures, and chronic foot ulcers.[10-12]

In an effort to reduce the high rate of wound healing complications after TAA, the senior author (SGP) has incorporated the use of a CETE device to augment closures of the anterior ankle incision. By removing tension off the incision, we believe this modality creates an optimal condition for healing, and therefore protects against the chance for wound dehiscence and breakdown. The goal of this article is to bring awareness to other surgeons the potential benefits of CETE in the prophylactic management of tenuous surgical incisions, specifically those used in an anterior approach to the ankle during TAA.

Figure 1.

Primary closure of anterior ankle incision after total ankle arthroplasty.



Technique

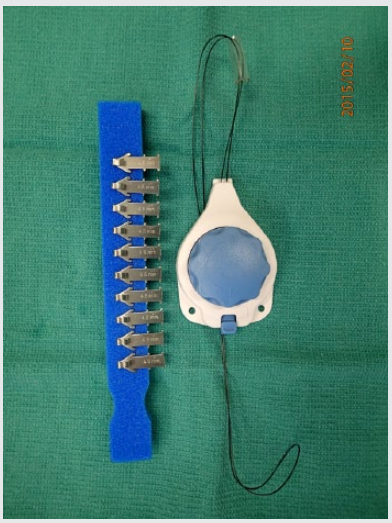
Once the incision is primarily closed and dry (Figure 1), a nonadherent dressing is placed over the incision, followed by a commercially available external tissue expander device (DermaClose RC, Wound Care Technologies, Inc, Chanhassen, MN). This device provides a calibrated and controlled amount of force to expand the tissue adjacent to the incision using a tension controller with an accompanying 52-cm loop of nylon suture and multiple barbed skin anchors (Figure 2).[13]

For all of our TAA anterior incisions, we use a total of 6 skin anchors. Three anchors are placed on each side of the incision, spaced evenly apart, or approximately 2 cm from each other, with the tips positioned approximately 3 cm from the incision. The skin anchors have a pair of flat angulated barbs, 4.5 mm in length, that are pressed into the skin. Theses barbs ensure the subcutaneous tissue is engaged for eventual migration. Each anchor is secured with 2 skin staples (Figure 3).

The tension line from the tension controller is placed over the hooked

Figure 2.

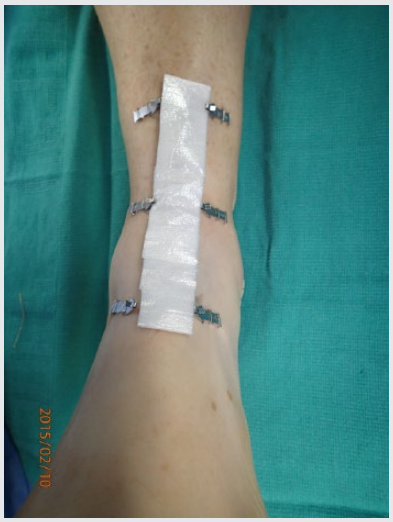
Contents of commercially available continuous external tissue expander (DermaClose RC, Wound Care Technologies, Inc, Chanhassen, MN). Through a tension controller with an accompanying 52-cm loop of nylon suture and multiple barbed skin anchors, this device provides a continuous calibrated force on the skin adjacent to the incision, resulting in expansion, while reducing tension on the incision.



edge of the anchors using a shoelace configuration. The knob on the tension controller is then turned clockwise until sufficient offloading has been achieved at the incision site (Figure 4). The amount of offloading is determined by the surgeon, based on visual inspection and typically requires less than 11 half rotations. To prevent overtensioning, only a maximum predetermined force of 1.2 kg may be applied and is signified when the audible clutch mechanism is engaged. Once the desired tension is achieved, the device is locked, and the same constant force will be maintained on the line until the device is removed.[14] This eliminates any need for retightening and provides for continuous calibrated dynamic tension on the skin surrounding the incision, resulting in expansion while reducing tension on the incision.

Figure 3.

Skin anchors placed along the periphery of the incision, spaced evenly apart from each other, with the tips positioned approximately 1cm from the incision. Nonadherent dressing placed over the incision before suture loop applied.



Standard sterile dressings are then applied over the construct. Padding is placed between the tension controller and adjacent skin to avoid skin breakdown from prolonged contact. The lower extremity is then immobilized in a bulky Jones splint with the ankle in neutral dorsiflexion and kept nonweightbearing.

At postoperative week 1, the soft tissue expander is removed, while the incision staples are left in place. The ankle is placed into a short leg cast and the patient remains nonweightbearing. At postoperative week 3, the incision staples are removed, Steri-Strips (3M, St Paul, MN) are applied (Figure 5), and the patient is placed into a compression stocking and controlled ankle motion boot. Progressive weightbearing in the boot is allowed at this time. Figure 6 depicts the incision at postoperative week 4. At postoperative week 6, the boot is discontinued and formal physical therapy is initiated.

Figure 4.

Fully assembled DermaClose device in place. Nylon suture loop placed in a shoelace configuration, securing each anchor at its hooked edge. Once the tension line is tightened with the tension controller, a continuous force will be maintained on the line until the device is removed.

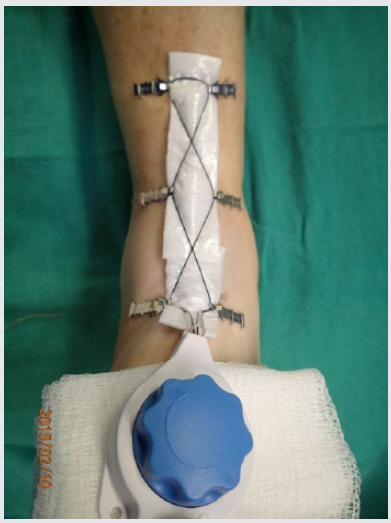


Figure 5.

Appearance of wound 3 weeks after surgery.

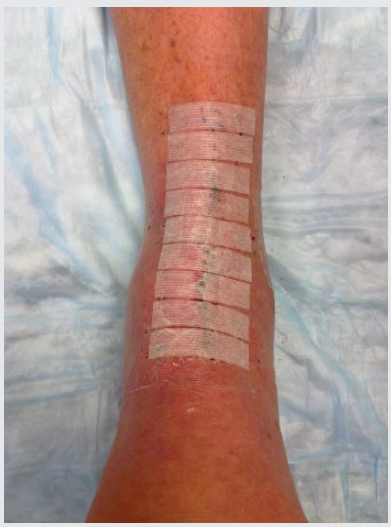
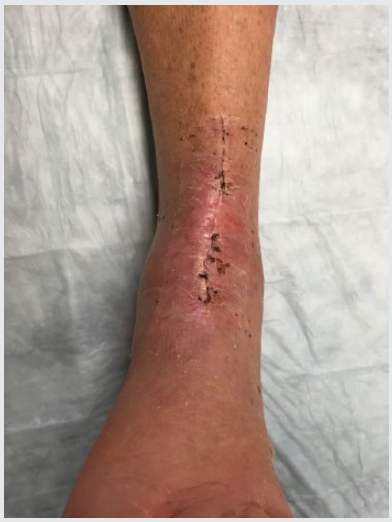


Figure 6.

Appearance of healed incision 4 weeks after surgery.



Discussion

Total ankle arthroplasty (TAA) is most commonly performed through an anterior ankle incision. While this approach offers excellent exposure and access to the joint, without disrupting the talar-malleolar relationship, the incision is at high risk for wound healing complications. This is due to a number of factors. The skin over the anterior ankle is relatively thin and devoid of substantial subcutaneous tissue. Not uncommonly, patients undergoing TAA may have a less than ideal soft tissue envelope because of prior trauma, previous surgical incisions, or venous insufficiency. Intraoperatively, soft tissue retraction during TAA can be traumatic, potentially further compromising the anterior skin flap. Postoperatively, positioning the ankle in neutral dorsiflexion compresses the vasculature crossing the ankle joint, thus limiting optimal perfusion at the incision site. Additionally, maintaining the ankle in an immobilized position fosters accumulation of edema, thus placing tension on the incision. It is, therefore, not surprising that wound healing

complications following TAA are relatively common, with a reported occurrence rate ranging from 4% to 28%.[5-7]

While relatively common, wound healing complications after TAA are not benign and carry an increased risk of progression to deep wound infection.[8] In a matched case-control study of 26 patients with periprosthetic ankle infections, Kessler et al[8] found that wound dehiscence persisting for 14 days or more and the presence of secondary wound drainage were both associated with periprosthetic joint infection with odds ratios of 15 and 5, respectively. Several reports have demonstrated that once a periprosthetic infection occurs, costly attempts at salvage and, in some cases, amputation may become necessary.[7,15]

Given the potential consequences of a compromised incision, obtaining primary healing in TAA is paramount, and various prevention strategies have been described. Among these include alternative approaches to the ankle, particularly in the patient with a poor anterior soft tissue envelope,[16,17] use of specific postoperative dressing protocols to control edema,[18] respectful soft tissue handling with avoidance of unnecessary or excessive retraction, meticulous wound closure, and strict patient selection. To improve patient selection, risk factors for developing a wound problem after TAA have been studied. In a retrospective study of 106 TAAs approached through an anterior incision, Raikin et al[6] reported a minor wound complication rate of 25% and a major wound complication rate of 8.5%. They identified diabetes as a risk factor for minor wound complications, while female gender, a history of corticosteroid use, and underlying inflammatory arthritis were risk factors for major wound complications.[6] Similarly, Whalen et al[7] reviewed their consecutive series of 57 primary TAAs and found a history of smoking greater than 12 pack years, peripheral vascular disease, and cardiovascular disease to be predictive of wound healing complications.

In our practice, we have started using a CETE device for tenuous anterior TAA incisions in patients at increased risk for wound problems. In a series of more than 35 TAA closures augmented with a CETE device we have seen significantly decreased wound-related complications compared to previous patients who underwent standard skin closure. We believe the benefit of this technique comes from the elimination of tension directly at the incision site. In many cases, we feel that incisions augmented with a CETE device heal faster, with less swelling and improved final wound appearance. Particularly in patients with multiple risk factors for wound problems after TAA, we feel this technique has played an important role in successfully preventing catastrophic wound complications. The CETE device has been well tolerated by our patients and is easily used in conjunction with any type of dressing, including incisional negative pressure wound therapy, if desired.

The efficacy of CETE in the management of acute and chronic soft tissue defects has been described in the plastic surgery, podiatry, and orthopaedic surgery literature. One of the growing uses for CETE has been in the closure of fasciotomy wounds.[11] A study of 28 patients with fasciotomy wounds found that a CETE device successfully achieved a tension-free closure without the need for additional flaps or skin grafts in 93% of patients with an average time to closure of 5 days. The initial wound size for all cases ranged from a length of 9 to 25 cm and a width of 4 to 15 cm. No intraoperative or long-term complications were reported.[19] Similarly, in a study at Walter Reed of 14 blast victims with significant soft tissue extremity trauma, CETE achieved delayed primary closure within 4.4 days in 86% of patients in wounds averaging 263 cm^2.[12]

While the above scenarios describe successful implementation of CETE in soft tissue cases where wound edge approximation is the goal, its use as a prophylactic adjunct on elective, primarily closed, but tenuous, surgical incisions has not yet been reported in the literature. This is the first description of the use of an external tissue expander for the prevention of wound healing complications in the setting of total ankle replacement.

A theoretical concern when using a CETE device, whether for wound edge approximation or for offloading high-tension closures, is skin necrosis from application of excess tension. To the best of our knowledge, no cases of skin necrosis have been reported in this setting. This may be a result of the device's internal calibration that prevents overtensioning greater than 1.2 kg, which the manufacturer has predetermined to be a safe maximum force for application in nonapproximated wounds.[20] Additionally, use of the device is contraindicated in ischemic and fragile tissues, which are generally at higher risk for skin necrosis.

Another potential drawback to the routine use of a CETE device as a prophylactic augment in TAA wound closures is the added cost to the procedure. In our experience, for the indication described above, no additional hospitalization or adjustments are required after application of this device in the operating room. A study on closure of fasciotomy wounds showed that using a CETE device resulted in an overall cost savings of 34% ($7858) when compared with the vessel loop technique and 18% ($3363) when compared with negative pressure wound therapy. These savings were realized through shorter hospital stays, less operating room time, and less nursing care.[19] On the other hand, salvaging a compromised wound that goes on to deep infection invariably requires additional procedures, extended hospital stay, and lengthy outpatient follow-up, all contributing to significantly higher costs of care compared with an uncomplicated TAA. Whalen et al[7] found that this cost was 5 times that of a successful primary TAA. Based on the high rate of wound-related problems in TAA and their associated costly consequences, the prophylactic use of a CETE device may be a sensible investment.

In conclusion, we believe that CETE can be a beneficial augment in the closure of anterior ankle incisions during TAA, particularly in patients at high risk for wound complications. Not only does CETE have the potential to prevent deep wound infection by maintaining skin edge approximation and allowing the incision to heal off tension, based on our experience, we feel it may decrease swelling and the time required to achieve complete healing. A well-designed prospective cohort study or randomized controlled trial would be helpful to definitively determine the efficacy of CETE in the healing of tenuous elective surgical incisions and the prevention of wound-related complications. FAS

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