Effect of Surgical Incision Closure Device on Skin Perfusion Following Total Ankle Arthroplasty

Ann Davis, DPM1, Mark Vaughan, DPM1, Jason Piraino, DPM, MS, FACFAS2
1 Resident, Foot and Ankle Surgery, University of Florida Health, Jacksonville, FL
2 Residency Director, Foot and Ankle Surgery, University of Florida Health, Jacksonville, FL

Statement of Purpose
Preservation of epidermal blood supply during total ankle arthroplasty has a physiological influence on uneventful incisional healing versus development of wound complications. Anatomic incisional placement, tissue handling, and closure technique can all impact tissue perfusion. This purpose of this study was to quantify the effect of skin closure devices on tissue perfusion.

Methodology and Hypothesis
This is a retrospective cohort study which compares the effect of staples and adhesive zip tie skin closure on epidermal perfusion following total ankle arthroplasty. Data was collected from patients who underwent total ankle arthroplasty by the senior author (JP) at University of Florida Health Jacksonville between May 2015 and January 2016. Patients who underwent the target skin closure techniques were utilized for pre-operative and post-operative evaluation. The primary outcome was measured using laser assisted indocyanine green angiography (LA-ICGA). Revision surgery was excluded. Patients were followed from 5 to 14 months post-operatively.

We hypothesize that there will be a less of an impact on perfusion to tissues closed with adhesive zip tie when compared to staples. This is due to the adhesive zip tie’s traumatic properties and design which distributes forces uniformly along the incision.

Procedure
Prior to the initial incision and tourniquet inflation, LA-ICGA measurement was taken over the planned incision site. This was used as the baseline perfusion for each patient for comparison following closure. The surgical technique consisted of an anterior ankle incision just lateral to the tibialis anterior tendon. Dissection was carried out with care to avoid all major vascular and nerve structures. Gentle retraction was used to maintain healthy tissue. All patients underwent deep and subcutaneous closure using vicryl staple skin closure. Two strips of adhesive lay longitudinally on either side of the incision. This design distributes forces uniformly along the incision.

The mean perfusion along the incision site preoperatively was compared to the mean perfusion along the incision site following skin closure. All data points were recorded from a single author. The mean was determined by using six equidistant data points directly along the planned incision location and the incision respectively. The difference in pre-operative mean was then calculated to quantify the mean decrease in perfusion. Analysis was conducted to compare drop in perfusion between the two groups of closure devices, stainless steel staples and adhesive zip tie. All wound complications were also noted as a secondary outcome.

Post-operative care was identical for all patients. Incisional negative pressure vacuum was placed at a pressure of 75mmHg for 48 hours. This was then removed and replaced with a sterile non-stick wound drape and wapped dressing. A controlled ankle motion orthopedic boot was applied and the patient was to leave this in place while being non-weight bearing for a minimum of 4 weeks. All patients had a wound check at approximately 14 days post-operatively. The skin closure device was removed when clinical healing was observed. All patients began active range of motion after incisional healing was noted clinically.

Literature Review
Surgical incision dehiscence is a major concern following total ankle arthroplasty. This can lead to superficial and deep soft tissue infections, and worse, bacterial colonization of the implant. Prolonged skin healing time delays return to activity, decreases patient satisfaction, and results in increased joint mobility. Dehiscence rate following TAA has been reported to be 28%. This is frequently attributed to patient comorbidities, tissue handling, and incision placement.

Maintaining adequate perfusion is one of the most important factors in ensuring wound healing. This can be accomplished with prudent tissue handling, careful anatomic placement of the incision, and meticulous closure techniques. Few studies exist to quantify tissue perfusion at the level of the epidermis.

Laser assisted indocyanine green angiography (LA-ICGA) has been used in many specialties, most predominantly plastic surgery, to assess skin perfusion and viability. After intravenous injection of plasma bound indocyanine green dye, an external camera placed over the site of interest will record the frequency of the dye representing the perfusion to the skin. Software then quantifies the frequencies, in percentage form, allowing objective comparison of perfusion. Higher percentage values represent more robust perfusion. A study using LA-ICGA to predict mastectomy skin flap necrosis found that a value of 33% has an 88% positive predictive value of removing nonviable skin and a 16% negative predictive value of removing healthy skin.

Adhesive zip tie is a relatively new device used for surgical incision closure. The system is single-use, sterile, and applied following subcutaneous closure. It is a preassembled device that is cut to the length of the incision. Two strips of adhesive lay longitudinally on either side of the incision with small adjustable zip ties laying perpendicular, connecting the adhesive strips. Once placed, the zip ties can be tightened or loosened as needed to bring skin edges together. This design distributes forces uniformly along the incision.

Results
A total of nine patients underwent total ankle arthroplasty, had skin closure with either staples or adhesive zip tie, and the utilization of LA-ICGA pre- and post-operatively during the nine month period of interest between May 2015 and January 2016. Of these patients, five (55.6%) had adhesive zip tie skin closure, while four (44.4%) had stainless steel staple skin closure. The mean patient age was 61.2 (range 46 to 66) years.

On direct comparison of the difference in perfusion pre-operative and post-operatively, adhesive zip tie had a lesser effect on incisional perfusion than staples with a p-value of <0.001. Adhesive zip tie resulted in a mean decrease in perfusion at the surgical incision site of 21.6 ± 4.1%.

Staples resulted in a mean decrease in perfusion of 39.3 ± 4.3%.

Incisional dehiscence occurred in two total patients. Both patients had skin closure performed. One patient had a decrease in perfusion at the incision site after closure of 45.4% and went on to heal uneventfully with local wound care. The second patient had a decrease in perfusion at the incision site after closure of 38.4% and also went on to heal with local wound care.

Analysis and Discussion
Surgical incision healing can be influenced by anatomic placement, tissue handling, and closure technique, all of which can affect maintaining adequate perfusion needed for tissue healing. In this small pilot study, we have determined statistical significance that adhesive zip tie maintains perfusion closer to baseline than stainless steel staples following total ankle arthroplasty. Further studies are needed to determine whether this maintenance in perfusion directly influences the rate of incisional dehiscence and/or wound complications.

Care needs to be taken in all steps of the surgical process to minimize incisional dehiscence and post-operative complications. Everything from patient selection to skin closure and post-operative dressings needs to be taken into careful consideration. New and emerging technologies can be used to the surgeon’s and patient’s advantage to obtain the best possible outcomes.

References