

## Statement of Purpose

The primary aim of this study was to examine the long term functional outcomes and viability of the vertical contour calcanectomy. Heel ulcers have a significant impact on lower extremity morbidity and confer high risk of major amputations. This retrospective case series shows the vertical contour calcanectomy as a surgical alternative in functional limb salvage.

## Methods and Procedures

Retrospective review 16 feet (14 patients) with recalcitrant heel wounds who underwent vertical contour calcanectomy were identified over a 3 year period (2014-2017), <12 months follow up.

- **Indication for VCC:** heel ulcerations secondary to pressure, ischemia, infection, inability to primarily close, osteomyelitis of the calcaneal tuber
- **Postoperative Management:** Non weight bearing until epithelialization of incision, transition to protected weight bearing with CROW boot for VCC patients made by in house prosthetist
- **Postoperative Outcomes:** Number of postoperative surgeries, major lower extremity amputation, 30 day readmission rates (related to the lower extremity only), mortality, and ambulatory status.
- **Level of Evidence:** IV, Therapeutic
- **Financial Disclosure:** No financial disclosures to report

Demographics	Number % (n=16)	Mean (range)
Age	63.8 (51-86)	Mode: 59
BMI	34kg (23-53)	Mode: 26
Diabetes Mellitus	85.7% (12/14)	
Charcot Neuroarthropathy	28.6% (4/14)	
Renal (ESRD+CKD)	28.6% (4/14)	
PVD	50% (7/14)	
Transplant	14.3% (2/14)	
CAD	14.3% (2/14)	
Cancer	28.6% (4/14)	
HIV	7.1% (1/14)	
Lymphatic/Venous Disease	35.7% (5/14)	
Smoker (current or former)	50% (7/14)	

Figure 1: Patient Demographics

## Literature Review

Heel ulcers are a major cause of morbidity worldwide. Prolonged immobilization, peripheral arterial disease, diabetes, poor nutritional status, presence of osteomyelitis, and complex comorbidities increase the risk of developing these ulcers (1). These heel ulcers often lead to a proximal amputation. Conservative treatments of negative pressure wound therapy and bioengineered tissue allograft exist, but heel ulcers are often recalcitrant to this unimodal approach.

Surgical treatment of recalcitrant heel ulcers requires a multimodal preoperative assessment addressing biomechanics, vascular status, and presence of infection. While the benefits of partial calcanectomy include: removal of infected bone, decrease in plantar pressure, decompression to allow soft tissue closure (1) risk factors for failure include presence of MRSA, poor nutritional status, and peripheral arterial disease (2). Current literature on the partial calcanectomy shows no consensus on the amount of bone to resect or the alignment of the osteotomies and can often lead to poor reproducibility (3). In patients that underwent partial calcanectomy secondary to a heel ulceration, 29% of patients went onto a below the knee amputation (4). The end goal of treatment is to create viable soft tissue closure, eradicate infection, and create a functional limb. The vertical contour calcanectomy should be reserved for patients with minimal to moderate ambulatory requirements that are often precluded from a hindfoot reconstruction.



Figure 2: Preoperative Radiograph



Figure 3: Preoperative Clinical Photo



Figure 4: Postoperative Radiograph



Figure 5: Postoperative Clinical Photo

## Results

	Number % (n=16)
	Mean (range)
	Mode
<b>Pre-Operative Considerations</b>	
Osteomyelitis Preoperative	50% (8/16)
Ulcer Duration (days)	Mean: 292/1 (10-1247) Mode: 129
Contralateral amputation	7.1% (1/14)
Pre-operative Angiography & Intervention	68.6 (11/16) & 31.3% (5/16)
<b>Operative Course</b>	
Primary Closure	50% (8/16)
Number of staged surgeries	1 surgery: 12.5% (2/16) 2 surgeries: 56.3% (9/16) 3 surgeries: 25% (4/16) 4 surgeries: 6.3% (1/16)
<b>Postoperative Outcomes</b>	
Number of Postoperative surgeries	None 50% (8/16) 1 surgery: 12.5% (2/16) 2 surgeries: 18.8% (3/16) 3 surgeries: 12.5% (2/16)
Major Amputation	18.8% (3/16)
30 Day Readmission for extremity	14.3% (2/14)
Mortality	21.4% (3/14)

Figure 6: Operative Considerations and Outcomes of 16 lower extremities (14 patients)

Ambulatory Status	Preoperative (n=14)	Postoperative 1 year (n=14)	Postoperative 2 years (n=8)	Postoperative 3 years (n=4)
Full Weight Bearing	50% (7/14)	42.9% (6/14)	75% (6/8)	75% (3/4)
Partial Weight Bearing	28.6% (4/14)	28.6% (4/14)	25.0% (2/8)	25% (1/4)
Non Weight Bearing	21.4% (3/14)	28.6% (4/14)	0% (0/8)	0% (0/4)

Figure 7: Ambulatory status of VCC Patients

## Analysis & Discussion

Since Gaenslen described the initial calcanectomy, the conventional partial calcanectomy has been portrayed as a viable alternative to a transtibial amputation (5). However, literature on the partial calcanectomy shows a wide variance of healing, reulceration, major amputation rates and postoperative morbidity (5). The "bone to soft tissue ratio" must be biased towards a soft tissue closure without tension, especially with postoperative edema (6). While negative pressure wound therapy or bioengineered allografts with offloading show some success, evidence shows early soft tissue coverage, especially with the unique fibrofatty heel pad, is key in preventing recurrent osteomyelitis (7).

While fear of inducing an iatrogenic calcaneal gait from an aggressive Achilles resection is a concern of many surgeons, patients can maintain adequate ambulation with active pedal flexors to compensate. The results of this study corroborate this: 69% of patients at the 1 year follow up maintained or improved their ambulatory status. These results are consistent in a study by Baravarian et al. showing loss of Achilles with proper orthoses maintaining similar ambulatory status and no appreciable subjective weakness (6).

Additionally, the quantity of calcaneus bone removed in the VCC does not appear to affect patient function per the Lower Extremity Functional Scale (4). Given the fact that limb length has a correlation to life expectancy, preservation of limb length using a VCC would decrease morbidity and mortality more effectively than a below knee amputation (8).

We have found that traditional partial calcanectomy angle of bone resection is often too acute for offloading plantar pressures. An osseous protuberance or abrupt cortical wall can lead to reulceration and increased risk of morbidity. Traditional partial calcanectomies have a major amputation rate of 52.5% (2). In contrast, the results of the VCC are promising, 50% of all procedures required no additional surgery; 81.25% of patients required 2 or fewer surgeries, and the total lower extremity amputation rate was 18.8%.

Despite the increased difficulty of healing calcaneal wounds, the goals remain the same: elimination of infection, adequate soft tissue coverage, and optimization of functional outcome (9). This case series for the VCC shows promising results. We recognize the number of patients is relatively low, and additional studies using validated scoring systems like the LEFS are warranted.

## References

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## Abstract

Heel ulcers have a significant impact on lower extremity morbidity and confer high risk of major amputations. Treating these ulcers is difficult due to poor tissue coverage and the bony os calcis, often leading to proximal amputation. This retrospective case series shows the vertical contour calcanectomy as a surgical alternative in functional limb salvage. The minimum follow up time for inclusion was 12 months.

## Literature Review

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## Level of Evidence

Level IV, Therapeutic

## Statement of Purpose

The primary aim of this study was to examine the long term functional outcomes and viability of the vertical contour calcanectomy

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## Methods

14 patients and 16 lower extremities underwent the vertical contour calcanectomy between 2014 and 2017

- Indications: heel ulcerations secondary to pressure, ischemia, infection, inability to primarily close, osteomyelitis of the calcaneal tuber
- Contraindications: forefoot, midfoot, hindfoot pathology that decreases likelihood of functional outcome
- Each patient comprehensively evaluated with perioperative testing including but not limited to chemistry panel, erythrocyte sedimentation rate, C-reactive protein, glycated hemoglobin level, international normalized ratio, foot and ankle radiographs, vascular evaluation including angiography with intervention as indicated, as well as a staged closure, allowing time for intraoperative cultures to speciate
- Postoperative management comprised of non weight bearing to operative leg until incision healed, then progression to protected weight bearing with fitting into a CROW boot or a different offloading shoe
- Inclusion criteria: minimum 12 month follow up
- Exclusion criteria: proximal amputation within the same hospital stay
- Body mass index, diabetes, renal disease, peripheral vascular disease, lymphedema/venous insufficiency, smoking status, Charcot, amputation, vascular intervention, wound recurrence, reoperation rate, and ambulatory status were evaluated.

## Results

56% of heel wounds treated with the vertical contour calcanectomy remained closed (n=16) at the 1 year follow up period. An average of 1.44 subsequent surgeries were required per patient. 69% of patients (n=13) at 1 year follow up and 100% of patients (n=8) at 2 years either returned to baseline or improved their ambulatory status. The average follow up time was 27.1 months (range = 13.5 - 51.1). The overall rate of major amputation was 19%.

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## Discussion

Since Gaenslen described the initial calcanectomy, the conventional partial calcanectomy has been portrayed as a viable alternative to a transtibial amputation (1). However, literature on the partial calcanectomy shows a wide variance of healing, reulceration, major amputation rates and postoperative morbidity (2). The “bone to soft tissue ratio” must be biased towards a soft tissue closure without tension, especially with postoperative edema (3).

	Number % (n=16) Mean (range) Mode
<b>Pre-Operative Considerations</b>	
Osteomyelitis Preoperative	50% (8/16)
# of days with ulcer prior to VCC Surgery	Mean: 292/1 (10-1247) Mode: 129
Contralateral amputation	6.3% (1/16)
<b>Operative Course</b>	
Primary Closure	50% (8/16)
# of Surgeries before closure of VCC	Single Surgery: 12.5% (2/16) Two Surgeries: 56.3% (9/16) Three Surgeries: 25% (4/16) Four Surgeries: 6.3% (1/16)
<b>Postoperative Outcomes</b>	
Number of Postoperative surgeries	No postoperative surgeries 50% (8/16) 1 postoperative surgery 12.5% (2/16) 2 postoperative surgeries 18.8% (3/16) 3 postoperative surgeries 12.5% (2/16)
Major Lower Extremity Amputation	18.8% (3/16)
30 Days Readmission rate (related to lower extremity)	12.5% (2/16)
Mortality	18.8% (3/16)

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## Conclusion

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## References

1. 11, 12, 13, 14
2. 12, 15
3. 8

