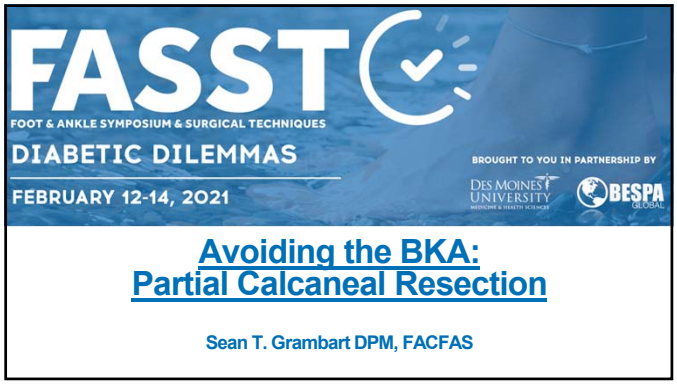
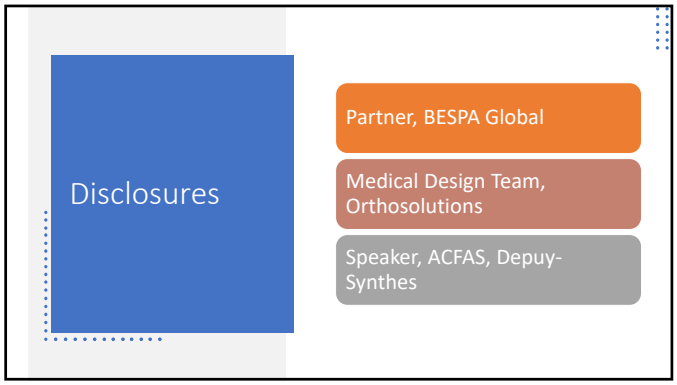
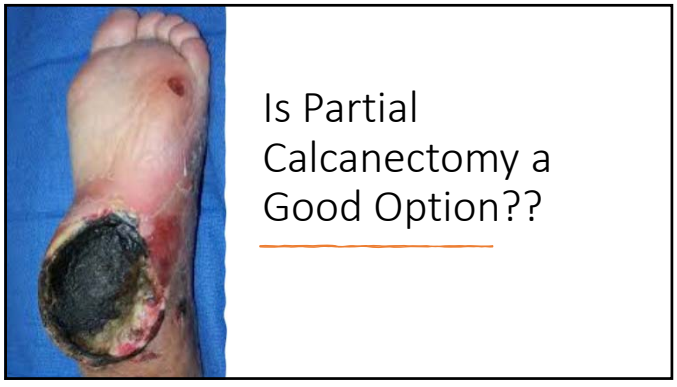

FASST
FOOT & ANKLE SYMPOSIUM & SURGICAL TECHNIQUES
DIABETIC DILEMMAS
FEBRUARY 12-14, 2021
BROUGHT TO YOU IN PARTNERSHIP BY
DES MOINES UNIVERSITY
BESPA
Avoiding the BKA:
Partial Calcaneal Resection
Sean T. Grambart DPM, FACFAS

1


Disclosures
Partner, BESPA Global
Medical Design Team, Orthosolutions
Speaker, ACFAS, Depuy-Synthes

2


Is Partial Calcanectomy a Good Option??

3

Crandall RC, Wagner FW Jr.
Partial and total calcanectomy: a review of thirty-one consecutive cases over a ten-year period.
J Bone Joint Surg Am. 1981 Jan;63(1):152-5

- 20 partial and 11 total calcanectomies in 29 patients 18 diabetics/8 spine injury
- Approximately one-half of the diabetic patients, immediate failure of the procedure led to amputation
- Primary wound-healing occurred in only 4/18 diabetics
- Non-diabetic patients 10 of the 13 heels showed primary healing
- Late failure also occurred in three diabetic patients
- The overall rate of failure in the diabetics was 65%
- "The rate of failure with calcanectomy in this report was high in diabetic patients: more than **ten times the 4.2% failure rate observed in 190 consecutive BKA** at our institution."

4

What do WE tell people about BKA??

5

Pinzur MS, Gold J, Schwartz D, Gross N.
Energy demands for walking in dysvascular amputees as related to the level of amputation.
Orthopedics 1992;15(9):1033–6.

- Cardiac function and oxygen consumption were measured in 25 patients who underwent amputation for peripheral vascular disease (PVD)
- 5 patients at each of the midfoot, Syme's, below-, through-, and above-knee amputation levels and the five controls
- **Normal walking speed and cadence decreased**
- **Oxygen consumption per meter walked increased with more proximal amputation**
- The **ratio of cardiac function and oxygen consumption at normal walking speed as compared with at rest increased with more proximal amputation**, and the capacity to increase walking speed and oxygen consumption lessened
- "Our results suggest that peripheral vascular insufficiency amputees function at a level approaching their maximum functional capacity. At more proximal amputation levels, the capacity to walk short or long distances is greatly impaired."

Desveaux L, Goldstein RS, Mathur S, et al.
Physical activity in adults with diabetes following prosthetic rehabilitation.
Can J Diabetes 2016;40 (4):336–41.

- To determine whether adults with diabetes and with transtibial amputations (TTAs) are meeting the recommended guidelines for physical activity intensity and daily step counts
- "Physical activity levels for adults with diabetes and TTAs remain stable following discharge from prosthetic rehabilitation but **fall well below recommended guidelines** of 6500 steps per day and 150 minutes of moderate to vigorous physical activity per week."

6

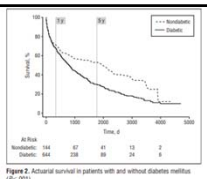


Figure 2. Actuarial survival in patients with and without diabetes mellitus ($P<.001$).

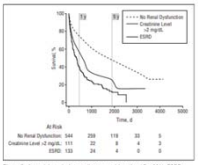


Figure 3. Actuarial survival according to renal function ($P<.001$). ESRD indicates end-stage renal disease. To convert milligrams per deciliter to micromoles per liter, multiply by 88.4.

Aulivola B, Hile CN, Hamdan AD, et al.
Major lower extremity amputation: outcome of a modern series.
AMA Arch Surg 2004;139(4):395–9.

- 1 and 5-year **survival** in patients with diabetes mellitus was **69.4% and 30.9%** vs 70.8% and 51.0% in patients without DM
- 1 and 5-year **survival** in end-stage renal disease patients was **51.9% and 14.4%** vs 75.4% and 42.2% in patients without renal failure

7

Smith DG, Stuck RM, Ketner L, Sage RM, Pinzur MS.
Partial calcanectomy for the treatment of large ulcerations of the heel and calcaneal osteomyelitis. An amputation of the back of the foot.
J Bone Joint Surg Am. 1992 Apr;74(4):571-6

- 12 patients who had a large ulceration over the heel were managed with a partial calcanectomy
- Only patients:
  - ankle-arm index more than 0.45, a TcPO2 >28 mmHg
  - albumin of more than 3.0 grams per deciliter
  - total lymphocyte count of more than 1500
- Follow-up averaged 33 months
- Wound healed after the partial calcanectomy in 10 of the 12 patients
- 9/10 patients maintained the level of mobility that they had had preoperatively

8

Smith DG, Stuck RM, Ketner L, Sage RM, Pinzur MS.
Partial calcanectomy for the treatment of large ulcerations of the heel and calcaneal osteomyelitis. An amputation of the back of the foot.
J Bone Joint Surg Am. 1992 Apr;74(4):571-6

TABLE I
DATA ON THE PATIENTS

Case	Age (Yrs.)	Diagnosis	Duration of Symptoms (Mos.)	Duration of Follow-up (Mos.)	Wound Healing	Ability to Walk*	
						Preop.	Postop.
1	77	Diabetes	7	64	Complete	Unlimited household	Unlimited household
2	22	Myelomeningocele	5	63	Complete; late superficial breakdown of skin, resolved	Limited community	Limited community
3	62	Diabetes	30	53	Complete	Unlimited community	Unlimited community
4	60	Peripheral vascular disease	6	47	Below-the-knee amputation	Limited household	Unlimited community
5	49	Diabetes	24	44	Complete	Unlimited community	Unlimited community
6	65	Diabetes	3	28	Complete	Unlimited community	Unlimited community
7	51	Diabetes	5	27	Complete; late superficial breakdown of skin, resolved	Unlimited community	Unlimited community
8	65	Diabetes	5	19	Complete	Unlimited community	Unlimited community
9	30	Quadriplegia	12	16	Complete	Quadriplegic	Quadriplegic
10	65	Peripheral vascular disease	6	15	Complete	Unlimited community	Unlimited community
11	45	Diabetes	84	12	Below-the-knee amputation	Limited community	Unlimited household
12	59	Peripheral vascular disease	6	7	Complete	Unlimited community	Unlimited community

9

Smith DG, Stuck RM, Ketner L, Sage RM, Pinzur MS.
Partial calcanectomy for the treatment of large ulcerations of the heel and calcaneal osteomyelitis. An amputation of the back of the foot.
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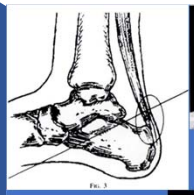

"Partial calcanectomy is a **reliable** and **predictable** salvage procedure, provided the patient has adequate vascular perfusion and nutritional competence."

10

Smith DG, Stuck RM, Ketner L, Sage RM, Pinzur MS.
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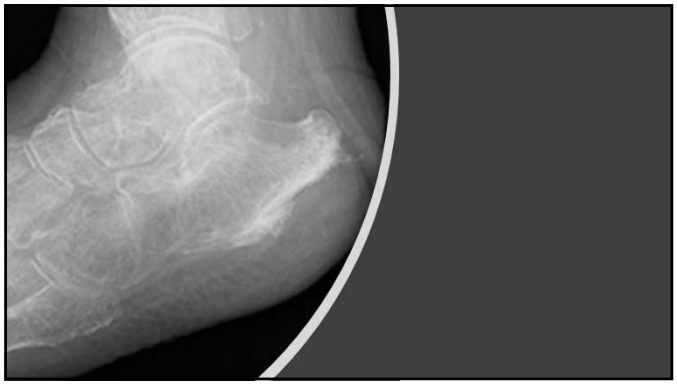
11

Was That the Only Thing That Changed?

12



13

14

Noah G. Oliver, John S. Steinberg, Kelly Powers, Karen K. Evans, Paul J. Kim, and Christopher E. Attinger

Lower Extremity Function following Partial Calcanectomy in High-Risk Limb Salvage Patients

Journal of Diabetes Research
Volume 2015

FIGURE 3: Category 1 partial calcanectomy: ≤50% resected.

FIGURE 4: Category 2 partial calcanectomy: >50% resected.

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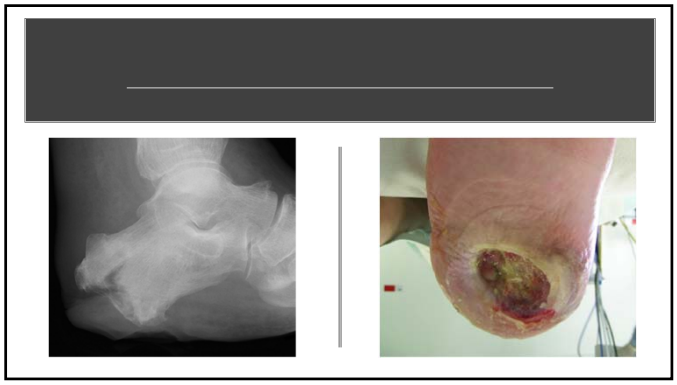

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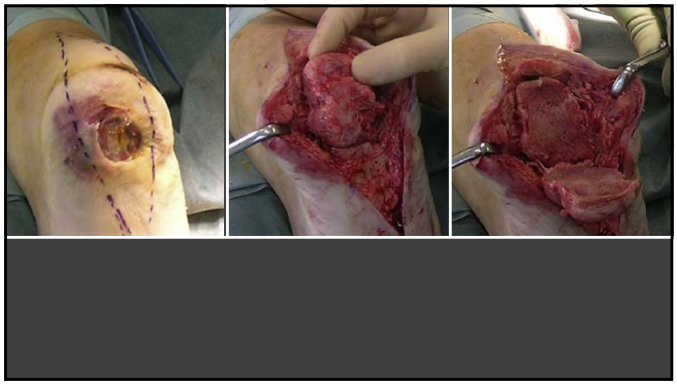

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18

Cates NK, Wang K, Stowers JM, Attinger CE, Kim PJ, Steinberg JS.
The Vertical Contour Calcanectomy, an Alternative Approach to Surgical Heel Ulcers: A Case Series.
J Foot Ankle Surg. 2019 Nov;58(6):1067-1071.

- 16 feet (14 patients) with recalcitrant heel wounds who underwent VCC
- Minimum follow-up time for inclusion was 1 year
- Average follow-up time was 27.1 months
- At 1 year of follow-up, 56% of heel wounds (9 of 16) treated with the VCC remained closed
- An average of 1.44 subsequent surgeries were required per patient
- Baseline or improved ambulatory status was achieved in 69% of patients (9 of 14) at 1-year follow up and 100% of patients (8 of 8) at 2-year follow up
- Rate of major amputation was 19%

19

Tammer Elmarsafi, DPM, Andrew J. Pierre, DPM, Kaihua Wang, DPM, Karen K. Evans, Christopher E. Attinger, Paul J. Kim, DPM, John S. Steinberg, DPM
The Vertical Contour Calcanectomy: An Alternative Surgical Technique to the Conventional Partial Calcanectomy
The Journal of Foot & Ankle Surgery 58 (2019) 381–386

Fig. 1 First osteotomy landmark. Two imaginary lines can be made dividing the superior and inferior aspects of the calcaneus. The first cardinal osteotomy (long horizontal yellow line) should be placed just inferior to the bisection (bold black line).

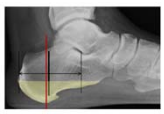

Fig. 2 Second osteotomy landmark. The second osteotomy (vertical red line) is made midway between the remaining posterior calcaneus and the axis of the malleoli. This line also corresponds with the lateral process of the talus on imaging. The osteotomy can be made at the bisection (bold black line) or adjusted depending on the size of the calcaneus. Larger calcanei can tolerate an osteotomy closer to the midline, but the osteotomy should never exit into the subtalar joint.

20

Tammer Elmarsafi, DPM, Andrew J. Pierre, DPM, Kaihua Wang, DPM, Karen K. Evans, Christopher E. Attinger, Paul J. Kim, DPM, John S. Steinberg, DPM
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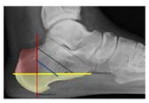


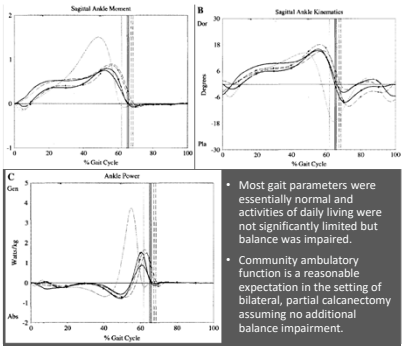
Fig. 3 Third osteotomy landmark. The third osteotomy is made at 45° to the previous osteotomies or parallel to the posterior facet of the subtalar joint on imaging (represented in blue). This site, however, can be approximated and fluoroscopy is not required.

21

Beals TC, MacWilliams BA, Webster J, Nickisch F. Gait and functional implications of bilateral, partial calcanectomy: case report. Foot Ankle Int. 2010 May;31(5):448-51.

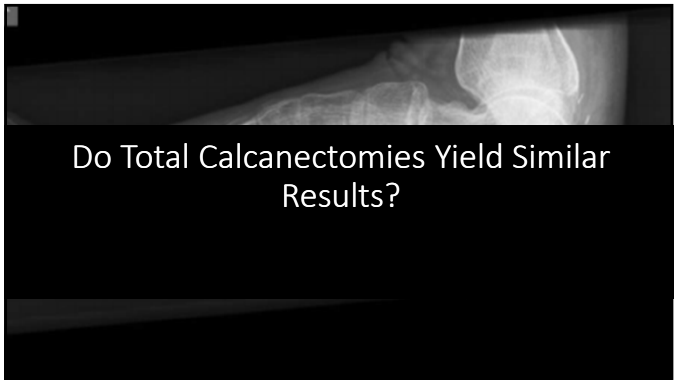
22

Beals TC, MacWilliams BA, Webster J, Nickisch F. Gait and functional implications of bilateral, partial calcanectomy: case report. Foot Ankle Int. 2010 May;31(5):448-51.



- Most gait parameters were essentially normal and activities of daily living were not significantly limited but balance was impaired.
- Community ambulatory function is a reasonable expectation in the setting of bilateral, partial calcanectomy assuming no additional balance impairment.

23



Do Total Calcanectomies Yield Similar Results?

24

Waibel FWA, Klammer A, Götschi T, Uçkay I, Böni T, Berli MC.
Outcome After Surgical Treatment of Calcaneal Osteomyelitis.
Foot Ankle Int. 2019 May;40(5):562-567.

- The aim of this study was to describe and compare overall revision and secondary amputation rates for each surgical option in our institution's cohort and to identify risk factors for secondary amputation
- Methods: 50 patients
- Revisions, secondary amputations, and possible risk factors for secondary amputation and overall revision

25

Outcome After Surgical Treatment of Calcaneal Osteomyelitis.
Waibel FWA, Klammer A, Götschi T, Uçkay I, Böni T, Berli MC.
Foot Ankle Int. 2019 May;40(5):562-567.

- CRP values greater than 5 mg/L at the index procedure were significantly associated with overall revision
- In limb-preserving surgical options, secondary BKA rates are higher than previously known
- Primary BKA is a procedure with a low reamputation rate of 5.6%
- PC can be considered, with 28.6% needing more proximal amputation
- "In TC, all patients underwent revision surgery and 50% had to undergo secondary BKA. Therefore, we hesitate to consider total calcanectomy as a surgical option in calcaneal osteomyelitis anymore."

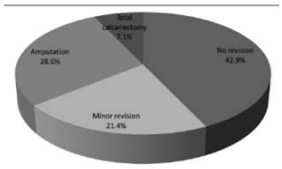


Figure 2. Revision details for partial calcanectomy.

26

Yammine K, El-Alam A, Assi C.
Outcomes of partial and total calcanectomies for the treatment of diabetic heel ulcers complicated with osteomyelitis. A systematic review and meta-analysis.
Foot Ankle Surg. 2020 Aug 12:S1268-7731

- Determine the primary outcome of healing rates following partial (PC) and total calcanectomies (TC) in treating calcaneal osteomyelitis due to diabetic heel ulcers
- 20 studies met the inclusion criteria comprising 295 patients with 300 calcanectomies (270 PC and 30 TC)
- Mean follow-up period of 29.3 months
- Osteomyelitis healing rate was of 80%
- Rate of secondary total calcanectomy was of 5.4%
- Rate of secondary BKA was of 17.1% with no difference between subgroups of TC and PC
- Combined mortality rate of both calcanectomies was of 13.4%
- Significant higher mortality was found following TC compared to PC ($p < 0.0001$)

27

Yammine K, El-Alam A, Assi C.
Outcomes of partial and total calcanectomies for the treatment of diabetic heel ulcers complicated with osteomyelitis. A systematic review and meta-analysis.
Foot Ankle Surg. 2020 Aug 12:S1268-7731

- "Partial and total calcanectomies were found to yield very good healing rates with acceptable complication frequencies. When compared to the reported outcomes of below and above-knee amputations in the literature, calcanectomies could be fairly considered as good alternatives to above ankle amputations"

28

Take Home Points

- This is not a MIS Procedure!
- Failures will occur
- Staged Procedure?

29

Thank You!

30