

Gaenslen's Split-heel Approach for Management of Chronic Calcaneal Osteomyelitis: A Case Report and Literature Review

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Received on: 04 July 2022; Accepted on: 18 August 2022; Published on: xxxx

ABSTRACT

Background: Calcaneal osteomyelitis is difficult to treat. Various surgical procedures to manage chronic osteomyelitis of the calcaneus, that is, partial, total calcaneotomy, split-heel approach, and vascularized flaps to cover the ulcer, have been employed with variable and often disappointing results. Way back in 1931, Gaenslen reported his split-heel or cloven-heel method approach, with satisfactory healing in all patients and no plastic or secondary operations. In spite of the uniformly good results in all calcaneum osteomyelitis cases shown subsequently, it seems that this is not a popular approach, the literature is sparse, and the most recent publication on this approach and technique was in 2010 by Bhattacharya and Das. This approach and technique has not received much attention as a preferred treatment choice primarily and is usually reserved for patients with resistant or recurrent disease. Our case report and systematic review of this method reveal that it is a safe and effective technique and that it shall be used primarily in all patients of calcaneal osteomyelitis, with or without a plantar ulcer, in children and adults alike.

Conclusion: Overall, it seems reasonable to state that it is a safe and very effective technique. Only two recurrences and one reoperation are noted in this entire literature review.

It remains a moot point whether this approach and technique shall be routinely indicated in all patients of calcaneal osteomyelitis with or without a plantar ulcer, and further studies may be required.

This approach ought to be renamed the Landerer-Gaenslen approach in future references.

We are hopeful that we have revisited and revived this useful and safe technique and attempted to rekindle the memory of the fascinating classic paper by author Gaenslen, reviewed and refined the indications through our case report and literature survey.

Level of evidence: Level 5.

Keywords: Calcaneal osteomyelitis, Gaenslen, Heel pad, Split-heel pad.

Journal of Foot and Ankle Surgery (Asia-Pacific) (2022); 10.5005/jp-journals-10040-1269

INTRODUCTION AND BACKGROUND

Calcaneal osteomyelitis is difficult to treat. Chronic osteomyelitis of the calcaneus presents a formidable management dilemma. There are different surgical procedures to manage chronic osteomyelitis of the calcaneus, that is, partial and total calcaneotomy, split-heel approach, and vascularized flaps to cover the ulcer. Gaenslen, in 1931, reported his split-heel or cloven-heel method approach, with satisfactory healing in all patients and no plastic or secondary operations.¹ In all but smaller circumscribed lesions, the usual medial or lateral approaches are apt to give inadequate exposure, with the result of recurrence or persisting sinuses due to incomplete removal of diseased bone.¹ The traditional approach, either medially or laterally, could only provide limited exposure to the affected calcaneus. The split-heel technique has the advantage of allowing for adequate exposure of the extensive lesion in the calcaneus. Concern about plantar scars seems unfounded as various authors reported painless scars with excellent functional and cosmetic results at long-term follow-up.¹⁻⁴ Gaenslen reported plantar scar so deeply situated that the plantar tissues form two thick cushions well adapted to weight-bearing without pain.¹ Subsequently, in recent times, others reported thin, flat, painless scars.^{4,5}

Various authors have noted distinct advantages of this approach and recommended it over others. Wang et al. stated, "the split-heel

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How to cite this article: Panchanadikar V, Waghela AB, Agrawal M, et al. Gaenslen's Split-heel Approach for Management of Chronic Calcaneal Osteomyelitis: A Case Report and Literature Review. *J Foot Ankle Surg (Asia-Pacific)* 2022;xx(xx):1-6.

Source of support: Nil

Conflict of interest: None

technique has distinct advantages over the conventional medial or lateral approach in the operative debridement of extensive and predominantly plantar chronic calcaneal osteomyelitis".⁴ Gaenslen's technique is recommended for refractory cases or patients with a draining sinus centrally located on the plantar aspect of the heel.^{2,5} The split-heel approach is an excellent, easy, and safe way of management for chronic osteomyelitis of calcaneus with a centrally located ulcer in selected cases.⁵ Hence in recent times, it has been used mainly for chronic osteomyelitis of calcaneus with a

centrally located ulcer or lesion or in refractory cases^{3,5} even though the earliest and largest series to date by Gaenslen made no such recommendation and included many patients with no plantar ulcer.¹

Despite the uniformly good results in all calcaneum osteomyelitis cases shown in literature, it seems that this is not a popular approach and perhaps is fading away. The most recent publication on this approach and technique is way back in 2010 by Bhattacharya and Das. This technique does not find any mention in the recent systematic review on surgical treatment and outcomes of calcaneal osteomyelitis in adults, except as one reference.^{6,7} The computerized search methodology may have some limitations. The comprehensiveness of the search process has been viewed as a key factor in preventing bias and providing a true representation of available research⁸ While MEDLINE is considered the premier source for accessing clinical medical information, it has been established that searching MEDLINE alone generally fails to identify all possible studies for inclusion in systematic reviews.^{9,10}

We are presenting a case report with the favorable result of this method, and a literature review in an attempt to revisit and revive this useful and safe technique, rekindle the memory of the fascinating classic paper by author Gaenslen, review and refine/redefine indications.

Search Strategy

A PubMed search was conducted by using the keywords "calcaneum split-heel." The numbers of results obtained were 32. Those articles which had all patients with calcaneum osteomyelitis treated by split-heel approach were included. The articles which included patients with calcaneal osteomyelitis treated by various approaches and the articles which included calcaneotomy as a treatment were excluded. Three articles that fulfilled our criteria case were selected. A further search was carried out in Google Scholar through similar articles and citations, and we obtained two more results as per the criteria. We did not find any systematic review or meta-analysis, nor randomized controlled or case-control studies that focussed on the topic. In the end, we could find only five articles that fulfilled our criteria.

CASE DESCRIPTION

A 54-year-old female patient was admitted to our hospital with a nonhealing draining ulcer over the plantar side of the left heel of 8 months duration following a thorn prick (Fig. 1). She had been treated earlier elsewhere with oral antibiotics and multiple dressings. No surgery was performed earlier. Plain radiography revealed osteomyelitis of the calcaneus with two lytic areas (Fig. 2). The diagnosis of chronic osteomyelitis was confirmed on a magnetic resonance imaging (MRI) scan (Figs 3 and 4). The patient has advised surgery of open debridement and curettage.

Surgery Steps

In the prone position, under spinal anesthesia, a pneumatic tourniquet was applied. A longitudinal incision is taken in the midline of the heel, splitting the Achilles tendon in the lower 3–4 cm of the heel proximally and distally extending to the plantar surface of the heel up to the level of the base of the fifth metatarsal. The incision is deepened through the skin, and fascia between abductor digiti quinti and flexor digitorum brevis keeping the lateral plantar artery and nerve at the distal end of the incision by subperiosteal dissection (Fig. 5).

The quadratus plantae muscle and plantar ligament were split, and the bony surface of the calcaneus was visualized. Calcaneus is



Fig. 1: Preoperative image



Fig. 2: Preoperative radiograph

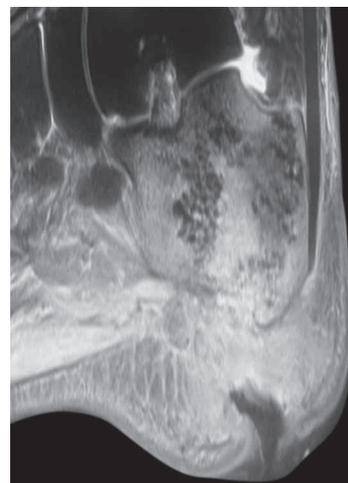


Fig. 3: Preoperative MRI-sagittal view

split by a broad osteotome, and the interior of the bone is exposed (Fig. 6). Infected and necrotic tissues were removed and sent for histopathological examination. Wash was given with hydrogen peroxide and povidone-iodine, followed by normal saline. The wound closed in layers with a negative suction drain with the limb

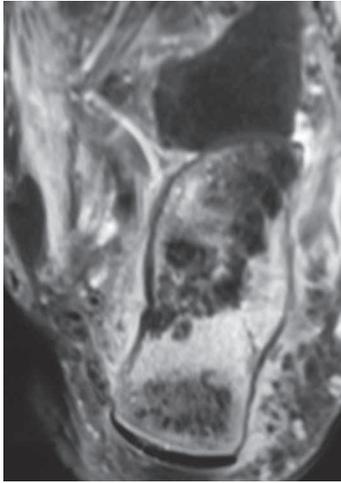


Fig. 4: Preoperative MRI-coronal view



Fig. 7: Follow-up image showing scar healing



Fig. 5: Intraoperative image 1



Fig. 8: Radiograph showing progressive bone healing



Fig. 6: Intraoperative image 2

resting in a below-knee slab. Dressings were done every 3rd day. The drain was removed on the 5th day when the drain was minimal (<20 mL). Intravenous antibiotic (cefuroxime) 1500 mg twice a day for 7 days. The aerobic culture report showed gram-positive cocci and gram-negative bacilli susceptible to cefuroxime. We continued the

same antibiotic orally with a dose of 500 mg twice a day for 21 days. The patient started non-weight-bearing ambulation immediately from the 2nd day. After 4 weeks, the surgical wound was completely healed without any discharge (Fig. 7). A radiograph at that time also showed progressive healing (Fig. 8). Progressive weight-bearing started 2 weeks after that. Follow-up at 3 months showed the patient walking with full weight-bearing with no symptoms and no scar tenderness. Further follow-ups were uneventful, with the last follow-up at 23 months showing healed non-tender scar in an asymptomatic patient without any recurrence (Fig. 9).

LITERATURE REVIEW AND DISCUSSION

Gaenslen, in 1931, reported his split-heel or cloven-heel method approach in 11 patients, which included seven children and four adults, for pyogenic and tuberculous osteomyelitis of calcaneum.¹ He described in detail all cases as case reports in the same article.

Like many scientific discoveries, this approach was accidentally discovered by Gaenslen when he was compelled to use it for the first time in the case of osteomyelitis of calcaneus in a child, and it was not the result of any academic study or cadaveric experiments. Because of the already existing, partially healed incision from the previous drainage operation, with discharging fistula, as well as the marked and diffuse swelling of the entire heel, the mid-plantar

incision was chosen by the author as the most direct route.¹ After a good result in this instance, he felt no hesitation in applying the method to subsequent patients. He also stated that in all but smaller circumscribed lesions, the usual medial or lateral approaches are apt to give inadequate exposure, with the result of recurrence or persisting sinuses due to incomplete removal of the diseased bone.¹

Subsequently, only four more reports covering children and adults are published.²⁻⁵ To this date, Gaenslen's remains the largest series. Broudy et al. in 1976, and Wang et al., in 2009, reported calcaneal osteomyelitis treated with this approach and technique in three children series each. Jerome and Thomas (one patient), in 2008, and Bhattacharyya and Das (three patients), in 2010, both reported the usefulness of this technique in adults with a nonhealing plantar ulcer.

Changing Indications

Gaenslen used this approach and technique in children and adults for pyogenic and tuberculous osteomyelitis lesions of the os calcis and associated adjacent tarsal bones and joints.¹ In Broudy et al.'s opinion, this technique is indicated for refractory cases with draining sinuses centrally located on the plantar aspect of the heel and requiring extensive debridement. The traditional approach, either medially or laterally, could only provide limited exposure to the affected calcaneus.² Wang et al. stated that Gaenslen's split-heel technique would be useful for chronic calcaneal osteomyelitis for refractory/recurrent cases for more extensive lesions within the calcaneus, or for puncture-related cases with lesions near the plantar aspect of the calcaneus.⁴ Jerome and Thomas and Bhattacharyya and Das expanded the indication and confirmed the utility of this approach/technique in adult patients of chronic osteomyelitis of calcaneus with a centrally located/plantar ulcer.^{3,5}

From this literature survey, it can be safely assumed that this approach and technique is indicated for pyogenic and tuberculous osteomyelitis of calcaneus in children and adults, in refractory or recurrent cases, or for more extensive lesions within the calcaneus, or puncture-related cases with lesions near the plantar aspect of the calcaneus, and for associated nonhealing ulcer of the heel. This approach and technique has not received much attention as a preferred treatment choice primarily and is usually reserved for patients with resistant or recurrent disease. Perhaps it can be used in adults with osteomyelitis of calcaneus even when there is no plantar ulcer, as Gaenslen used this approach and technique successfully in three adult patients who did not have a nonhealing plantar ulcer.



Fig. 9: Completely healed scar

Calcaneal osteomyelitis is difficult to treat.⁶ In the studies with bone treatment only, infection recurrence ranged from 0 to 35% and the amputation rate from 0 to 29%.⁶ However, Gaenslen's approach and technique has been used by various authors, and all have demonstrated universally good results and very few recurrences/reoperations and no complications. The high success rate of this approach/technique can probably be attributed to eminently satisfactory exposure and, though purely conjectural, osteotomy of calcaneus enhancing local circulation resulting in complete healing. It is observed that Ilizarov transverse tibial bone transport and microcirculation reconstruction is of great significance for promoting the healing of lower limb ulcer^{11,12}; however, the healing effects of a local fracture or osteotomy are unknown.

The Surgical Technique of Gaenslen

The approach or technique has not changed in the last 9 decades except for the method of wound closure.

The surgical steps and tips, in brief, as Gaenslen described, are,

- An expulsion bandage and an Esmarch bandage.
- Patient lying facedown.
- The incision is made beginning on the plantar surface of the foot directly opposite the tuberosity of the fifth metatarsal bone, on a line bisecting the heel and the middle toe, then extending over the heel and splitting the Achilles tendon in the lower 3 or 4 cm.
- The incision extends through the skin and plantar aponeurosis.
- It lies between the abductor of the small toe and the short flexors of the toes, though no special effort is made to identify these structures (Fig. 10).
- The external plantar artery and nerve are seen at the distal angle of the wound. These structures are carefully retracted to the medial side. A few unimportant vessels to the abductor of the small toe are sacrificed.
- The fibers of the plantar quadratus muscle are exposed and split longitudinally, also the long plantar ligament.
- The os calcis is now divided with a broad chisel into an inner and outer half, the chisel passing obliquely from behind forward and toward the dorsum so far as is necessary to expose the lesion.
- Two halves of the heel can be retracted like an open book when the lower 3 or 4 cm of the Achilles tendon are split in the midline. When this was done, the exposure was eminently satisfactory.
- Sequestra necrotic tissue and granulation tissue were removed.
- The wound is left wide-open and packed.

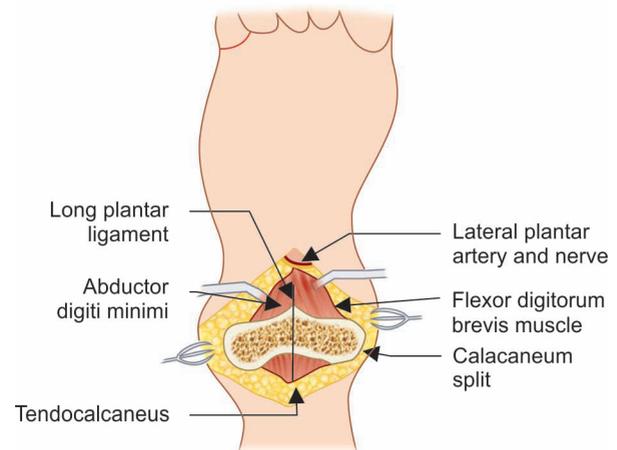


Fig. 10: Diagrammatic representation of Gaenslen's approach

Changing Technique of Wound Closure and Resultant Scar Formation

The operative technique has not changed in any way in 9 decades except in the skin closure method. In earlier years, wounds had been left open and packed, this resulted in thick buried (retraction) but painless scars reported by Gaenslen and Broudy et al.^{1,2} Bhattacharyya and Das stated, "In the original series reported by Gaenslen, the wound was kept open and all wounds healed with secondary intention. Hence, the healing scar was thick, cured? (curled in) and painless because of its cushioning effect. On the contrary primary closure of incision was performed in this reported series. Hence, scar tissue was thin and also painless."⁵ In later years, primary skin closure on the drain has been the norm. This change in technique has resulted in thin painless scars.³⁻⁵ In our patient, the scar was thin, flat, and painless.

Effectiveness, Safety, and Utility

All authors have reported excellent healing and universal satisfactory end results and medium to long follow-ups ranging from a minimum of 6 months up to 10 years. Only two recurrences and only one reoperation are noted in the entire literature.^{1,4} In the most recent publication on this subject, Bhattacharya and Das stated, "in this reported series, the split heel approach has been adopted as a safe procedure with an excellent outcome in selected cases."⁵ They further state, "there are several reports recommending partial calcaneotomy for chronic osteomyelitis of calcaneus with the nonhealing ulcer, old fracture calcaneum. The success rate of this procedure is very high in our series with complete closure of all heel wounds and no signs of dehiscence. The chance of injury to the neurovascular bundle was insignificant."⁵

Instinctive concern about the plantar scar on the weight-bearing part seems unfounded as various authors reported painless scar, with excellent functional and cosmetic results at long-term follow-up.^{1,2,4} Gaenslen reported plantar scar so deeply situated that the plantar tissues form two thick cushions well adapted to weight-bearing without pain.¹ Subsequently, in recent times, others reported thin, flat, and painless scars.^{4,5}

Broudy et al. quoted Martini et al. stating, "split heel technique is ineffective in eradicating infection, cosmetic appearance is unsatisfactory and the scar is fragile." However Martini et al., in their paper, do not quote any supporting literature for their observations, and reference to only one case treated by Gaenslen technique is quoted, that too in the table of cases.¹³ Hence it becomes difficult to justify the statement. Moreover, in the cases of Martini et al., all patients of partial or total resection of calcaneus treated later in the series by split-heel incision healed satisfactorily, but those treated earlier by horseshoe-shaped incision developed reopening of wounds.¹³

Complications

Complications reported after this procedure include growth disturbance of the calcaneus in children,^{1,2,4} limited motion/fusion/degeneration of the subtalar joint leading to triple fusion.² However, it is not clear whether these are due to infection resulting in local damage or due to surgical calcaneal split or both.

Despite the excellent functional results reported by various authors, this time-tested technique seems to have fallen off the radar of orthopedic surgeons. The last publication on this topic appeared in 2010 by Bhattacharyya and Das. Jerome and Thomas, in a case report, alluded to the split heel approach stating, "However, partial calcaneotomy has not received much attention, and it

seems that surgeons are often unaware that it is an option for the management of large ulcerations of the heel or osteomyelitis of the calcaneus."³ A recent systematic review article makes no mention of this technique.⁶ There is a need to revisit and revive this useful and safe technique, and hopefully, we have attempted well to rekindle the memory of the fascinating classic paper by author Gaenslen to review and refine/redefine indications of his technique.

It would be of interest to orthopedic historians to note that sterile strips have been used for closure since the times of Gaenslen; sterile adhesive strips assisted in wound closure after 4 days in his first patient though vaseline pack and plaster immobilization were used in subsequent patients. It is also pertinent to note that as mentioned by Gaenslen himself in his paper, this approach and technique was first used and published by Landerer in 1895, that is, 27 years before Gaenslen's first case in 1922, though Gaenslen discovered this approach independently and applied it in 11 patients.^{1,11} In view of the information unearthed, this approach ought to be renamed as the Landerer-Gaenslen approach.

CONCLUSION

Overall it seems reasonable to state that it is a safe and very effective technique. Only two recurrences and one reoperation is noted in this entire literature review.

No procedure-related complications are noted.

The plantar scar is always painless.

It remains a moot point whether this approach and technique shall be routinely indicated in all patients of calcaneal osteomyelitis with or without a plantar ulcer, and further studies may be required.

This approach ought to be renamed the Landerer-Gaenslen approach in future references.

We are hopeful that we have revisited and revived this useful and safe technique and attempted to rekindle the memory of the fascinating classic paper by author Gaenslen, reviewed and refined the indications through our case report and literature survey.

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