International Journal of Research in Medical Sciences
Agwulonu I et al. Int J Res Med Sci. 2025 Oct;13(10):3957-3962
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20253130

Original Research Article

Comparing surgical outcomes in end-bearing amputation stumps: a prospective cohort study of different surgical techniques

Ifeanyi Agwulonu[1]*, Oluwaseyi Idowu[2], Chinoso Osuala[3], Moses O. Oyewunmi[1], Badmus Hakeem[4]

[1]Department of Surgery, Orthopedic and Traumatology Unit, Babcock University Teaching Hospital, Ilishan Remo, Nigeria
[2]Department of Orthopedic and Traumatology, National Orthopaedic Hospital Igbobi, Nigeria
[3]Department of Orthopedic and Traumatology, Ebonyi State Teaching Hospital, Abakaliki, Nigeria
[4]Department of Orthopedic and Traumatology, Hospital for Trauma and Surgery, Lekki, Nigeria

Received: 11 August 2025
Accepted: 17 September 2025

***Correspondence:**
Dr. Ifeanyi Agwulonu,
E-mail: agwulonic@yahoo.ca

ABSTRACT

Background: Lower limb amputation outcomes are influenced by surgical technique, which impacts stump stability, prosthetic fitting, and complication rates. This study compared postoperative outcomes of fascia-to-fascia (including fascia-to-periosteum), myodesis, and myoplasty in below-knee amputations.
Methods: A five-year retrospective cohort study at two Nigerian tertiary centers included 96 adults who underwent unilateral below-knee amputation between January 2019 and December 2024. Data on patient characteristics, operative details, and outcomes were analyzed using Chi-square/Fisher's exact tests and Kruskal-Wallis tests.
Results: Mean age was 46.9±12.8 years; 69.8% were male. Fascia to fascia achieved the best prosthetic fitting (48.4%) and stump stability (49.1%), with the lowest reoperation (6.7%) and infection rates (15.2%). Myodesis had the highest reoperation and infection rates, while myoplasty had the shortest surgery time and lowest pain. fascia-to-fascia (including fascia-to-periosteum), took longest to perform (125±15 minutes) and had the highest pain scores.
Conclusions: Fascia to fascia fixation appears superior for long term stump integrity and prosthetic function, which is particularly valuable in resource limited Nigerian settings. Nevertheless, its association with greater pain and longer operative time highlights the need for targeted strategies to optimise analgesia and surgical efficiency without compromising outcomes.

Keywords: Below-knee amputation, Fascia to fascia, Fascia to periosteum, Myodesis, Myoplasty, Prosthetic fitting, Stump stability

INTRODUCTION

Below knee amputation is one of the most frequently performed major limb removal procedures worldwide, particularly in regions with high incidence of trauma, peripheral vascular disease, and severe infection.[1,2] Studies have shown considerable regional variation in the causes of lower limb amputations. In some centers, trauma, particularly from motorcycle accidents and road traffic injuries, accounts for the majority of cases, especially among young adult males, with reported rates ranging from 42% to 69% of cases.[3,4] In other regions, diabetic foot gangrene has emerged as the leading cause, responsible for between 57% and over 64% of lower limb amputations, particularly among older adults, and is often linked to late diagnosis and inadequate management of diabetes.[2,5] Other causes include tumors, chronic infections, and complications arising from traditional bone setter practices.[4,6,7]

The long term success of below knee amputation depends not only on the cause of amputation but also on the surgical technique used to prepare the stump for prosthetic use.[8] A stable end bearing stump with adequate soft tissue coverage is critical for patient comfort, prevention of complications, and functional rehabilitation.[9] Several surgical methods have been developed to achieve this objective. Myodesis involves direct suturing of muscle or tendon to the bone.[10] Myoplasty involves suturing opposing muscle groups or their fascia together over the bone without direct attachment to the bone.[11] Variations such as fascia-to-fascia (including fascia-to-periosteum) closure have been proposed to enhance tissue stability and padding.[12]

In high income countries, advanced methods such as osteomyoplastic techniques have been associated with improved functional outcomes and lower revision rates.[13] However, these require more surgical resources and specialized equipment, which are not always readily available in many Nigerian hospitals. In such settings, simpler yet effective methods like fascia-based closures may offer significant advantages. This five-year retrospective cohort study aimed to compare three techniques used in below knee amputations: myoplasty, fascia-to-fascia (including fascia-to-periosteum) and myodesis. This study sought to provide evidence based guidance on the most effective and practical technique for use in the Nigerian surgical context, where optimizing functional outcomes with limited resources remains a critical goal.

METHODS

Study design and setting

This study was conducted as a five-year retrospective cohort analysis comparing surgical outcomes of below-knee amputations performed at two tertiary orthopedic centers in Nigeria: Babcock University Teaching Hospital, Ogun State, and the National Orthopaedic Hospital, Igbobi, Lagos. The study covered the period from January 2019 to December 2024. Both hospitals are major referral facilities for trauma, diabetic foot care, and complex limb reconstruction, receiving patients from multiple states in Nigeria.

Study population

The study population comprised adult patients aged 18 years and above who underwent unilateral below-knee amputation during the study period. Three surgical techniques were evaluated: myoplasty, which involves suturing opposing muscle groups over the bone end; fascia-to-fascia (including fascia-to-periosteum) suturing, where the fascial layer is anchored to the periosteum of the tibia and reinforced with fascial closure over the stump; and myodesis, in which the muscle is anchored directly to bone through drilled holes in the tibia, representing the standard reference technique in many surgical centers.

Inclusion and exclusion criteria

Patients were included if they had complete medical records containing operative notes, postoperative progress charts, and follow-up data. Only primary below-knee amputations were considered, with a minimum follow-up period of six months after surgery. Patients were excluded if they had bilateral amputations during the same admission, underwent amputation for acute life-threatening sepsis in which soft tissue handling was severely compromised, or were lost to follow-up before three months.

Sample size and sampling technique

A census sampling technique was adopted, including all patients who met the eligibility criteria within the study period. A total of ninety-six cases (96) were identified from operative registers and electronic medical records. These cases were subsequently categorized into myoplasty (n=28), fascia-to-periosteum and fascia-to-fascia (n=34), and myodesis (n=34) groups. This sample size was deemed adequate for comparative statistical analysis according to Cohen's recommendations for detecting medium effect sizes in three-arm cohort studies with an alpha level of 0.05 and a statistical power of 80 %.

Data collection

Data were extracted from patient case notes, operative records, and follow-up clinic reports using a structured data abstraction form. The variables collected included demographic characteristics such as age, sex, occupation, and comorbidities including diabetes and peripheral vascular disease; indications for amputation such as trauma, diabetic foot gangrene, chronic infection, tumor, or other causes; and operative details including type of anesthesia, surgical technique used, intraoperative complications, and duration of surgery. Outcome measures recorded included stump stability, reoperation rate, stump hematoma, infection rate, post-operative pain, adequacy of soft tissue padding over the tibial stump, and prosthetic fitting success within six months.

Operative techniques

Three surgical stump closure methods were employed in this study: fascia to fascia including fascia to periosteum, myodesis, and myoplasty. In the fascia-to-fascia technique, during flap repair the opposing fascial layers and epimysium were approximated without incorporating the full muscle bulk as done in myoplasty. The fascia to periosteum variation involved suturing the fascia investing the posterior flap muscles directly to the periosteum of the tibial crest, with all posterior muscle fasciae converging to a single fixation point. For all internal repairs in this group, number 2 vicryl sutures were used. Skin closure was done with number 1 prolene or nylon using vertical or horizontal mattress stitches. No wound drains were inserted; the stump was dressed with firm crepe bandaging after

packing with a single abdominal towel or multiple layers of gauze. In myodesis, muscle was anchored directly to bone to enhance stability and prevent retraction. In myoplasty, opposing muscle groups were sutured together over the bone end to create a padded soft tissue envelope.

Outcome assessment

Stump stability was evaluated by senior physiotherapists and prosthetists during gait training and was graded as optimal, moderate, or poor. The reoperation rate was recorded for any surgical procedure required on the stump after the primary amputation. Infection was defined as a clinical diagnosis requiring antibiotic therapy, with or without wound breakdown. Postoperative pain was assessed at two weeks, six weeks, and three months using a visual analogue scale ranging from 0 to 10. Prosthetic fitting was considered successful if the patient achieved independent ambulation with a prosthesis within six months after surgery.

Data management and statistical analysis

All data were entered into Microsoft Excel 2019 and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were applied to summarize baseline characteristics, with continuous variables expressed as means and standard deviations or medians with interquartile ranges, and categorical variables presented as frequencies and percentages. Comparisons between the three surgical technique groups were made using the Chi-square test or Fisher's exact test for categorical variables, Kruskal-Wallis test for continuous variables.

Ethical considerations

Ethical approval for the study was obtained from the research and ethics committees of Babcock University Teaching Hospital and the National Orthopaedic Hospital, Igbobi. As the study was retrospective and based on existing records, the requirement for informed consent was waived. All patient data were anonymized before analysis, and confidentiality was maintained in accordance with the principles of the Declaration of Helsinki.

RESULTS

Of the 96 participants, 67 (69.8%) were male and 29 (30.2%) were female. The age distribution showed that 7 (7.3 %) were below 30 years, 27 (28.1%) were aged 31-40 years, 20 (20.8%) were aged 41-50 years, 24 (25.0%) were aged 51-60 years, and 18 (18.8%) were above 61 years. The mean age was 46.9±12.8 years.

According to Table 2, diabetic foot gangrene was the most common indication for amputation, observed in 65 participants (67.7%), followed by trauma in 19 (19.8%), tumour in 7 (7.3%), and chronic infection in 5 (5.2%). Among those with comorbidities (n=74), diabetes was most frequent (47.8%), followed by hypertension (27.8%), peripheral vascular diseases (13.0%), peptic ulcer disease (7.0%), and asthma (4.3%). The most frequently performed surgical techniques were fascia-to-periosteum/fascia-to-fascia and myodesis, each in 34 participants (35.4%), while myoplasty was performed in 28 participants (29.2%).

Table 1: Sociodemographic characteristics of patients.

	Frequency	Percent
Gender		
Female	29	30.2
Male	67	69.8
Age (in years)		
<30	7	7.3
31-40	27	28.1
41-50	20	20.8
51-60	24	25.0
>61	18	18.8
Mean±SD	846.9±12.8	
Height		
Mean±SD	166.4±7.5	
Weight		
Mean±SD	69.8±9.2	
BMI		
Mean±SD	25.2±3.1	
Occupation		
Artisan	19	19.8
Civil Servant	19	19.8
Farmer	24	25.0
Student	6	6.3
Trader	13	13.5
Unemployed	15	15.6

Table 2: Clinical characteristics and surgical techniques.

	N	%
Laterality		
Nil		
Indication for amputation		
Chronic infection	5	5.2
Diabetic foot gangrene	65	67.7
Trauma	19	19.8
Tumor	7	7.3
Comorbidities* (n=74)		
Diabetes	55	47.8
Hypertension	32	27.8
Peripheral vascular diseases	15	13.0
Asthma	5	4.3
PUD	8	7.0
Surgical technique		
Fascia-to-periosteum/ fascia-to-fascia	34	35.4
Myodesis	34	35.4
Myoplasty	28	29.2

*Multiple options, PUD: peptic ulcer diseases

Table 3: Post-operative outcomes of participants.

	Frequency	Percent
Prosthetic fitting		
Successful	60	62.5
Unsuccessful	36	37.5
Stump stability		
Moderate	20	20.8
Optimal	65	67.7
Poor	11	11.5
Stump hematoma		
No	82	85.4
Yes	14	14.6
Re-operation		
No	81	84.4
Yes	15	15.6
Infection		
No	80	83.3
Yes	16	16.7
Padding tibia		
Adequate	81	84.4
Inadequate	15	15.6

In Table 3, prosthetic fitting was successful in 60 participants (62.5%) and unsuccessful in 36 (37.5%). Stump stability was optimal in 65 participants (67.7%), moderate in 20 (20.8%), and poor in 11 (11.5%). Stump hematoma occurred in 14 participants (14.6%), while 82 (85.4%) had none. Re-operation was performed in 15 participants (15.6%). Infection was recorded in 16 participants (16.7%). Padding of the tibia was adequate in 81 participants (84.4%) and inadequate in 15 (15.6%).

As depicted in Table 4, fascia-to-periosteum/fascia-to-fascia was most often associated with successful prosthetic fitting (48.4%) compared with myodesis (29.0%) and myoplasty (22.6%, p=0.002). Optimal stump stability was most frequent with fascia-to-fascia (49.1%) and least with myoplasty (17.0%, p=0.012). Stump haematoma was least common with fascia-to-fascia (21.4%) and most with myodesis (38.2%, p=0.050). Re-operation was lowest with fascia-to-fascia (6.7%) and highest with myodesis (51.1%, p=0.001). Infection was lowest with fascia-to-fascia (15.2%) and highest with myodesis (45.5%, p=0.011). Adequate tibial padding was most common with fascia-to-fascia (43.8%) and least with myoplasty (23.4%, p=0.043). Mean post-operative pain score was highest with fascia-to-periosteum/fascia-to-fascia (4.8±2.5) and lowest with myoplasty (3.2±2.0, p=0.041) (Table 5). Mean surgery time was longest for fascia-to-fascia (125±15 minutes) and shortest for myoplasty (105±12 minutes, p=0.036).

Table 4: Association between surgical technique and post-operative outcomes.

	Fascia-to-fascia (including fascia-to-periosteum) N (%)	Myodesis N (%)	Myoplasty N (%)	Pearson Chi square	P value
Prosthetic fitting					
Successful	30 (48.4)	18 (29.0)	14 (22.6)	12.934	0.002
Unsuccessful	4 (11.8)	16 (47.1)	14 (41.2)		
Stump stability					
Moderate	5 (23.8)	7 (33.3)	9 (42.9)		
Optimal	26 (49.1)	18 (34.0)	9 (17.0)	12.823	0.012
Poor	3 (13.6)	9 (40.9)	10 (45.5)		
Stump hematoma					
No	28 (38.4)	21 (28.8)	24 (32.9)	5.985	0.050
Yes	6 (26.1)	13 (56.6)	4 (17.4)		
Re-operation					
No	31 (60.8)	11 (21.6)	9 (17.6)	30.610	0.001
Yes	3 (6.7)	23 (51.1)	19 (42.2)		
Infection					
No	29 (46.0)	19 (30.2)	15 (23.8)	9.065	0.011
Yes	5 (15.2)	15 (45.5)	13 (39.4)		
Padding tibia					
Adequate	28 (43.8)	21 (32.8)	15 (23.4)	6.293	0.043
Inadequate	6 (18.8)	13 (40.6)	13 (40.6)		

Table 5: Comparison of post-operative pain and surgery time by surgical technique.

	Fascia-to-fascia (including fascia-to-periosteum) Mean±SD	Myodesis Mean±SD	Myoplasty Mean±SD	P value
Post-op pain score	4.8±2.5	3.9±2.2	3.2±2.0	0.041
Surgery time (minutes)	125±15	115±14	105±12	0.036

DISCUSSION

The findings of this study indicate that the fascia-to-fascia (including fascia-to-periosteum) technique yielded superior outcomes in several post-operative parameters, particularly in terms of stump stability, prosthetic fitting success, reduced rates of infection, and lower need for re-operation. This aligns with the work of Hislop et al who reported that secure fascial fixation enhances mechanical stability and allows for better prosthetic control by distributing tension evenly across the muscle envelope.[14] By anchoring the fascia to a firm periosteal or fascial structure, the technique minimizes muscle retraction and prevents undue tension at the suture line, both of which are critical in optimizing stump shape for prosthetic use.[15]

The superiority of fascia-to-fascia (including fascia-to-periosteum) in reducing complications such as infection and poor stump stability can also be attributed to the creation of a well-padded distal stump with improved vascularity.[16] Adequate tissue coverage over bony prominences reduces the risk of skin breakdown and subsequent infection, an important consideration in low-resource environments where wound care follow-up may be inconsistent.[17] Additionally, in Nigeria where many amputees live in rural areas and depend on lower-limb prostheses for mobility, a stable and well-contoured stump directly impacts rehabilitation outcomes.

However, an important observation is that fascia-to-fascia (including fascia-to-periosteum) was associated with the highest mean post-operative pain scores and the longest operative times. The increased pain may be explained by the additional handling and manipulation of tissue during fascial fixation, as well as the potential for increased tension on soft tissues in the early post-operative period. Prolonged operative duration is likely due to the meticulous suturing and layer-by-layer alignment required in this method, as opposed to myoplasty which involves a simpler approximation of muscle over bone. In resource-limited Nigerian surgical theatres, where operating lists are often long and anaesthetic resources limited, longer surgery times may contribute to perioperative strain and limit case throughput. This has been highlighted by Rao et al, who emphasized the need for balancing surgical thoroughness with efficiency in such settings.[18]

The finding of higher pain scores in fascia-to-fascia patients contrasts with some Western reports, which found no significant difference in post-operative pain between myodesis and fascial techniques.[19,20] This discrepancy may reflect contextual differences including pain management protocols, patient pain thresholds, and the use of regional anaesthesia. In Nigeria, opioid availability is often restricted due to regulatory controls, and multimodal analgesia may not always be optimized, potentially amplifying the subjective pain experience post-operatively.

From a functional standpoint, while fascia-to-fascia provides excellent long-term stability, the trade-off in immediate post-operative discomfort may influence early mobilization. Some authors have suggested that myodesis offers a compromise by providing good stability with shorter operative time and potentially less pain, although our data show myodesis carried higher rates of complications such as re-operation and infection.[11,21,22] This may reflect surgical expertise distribution; in Nigeria, the surgeon's familiarity and experience with a given technique can be a decisive factor in outcomes, especially when managing complex vascular or traumatic amputation cases.

CONCLUSION

Overall, while fascia-to-fascia (including fascia-to-periosteum) fixation may offer the greatest reliability for long term prosthetic function and stump integrity, it is important to address its potential drawbacks through improved pain control measures and greater operative efficiency. In the Nigerian setting, where access to prosthetic services is limited and many amputees must rely on a single prosthesis for many years, prioritizing a durable and stable stump remains a reasonable approach despite the possibility of higher postoperative pain and longer surgery times. Future research could explore whether implementing structured pain management programs and providing training in faster fascial fixation techniques can maintain the advantages of fascia-to-fascia fixation while reducing its disadvantages.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Nwosu C, Babalola MO, Ibrahim MH, Suleiman SI. Major limb amputations in a tertiary hospital in North Western Nigeria. Afr Health Sci. 2017;17(2):508-12.
2. Onwuasoigwe O, Okwesili IC, Onyebulu LO, Nnadi EC, Nwosu ADG. Lower limb amputations in Nigeria: An appraisal of the indications and patterns from a premier teaching hospital. Int J Med Health Develop. 2021;26(1):64-9.
3. Omoke N, Nwigwe C. Limb amputations in Abakaliki, South East Nigeria. Afr J Med Health Sci. 2016;15:30-5.
4. Ajibade A, Akinniyi O, Okoye C. Indications and complications of major limb amputations in Kano, Nigeria. Ghana Med J. 2013;47(4):185-8
5. Abang I, Asuquo J, Anisi C, Agweye P, Essiet I, Ikpeme I. Indications and Pattern of Limb Amputation: A Tertiary Hospital Experience, South-South, Nigeria. Rec Adv Biol Med. 2018;4:41-5.
6. Salihu M, Arojuraye S, Alabi I, Yunusa R, Mazankwarai M. (2021). Traditional bone setting: an

avoidable cause of major limb amputations. Int J Res Orthopaed. 2021;7:194-8.
7. Echem R, Eyimina P. Traditional bone setter's gangrene of the upper extremity in children: experience from a tertiary health institution. J Med Sci. 2020;8:62-70.
8. Robinson V, Sansam K, Hirst L, Neumann V. Major lower limb amputation: What, why, and how to achieve the best results. Orthopaed Trauma. 2010;24(4):276-85.
9. Patil RK, Hamed AO, Venugopal S, Cherian M, Malhotra G. Coverage of below elbow amputation stump with a soft-tissue periosteal flap. Indian J Plast Surg. 2016;49(2):284-6.
10. Ovadia SA, Askari M. Upper extremity amputations and prosthetics. Semin Plast Surg. 2015;29(1):55-61.
11. Fabre I, Thompson D, Gwilym B, Jones K, Pinzur M, Geertzen JHB, et al. Surgical techniques of, and outcomes after, distal muscle stabilization in transfemoral amputation: a systematic review and narrative synthesis. Ann Vasc Surg. 2024;98:182-93.
12. Brey EM, Cheng MH, Allori A, Satterfield W, Chang DW, Patrick Jr CW, Miller MJ. Comparison of guided bone formation from periosteum and muscle fascia. Plast Reconstr Surg. 2007;119(4):1216-22.
13. Taylor BC, French B, Poka A, Blint A, Mehta S. Osteomyoplastic and traditional transtibial amputations in the trauma patient: perioperative comparisons and outcomes. Orthopedics. 2010;33(6):390.
14. Hislop P, Sakata K, Ackland D, Gotmaker R, Evans M. Acromioclavicular joint stabilization: a biomechanical study of bidirectional stability and strength. Orthopaed J Sports Med. 2019;7.
15. Lempainen L, Sarimo J, Orava S. (2007). Recurrent and chronic complete ruptures of the proximal origin of the hamstring muscles repaired with fascia lata autograft augmentation. Arthroscopy J Arthrosc Rel Surg. 2007;23(4):441.e1-5.
16. Kala PC, Dave A, Dixit PK, Karmakar S, Katrolia D. Usefulness of fasciocutaneous flaps for revision of below-knee amputation stumps. J West Afr Coll Surg. 2025;15(2):187-90.
17. Stephens M, Bartley CA. Understanding the association between pressure ulcers and sitting in adults: What does it mean for me and my carers? Seating guidelines for people, carers, and health and social care professionals. J Tissue Viabil. 2018;27(1):59-73.
18. Rao AJ, Bullis C, Holste KG, Teton Z, Burchiel KJ, Raslan AM. Balancing operative efficiency and surgical education: a functional neurosurgery model. Oper Neurosurg. 2019;17(6):622-31.
19. Lyapis A, Ulrich A, LaMonica R, Kuo CL, Kaye L, Luciano D. Does the difference in fascial closure technique affect postoperative pain? J Minim Invas Gynecol. 2017;24(7):1190-4.
20. Eren CY, Gursoy OO, Gurer HG, Şener T. Does a new fascial closure technique during cesarean section have an impact on the postoperative corner pain and patient satisfaction? J Clin Med Rev Rep. 2022;4(2).
21. Pascale BA, Potter BK. Residual limb complications and management strategies. Curr Phys Med Rehabil Rep. 2014;2:241-9
22. Konduru S, Jain AS. Trans-femoral amputation in elderly dysvascular patients: reliable results with a technique of myodesis. Prosthet Orthot Int. 2007;31(1):45-50.

Cite this article as: Agwulonu I, Idowu O, Osuala C, Oyewunmi MO, Hakeem B. Comparing surgical outcomes in end-bearing amputation stumps: a prospective cohort study of different surgical techniques. Int J Res Med Sci 2025;13:3957-62.