Trans-knee amputation with posterior myocutaneous flap in patients with advanced peripheral arterial disease

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Background
Critical limb ischemia can result in major amputation when revascularization proved to be impossible. Major amputation is sometimes unavoidable in patients with acute lower limb ischemia with irreversible damage (category III). When compared with the above-knee amputation (AKA), trans-knee amputation (TKA) or knee disarticulation has a durable end weight-bearing stump with a long, powerful, active lever arm for control of the prosthesis with excellent muscle attachments. The round distal stump enhances suspension of the prosthesis. Another advantage is decreased operative blood loss with less bony or muscular disruption, less energy consumption, and resistance to infection by maintaining the cartilage barrier to infection.
Purpose
Our objective is to evaluate the outcomes of TKA with posterior myocutaneous flap in patients with advanced peripheral arterial disease who are not candidates for below-knee amputation (BKA).
Patients and methods
his prospective interventional study included 24 patients with advanced peripheral arterial disease in need for amputation and BKA is likely to fail. All patients underwent TKA with posterior myocutaneous flap including gastrocnemius muscle. The indication for amputation was critical limb ischemia owing to unreconstructable peripheral arterial disease in 21 (87.5%) patients in whom revascularization options are unavailable or exhausted and irreversible (category III) acute thrombotic lower limb ischemia in three (12.5%) patients.
Results
The study was conducted on 24 patients, comprising 15 (62.5%) males and nine (37.5%) females. The mean age of patients was 65.8±10.5 years. Overall, four (16.6%) patients had previous contralateral AKA. Three (12.5%) patients died: two patients died in the early 3 postoperative days and one patient died in the same hospital admission after 35 days. For the remaining 21 patients, healing by primary intention was achieved in 15 (71.4%) patients, by delayed primary intention (tertiary intention) in one (4.8%) patient, and by secondary intention in two (9.6%) patients. Major wound dehiscence occurred in three (14.2%) patients requiring AKA.
Conclusion
TKA with posterior myocutaneous flap is a safe operative method of amputation in patients with advanced peripheral arterial disease with good healing rates and acceptable functional outcomes. If it is not possible to perform BKA, TKA should be considered before AKA.

Keywords:
knee disarticulation, peripheral arterial disease, trans-knee amputation

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Introduction

Most major lower extremity amputations are due to critical limb ischemia (CLI). Increased availability and use of endovascular and surgical interventions have resulted in a significant decrease in amputation for CLI. In a group of CLI with unreconstructable peripheral arterial disease or in whom attempts for reconstruction have failed, amputation becomes inevitable [1]. The ratio of below-knee amputation (BKA) to above-knee amputation (AKA) in large surveys is around 1 : 1. Approximately 60% of BKAs only heal by primary intention, 15% heal after secondary procedures, and 15% need to be converted to an above-knee level. Overall, 10% die in the perioperative period [2]. Major amputation is sometimes unavoidable in patients with acute lower limb ischemia with irreversible damage (category III). Amputation in acute lower limb ischemia is frequently at or above the knee joint because arterial occlusion

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occurs in the popliteal or more proximal arteries. The CLI amputee population usually consists of elderly patients with comorbidities and minimal rehabilitation potential. They are ideal candidates to benefit from the trans-knee amputation (TKA) [3].

Functional outcomes are superior following BKA compared with AKA. Consequently, BKA is preferred when clinically feasible based upon location of injury (infection or trauma) and lower extremity perfusion. When BKA is likely to fail, AKA is often regarded as the next level for amputation. Although TKA patients have better maintenance of independent living status than AKA patients, TKA represents less than 2% of all lower extremity amputations performed annually [4].

Appropriate amputation level selection is very important to prevent reamputations. When compared with AKA, TKA has a durable end weight-bearing stump with a long, powerful, active lever arm for control of the prosthesis with excellent muscle attachments. The round distal stump enhances suspension of the prosthesis. Another advantage is decreased operative blood loss with less bony or muscular disruption, less energy consumption, and resistance to infection by maintaining the cartilage barrier to infection [5].

The long posterior myofasciocutaneous flap was popularized in BKA by Burgess [6] with improved rate of survival of the flap owing to maintenance of vascular continuity from muscle to skin. Use of the posterior myofasciocutaneous flap in TKA for ischemic limbs was first reported by Klaes and Eigler [7]. When the posterior myofasciocutaneous flap incorporating the gastrocnemius bellies is used, it provides excellent padding and blood supply, ideal for prosthetic rehabilitation; prevents flap necrosis; and is supposed to have better outcomes [8]. In patients who are unlikely to ambulate TKA may decrease the possibility of knee flexion contracture after BKA and hip flexion contracture after AKA [9].

TKA with its end weight-bearing stump is more physiological than the transfemoral or transtibial levels and provides axial support in combination with circumferential tension and transverse musculoskeletal contouring. Its longer lever arm is important for better sitting balance and leverage, especially important for older and bilateral amputee patients [10].

Despite the advantages of TKA, surgeons often avoid TKA because of assumed wound healing complications and poor prosthetic fitting skills [11]. These arguments might be no longer relevant because surgical techniques and prosthesis technology have improved considerably [12].

Our objective is to evaluate the outcomes of TKA with posterior myocutaneous flap in patients with advanced peripheral arterial disease who are not candidates for BKA.

Patients and methods

This is a prospective interventional study. The study was approved by the Ethics Board of our hospital. The study included 24 patients with advanced peripheral arterial disease in need for major amputation and BKA is likely to fail. The indication for amputation was either CLI (Rutherford categories IV–VI) owing to extensive foot gangrene on presentation with unreconstructable peripheral arterial disease because revascularization options are unavailable or exhausted and irreversible (category III) acute lower limb ischemia [13]. The study was conducted between January 2016 and July 2019, with a mean follow-up period of 11.7±9.2 months.

Preoperative evaluation

The first step in preoperative preparation of the patient is acceptance of the procedure, which frequently takes days to weeks, and the second step is appropriate amputation level selection that must be the most distal level that can heal uncompromised to prevent reamputations with increased morbidity and mortality. The clinical judgment (the level of the most distal palpable pulse, skin temperature at the level of proposed amputation) is the best predictor for a maximal viable stump length, but additional information is required to assess the healing potential at the selected level and other proceedings for better patient preparation:

(1) Arterial duplex examination and multidetector row computed tomography angiography.
(2) Informed consent for the procedure and the study and good psychological support.
(3) Standard evaluation with a thorough history and careful physical examination.
(4) Routine preoperative laboratory tests and radiological studies.
(5) Congestive heart failure, unstable angina, or recent myocardial infarction was addressed.
(6) Management of associated hypertension, diabetes, or renal failure when present was optimized.
(7) Routine deep venous thrombosis prophylaxis with careful perioperative deep venous thrombosis screening with duplex ultrasound.

Surgical technique

The patient is placed supine with the lower limb prepared and draped to the groin. The technique takes advantage of the well-vascularized posterior myocutaneous flap as consisting of the gastrocnemius muscle and posterior skin. Marking of skin incisions is shown in Fig. 1.

After incising the skin anteriorly and with two midlateral incisions, incisions are joined posteriorly. The posterior myocutaneous flap is prepared by incising the deep fascia and entering the plane between the gastrocnemius and soleus muscles to separate them (Fig. 2).

The knee joint is opened from the posterior approach. The incision is then extended through the collateral, medial, lateral, and cruciate ligaments, and the hamstring tendons are transected. The tibial nerve, the peroneal nerve, and the popliteal artery and vein should then be identified. The nerves should be transected proximally under tension to avoid neuroma formation, and the vessels should be ligated. The patellar tendon can then be separated from the tibia and sutured to the cruciate ligaments. After insertion of a 18-Fr suction drain between the condyles, the fascia of the muscle flap is sutured to the ventral knee joint capsule using absorbable sutures and then the wound is closed with interrupted prolene sutures or staples (Fig. 3).

Statistical analysis

IBM SPSS 20.0 Statistics for Windows was used for the analysis (IBM Corp., Armonk, New York, USA). Number, percentage, mean, and SD were used as descriptive statistical methods for the evaluation of the data.

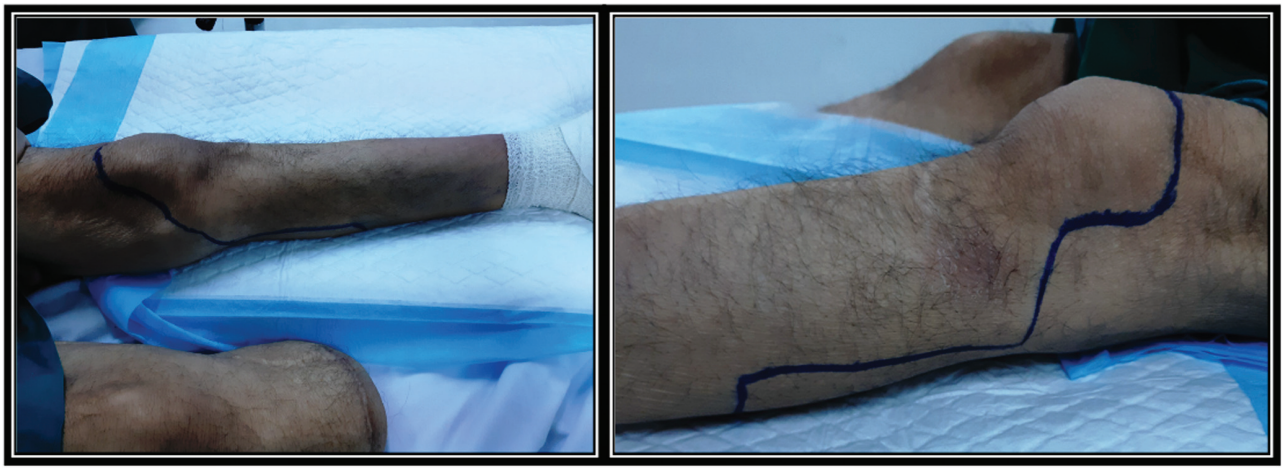
Results

The study was conducted on 24 patients, comprising 15 (62.5%) males and nine (37.5%) females. The mean age of patients was 65.8±10.5 years. Overall, four (16.6%) patients had previous contralateral AKA. The baseline characteristics of the study patients are shown in Table 1.

Figure 2

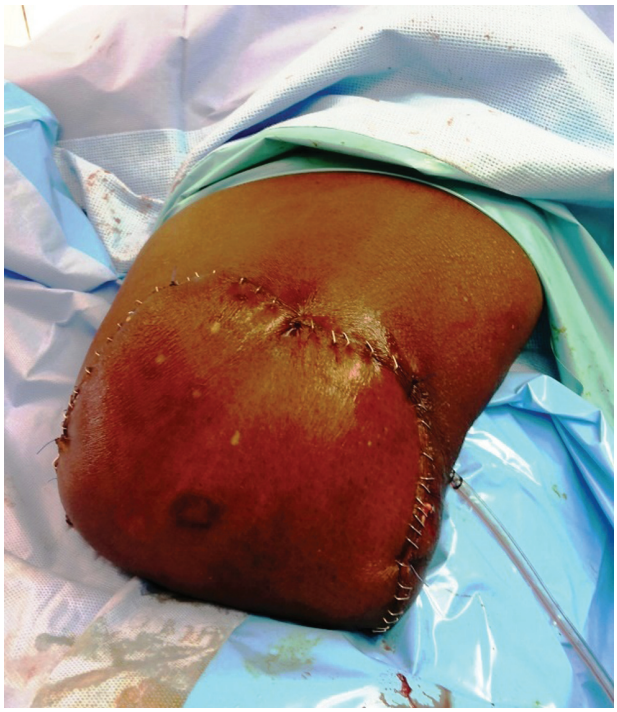
The completed posterior myocutaneous flap consisting of gastrocnemius muscle and posterior skin.

Figure 1



Skin incisions for trans-knee amputation with posterior myocutaneous flap.

Figure 3



The completed trans-knee amputation with posterior myocutaneous flap.

Table 1 The characteristics of the study patients

Items	*n* (%)
Number of patients	24
Number of procedures	24
Left-side amputation	14 (58.3)
Right-side amputation	10 (41.7)
Age (years) (mean±SD)	65.8±10.5
Male sex	15 (62.5)
Female sex	9 (37.5)
Previous minor foot amputation	8 (33.3)
Previous contralateral AKA	4 (16.6)
Hypertension	20 (83.3)
Diabetes mellitus	22 (91.6)
Chronic kidney disease	7 (29)
Hemodialysis patients	4 (16.6)
Smoking	21 (87.5)
Ischemic heart disease	16 (66.6)
Congestive heart failure	5 (20.8)
Previous stroke	5 (20.8)
Bedridden patients	6 (25)

AKA, above-knee amputation.

All patients underwent TKA with posterior myocutaneous flap including gastrocnemius muscle. The indication for amputation was CLI owing to unreconstructable peripheral arterial disease in 21 (87.5%) patients in whom revascularization options are unavailable or exhausted and irreversible (category III) acute thrombotic lower limb ischemia in three (12.5%) patients. Three (12.5%) patients died:

Table 2 Summary of the results and outcomes of the study

Items	*N/n* (%)
Patients with critical limb ischemia	21/24 (87.5)
Patients with irreversible acute limb ischemia	3/24 (12.5)
Mortality	3 /24 (12.5)
Healing by primary intention	15/21 (71.4)
Healing by delayed primary intention	1/21 (4.8)
Healing by secondary intention	2/21 (9.6)
Conversion to above-knee amputation	3/21 (14.2)
Ability to walk with a prosthesis	10/21 (47.6)
Follow-up period (months) (mean±SD)	11.7±9.2

two patients died in the early 3 postoperative days owing to myocardial infarction and one patient died in the same hospital admission after 35 days from pneumonia and sepsis.

From the remaining 21 patients, healing by primary intention was achieved in 15 (71.4%) patients, by delayed primary intention (tertiary intention) in one (4.8%) patient, and by secondary intention in two (9.6%) patients. Major wound dehiscence occurred in three (14.2%) patients requiring AKA. The patients were followed-up after the procedure, with a mean follow-up of 11.7± 9.2 months. The results and outcomes of the study are summarized in Table 2.

Discussion

When major lower limb amputation is indicated, the lowest level of amputation that will heal is the ideal level for limb amputation. Whenever possible, TKA is preferred over AKA, and the only contraindication to TKA is the possibility of a successful BKA, so should be considered before AKA [14]. Although AKA has the advantage of a high incidence of wound healing, it usually eliminates any hope of maintaining ambulatory and independent living status in the elderly patient with peripheral arterial disease [11]. In contrast to AKA, TKA offers several advantages. Surgically, TKA is simple, quick to perform, and less traumatic because no bone has to be transected. Clinically, the most important advantages of a TKA are less energy consumption during walking and the potential for direct load transfer to the residual limb compared with AKA, so superior rehabilitation of patients with peripheral arterial disease who undergo TKA compared with AKA [15].

In an effort to minimize the disadvantages of TKA, several modifications with a variety of surgical flap designs have been devised. Instead of a long anterior flap used previously, sagittal flaps have been promoted [16]. The long posterior myocutaneous flap which gives adequate blood supply for healing was introduced in 1985 [7], and when combined with

modern polycentric prosthetic joints, TKA can offer improved walking stability in this geriatric population, enabling the performance of daily activities and thereby independence and a better quality of life [17].

Klaes and Eigler [7] who used the posterior myofasciocutaneous flap in TKA for ischemic limbs for the first time reported healing by primary intention in 15 (79%) of 19 patients. The same rate of healing by primary intention was reported by Heinz [18] in 32 patients of 41 (78%) patients. Another study by Kock *et al.* [19] reported 70% primary healing, 9% secondary healing, and ~20% had a conversion to AKA. Our results in terms of primary and secondary healing are comparable to the previously mentioned studies. In the current study, the percent of conversion to AKA is 14.2%, which is less than that reported by Kock *et al.* [19] but more than that reported by Bowker *et al.* [20]; they reported revision to AKA in seven (9%)stumps.Regarding the ambulation rate after TKA using the posterior myocutaneous flap, the prosthetic ambulation rate in a retrospective study [12] was 75%. This rate is better than the rate in the current study, which was 47.6%. This percentage is near to that reported by Kock *et al.* [19], as they reported that 29 (54%) of 54 patients were able to walk with a prosthesis. Our prosthetic ambulation rate is better than the rate reported by Bowker *et al.* [20], which was 31%. A very important factor in postamputation walking is that patients who were able to walk before amputation were able to continue walking by prosthesis after amputation.

Owing to the functional advantages of TKA over AKA and the very acceptable wound healing rate achieved with the long posterior myocutaneous flap, we hope that TKA should be considered before AKA when it is not possible to perform BKA.

Conclusion

TKA with posterior myocutaneous flap is a safe operative method of amputation in patients with advanced peripheral arterial disease with good healing rates and acceptable functional outcomes. If it is not possible to perform BKA, TKA should be considered before AKA.

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Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Tunis SR, Bass EB, Steinberg EP. The use of angioplasty, bypass surgery, and amputation in the management of peripheral vascular disease. N Engl J Med 1991; 325:556–562.

2 Norgren L, HiaV WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG. Intersociety consensus for the management of peripheral arterial disease (TASC II). J Vasc Surg 2007; 45(Suppl S):S5–S67.

3 Acar RD, Sahin M, Kirma C. One of the most urgent vascular circumstances: acute limb ischemia. SAGE Open Med 2014; 1.

4 Behr J, Friedly J, Molton I, Morgenroth D, Jensen MP, Smith DG. Pain and pain-related interference in adults with lower-limb amputation: comparison of knee-disarticulation, transtibial, and transfemoral surgical sites. J Rehabil Res Dev 2009; 46:963–972.

5 Pinzur MS. Knee disarticulation: surgical management. In: Smith DG, Michael JW, Bowker JH, editors. Atlas of amputations and limb deficiencies surgical, prosthetic and rehabilitation principles. 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2004. 517–523.

6 Burgess EM. The below-knee amputation. Bull Prosthet Res 1968; 10:19–25.

7 Klaes W, Eigler FW. A new technique for trans-knee amputation. Chirurg 1985; 56:735–740.

8 Kock H-J., Friederichs J, Ouchmaev A, Hillmeier J, Von Gumppenberg S. Long-term results of through-knee amputation with dorsal musculocutaneous flap in patients with end-stage arterial occlusive disease. World J Surg 2004; 28:801–806.

9 Baumgartner RF. Knee disarticulation versus above-knee amputation. Prosthet Orthot Int 1979; 3:15–19.

10 Pinzur M. Knee disarticulation/surgical procedures. In: Bowker J, Michael J, editors. Atlas of limb prosthetics. 2nd ed. St. Louis: Mosby Year Book 1992. 479–486

11 Morse BC, Cull DL, Kalbaugh C, Cass AL, Taylor SM. Through knee amputation in patients with peripheral arterial disease: a review of 50 cases. J Vasc Surg 2008; 48:638–643.

12 Murakami T, Murray K. Outcomes of knee disarticulation and the influence of surgical techniques in dysvascular patients: a systematic review. Prosthet Orthot Int 2016; 40:423–435.

13 Rutherford RB, Baker JD, Ernst C, Johnston K, Porter J, Ahn S, Jones D. Recommended standards for reports dealing with lower extremity ischemia: revised version. J Vasc Surg 1997; 26:517–538.

14 Batch JW, Spittler AW, McFaddin JG. Advantages of the knee disarticulation over amputations through the thigh. J Bone J Surg 1954; 36-A:921–930.

15 Cull DL, Taylor SM, Hamontree SE, Langan EM, Snyder BA, Sullivan TM, *et al.* A reappraisal of a modified through-knee amputation in patients with peripheral vascular disease. Am J Surg 2001; 182:44–48.

16 Smith CG, Michael JW, Bowker JH. Atlas of amputations and limb deficiencies: surgical, prosthetic and rehabilitation principles. 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2004.

17 Fortington LV, Rommers GM, Geertzen JH, Postema K, Dijkstra PU. Mobility in elderly people with a lower limb amputation: a systematic review. J Am Med Dir Assoc 2012; 13:319–325.

18 Heinz J. Trans-knee amputation with myocutaneous flap based on gastrocnemius muscle in peripheral arterial occlusive disease. Zentralbl Chir 1992; 117:167–170.

19 Kock HJ, Walz MK, Krause V, Klaes W, Eigler FW. Results of the trans-knee amputation with dorsal myocutaneous flap in patients with end-stage peripheral arterial disease. Chirurg 1994; 65:1028–1033.

20 Bowker JH, San Giovanni TP, Pinzur MS. North American experience with knee disarticulation with use of a posterior myofasciocutaneous flap. Healing rate and functional results in seventy-seven patients. J Bone Joint Surg 2000; 82-A:1571–1574.