

The role of the gastrocnemius muscle flap in the treatment of failed Total Knee Arthroplasty.

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ABSTRACT

Introduction: Total knee arthroplasty (TKA), although generally a safe operation, fails in a small number of patients with substantial morbidity. Muscle flaps and especially the medial gastrocnemius offer a viable treatment option for limb salvage. The surgical technique is described and the senior author's personal experience is reviewed.

Patients and methods: A retrospective study of patients treated with a medial gastrocnemius flap for failed TKA was conducted. Five patients were found, 4 female and one male. Mean age was 63.8 years (range, 38 – 85 years). Four patients were operated at the Middlesex and UCH Hospitals, London and one at Metropolitan General Hospital, Athens. All patients had a preexisting skin defect of the knee area with exposed tendon, bone and/or implant. The surgical technique used is briefly described. Postoperative antibiotics were administered to all patients for a minimum of 6 weeks.

Results: There were no flap or donor site complications. All flaps and skin grafts survived. One patient died at home five weeks postoperatively of unrelated causes. One patient presented with a wound breakdown three weeks after the flap operation. The defect was covered with a lateral tibial fasciocutaneous flap. The Oxford Knee Score improved in all patients.

Conclusion: The medial gastrocnemius muscle flap remains the first line of treatment of failed total knee arthroplasties. Early use of the flap is recommended in order to achieve the best possible outcome.

Key words: Total knee arthroplasty, infection, surgery, failure, muscle flaps, gastrocnemius muscle, reconstruction.

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Introduction

Total knee arthroplasty (TKA) provides excellent results for most patients with osteoarthritis. A number of complications, however, including infection, delayed wound healing, wound dehiscence, and skin necrosis pose substantial risk to patient morbidity (prosthetic infection, amputation etc.) and mortality. Soft tissue coverage by means of flap reconstruction is a viable treatment option which can save the limb and, occasionally, even the patient's life.

Various local (rotation) and distant (free) flaps have been utilized to cover wound defects of the knee and improve vascularization and antibiotic/nutrient delivery to the area: muscle flaps (medial gastrocnemius, lateral gastrocnemius, rectus abdominis, latissimus dorsi, gracilis), chimeric and fasciocutaneous flaps (random pattern, perforator). Size of the defect, donor site morbidity and condition of the patient are the main considerations dictating flap choice.

The gastrocnemius flap, basically the medial gastrocnemius, remains the commonest method of reconstruction for defects at or distal to the inferior pole of the patella (1-5). This axial pattern muscle flap is supplied by the medial sural artery and can be rotated to cover soft tissue defects of the anterior distal aspect of the knee (6, 7). It is a versatile flap due to its substantial size, mobility, ease of harvest, and minimal functional loss and donor site morbidity (1, 8). The flap ranges from 5 to 9 cm in width and from 13 to 20 cm in length (8). It improves the delivery of oxygen, systemic antibiotics, and immune modulators to an infected joint (1, 9).

Aim of this paper is to evaluate the personal experience and the results of the senior author (Ch. I). A small series of 5 patients operated on because of a preexisting knee defect after total knee arthroplasty (TKA) have been reviewed. The surgical technique is described, the advantages and disadvantages of the medial gastrocnemius muscle flap are discussed and a comparison with other reconstructive methods according to recent literature reviews is presented.

Patients and methods

A retrospective study of patients treated with a medial gastrocnemius flap after failed TKA was

conducted. The study group consisted of 5 patients, 4 female and one male. Mean age was 63.8 years (range, 38-85 years). The left knee was involved in 3 cases and the right in two (Table 1). Four patients were operated on at the Middlesex and UCL Hospitals, London and one at Metropolitan General Hospital, Athens (all five Ch. I). The indication for using a gastrocnemius flap in this setting was deficient soft tissue over the anterior knee (Fig. 1). All five patients had a preexisting skin defect with exposed (or ruptured) tendon, bone or implant (Fig. 2). The medial head of the gastrocnemius muscle was used in all five cases and the muscle flap was covered with a split thickness skin graft in four of them. Three patients met Musculoskeletal Infection Society criteria for periprosthetic joint infection (10), with the most common infecting organisms being Staphylococcus species. In one case, a concomitant pre-flap patellar tendon reconstruction was performed; a rectus femoris tendon turnover was utilized for this purpose.

Antibiotics were administered for a minimum of 6 weeks (two weeks i.v., then per os) to all patients. Postoperatively, all patients were assessed clinically at regular interval

Surgical technique

The patient is positioned supine and a thigh tourniquet is placed high on the ipsilateral thigh. After obtaining tissue cultures, debridement of osseous, soft tissue and retained implant surfaces as well as sinus tracts and devitalized tissue is carried out. Once the revision is completed, the residual soft tissue defect is assessed (Fig. 3). An incision is placed 2 to 3 cm posterior to the middle border of the tibia (Fig. 4A), from the distal end of the muscle belly to the level of the popliteal fossa. The skin bridge to the knee defect ought to be at least 7 cm wide in order to prevent skin necrosis. After skin incision, bilateral skin flaps are elevated (above the gastrocnemius fascia); the saphenous vein is preserved. The medial gastrocnemius muscle is exposed along its length, the fascia is opened and the avascular plane between gastrocnemius and underlying soleus muscle is developed (Fig. 4B). Care is taken to preserve the plantaris, which lies between these muscles. The median raphe is identified (between the two heads

| Patient | Age | Sex | Side | Comorbidities | Complications | SSG | Latest Outcome |
|---------|-----|-----|------|---------------|------------------------------------|-----|----------------------|
| M F | 38 | F | RI | RA | None | Yes | OK |
| C F | 49 | F | LE | None | None | Yes | OK |
| G L | 82 | M | LE | DM HTN | Dehiscence Second(Skin) Flap | Yes | OK |
| P N | 65 | F | RI | None | None | Yes | OK |
| B B | 85 | F | LE | HTN HF | None | No | Died 5 weeks postop. |

RA: Rheumatoid arthritis

DM: Diabetes mellitus

HTN: Hypertension

HF: Heart failure

SSG: Split thickness skin graft

in the proximal third of the leg), so is the sural nerve which traverses the midline between the two heads. The dissection of the muscle is completed and this is sharply detached from its distal attachment leaving approximately 1 cm of Achilles tendon attached to the flap (Fig. 5). The muscle is carefully elevated proximally, with care not to sever the sural nerve, up to the level of the popliteal fossa. The dominant blood supply of the medial gastrocnemius is the sural artery (branch of the popliteal artery) accompanied by one or two veins and a branch of the tibial nerve (Fig. 6). Proximal dissection to the level of the popliteal fossa crease will protect the more proximally located flap pedicle even without direct visualization. After elevating the flap, this is rotated and transposed (under the skin tunnel) over the defect on the anterior part of the knee (Fig. 7). The flap should cover the defect without tension. It is secured with peripheral sutures (within the remaining cuff of aponeurosis and peripheral fascia) so as to minimize strangulation of the muscle and its blood supply (Fig. 10A). The donor site is closed in

layers over a vacuum drain. The remaining parts of the recipient site (skin) are closed without tension. The extent of feasible closure should have been estimated prior to inseting the flap so that appropriate flap positioning is achieved. Where the skin cannot be approximated, the skin flaps should be sutured directly to the underlying muscle flap. A split thickness skin (SSG) graft is harvested from the ipsilateral thigh (Fig. 8), meshed (or not), placed and secured on top of the flap (Fig. 9). The wound is dressed with a non-adhesive dressing (paraffin gauze, Jelonet R, Smith & Nephew, Watford, England), sterile swabs, natural fiber padding (Velband®, Essity, Hull, England) and an elastic bandage. The skin graft donor site is covered with an adhesive dressing (Tegaderm® Film, 3M, Saint Paul, Minnesota, USA or Opsite® transparent adhesive wound dressing, Smith & Nephew, Kingston upon Hull, UK), sterile swabs and a compressive elastic bandage.

Results

There were no flap or donor site complications.



Fig.1. The soft tissues over the anterior knee after TKA are deficient.



Fig.2. Skin defect with exposed tendon.



Fig.3. Exposed knee prosthesis and soft tissue defect after completion of TKA revision.

All flaps and skin grafts survived (flap success rate 100%). One patient (BB) died at home of heart failure five weeks postoperatively. She had been discharged from hospital six days after flap cover of the exposed left knee prosthesis, which had resulted after a fall and subsequent scar breakdown and knee infection. Because of her medical history and in order to shorten anesthesia time, no skin graft was used. One month postoperatively, healthy granulation tissue had covered the muscle and there were clear signs of epithelialization (Fig. 10). The other four patients survived and were fit at last follow-up (median 12 months, range 1 to 30 months) (Fig. 11). There was one postoperative complication (operation success rate 80%). The male patient (GL) presented with a wound dehiscence three weeks after gastrocnemius transfer. Cover of the small defect was achieved with a lateral tibial fasciocutaneous

flap (Fig. 12). The Oxford Knee Score improved in all four patients.

Discussion

Total knee arthroplasty (TKA) is a common and safe orthopedic procedure worldwide; complications, however, can be devastating. Soft tissue compromise or periprosthetic joint infection may cause failure of prosthesis, requiring knee fusion or amputation (2). Fortunately, the incidence of failure of TKA has been reported low. In a review of 20,184 TKAs, merely 58 patients required flap reconstruction (4). Other authors have reported that the rate of infection or wound healing complications in patients who have undergone TKA ranges from 0.33% to 10.5% (11, 12).

Muscle flaps represent a valid treatment option in cases of failure; they cover the wound defect, improve vascularization and antibiotic/nutrient delivery to the knee area. Muscle provides a well-vascularized and substantial tissue mass for elimination of dead space. Muscular flaps have been shown to be advantageous compared to fasciocutaneous flaps when covering chronically infected wounds due to increased collagen deposition and greater inhibition of bacterial growth (8). Several local and free flaps have been utilized; the gastrocnemius muscular flap, however, is the most widely used method (1-5, 13, 14) of reconstruction for knee defects due to its reliability and ease of harvest (8). The medial head of the gastrocnemius is supplied by the medial sural artery and can be rotated to cover soft tissue defects of the medial, anterior and upper knee. Its



Fig.4. A. The skin incision has been drawn 2-3cm posterior to the middle border of the tibia. B. Bilateral skin flaps have been elevated and the plane between gastrocnemius and soleus has been developed.



Fig.5. The gastrocnemius muscle has been detached from its distal attachment.

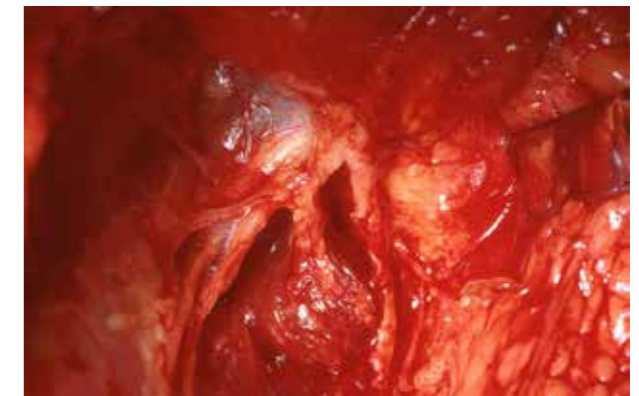


Fig.6. The dominant blood supply to the muscle is the sural artery.

width ranges from 5 to 9 cm and its length from 13 to 20 cm. Its calculated area in anatomical position was $32.5 \pm 8.55 \text{ cm}^2$ (range 22.3 to 47.5 cm^2) (7). It is commonly used for wounds between 3 and 7 cm in width and with surface areas between 33 and 49 cm^2 (7, 8). The flap can be easily rotated to cover medial and distal defects in the area of the tibial tubercle or patellar tendon (8). The arc of rotation can be further extended by 20% to 50% or 5 to 8 cm with dissection of the muscle of origin and the pes anserinus (7). Some authors have reported division or excision of the superficial and deep fascia in order to extend the width and length of the muscle or increase the chances of skin graft take (8). We do not support the notion that fascial excision facilitates the healing of the skin graft and consider it therefore

an unnecessary act. The skin graft is not indispensable, as it was shown in this study. Granulation of the fascia and reepithelialization will occur in 4 to 6 weeks (Fig.12), provided meticulous wound care is provided to the patient. The above may prove useful when one wishes to reduce operating time especially in compromised or overaged patients.

The lateral gastrocnemius muscle can also be used for cover of anterior as well as lateral knee defects. It is smaller (5 x 12 cm) and has a lesser arc of rotation (obstructed anterior rotation caused by the fibula) compared to the medial gastrocnemius. An additional difficulty is the eventual dissection and decompression of the common peroneal nerve. It is therefore less frequently used than the medial gastrocnemius. Occasionally, both heads can be used



Fig.7. The muscle flap has been rotated and transposed (under the skin tunnel) into the defect.



Fig.8. A split thickness skin flap is harvested from the ipsilateral thigh.



Fig.9. A.The muscle flap in situ.B. A skin graft has been placed and secured on top of the flap.



Fig.10. A. Fibrin covers the gastrocnemius flap 5 days postoperatively. B. Healthy granulation tissue has covered the muscle flap (no skin graft was used) and signs of epithelialization are evident.

for the reconstruction of large defects centered over the patella.

Medial gastrocnemius defect coverage may be performed at the time of TKA debridement with exchange of modular components, prosthetic explantation and antibiotic spacer placement, antibiotic spacer exchange, or second-stage prosthesis reimplantation (1). The decision regarding timing of the flap procedure is made on the basis of when the soft tissues are deemed insufficient and not on the basis or belief that placement at one stage or another is advantageous (1). Early cover of the defect has fewer complications and improves end results with respect to tissue loss from infection, healing time, and hospitalization and rehabilitation (15, 16).

Defects exceeding the size of the gastrocnemius muscle are a contraindication to its use. The tech-



Fig.11. A. gastrocnemius flap covered with meshed skin graft. B.The same patient depicted one year postoperatively.



Fig.12.A. Intraoperative aspect of patient GL immediately after extensive debridement second to an infected TKA; a gastrocnemius flap has been dissected in order to cover the defect. B.A lateral medially based tibial fasciocutaneous flap was used to cover a small gastrocnemius dehiscence. C. Close up view of the fasciocutaneous flap.



nique may also not be ideal in very thin patients who may have smaller gastrocnemius muscle bellies. In cases of a previous arterial bypass, an arteri-

ogram should be obtained to confirm the patency of the sural artery pedicle (17).

Reported success rates after use of a medial gas-

trocnemius flap vary widely (3). Despite adequate tissue coverage, several patients experience recurrent infection requiring additional surgical treatment. Persistent or recurrent infection rates have been reported in ca 50% of patients by various authors (1, 3, 14). Satisfactory results have been reported in 80 - 92% of patients (4, 13, 18, 19), which coincides with the findings of the present small case series. In a series from Johns Hopkins Medical Institutions, Baltimore (17), secondary plastic surgery procedures were necessary in 5/29 knees (17%), and secondary orthopedic procedures were necessary in 4/29 knees (14%). Cepas et al (4) observed superior functional knee joint salvage rates in the group of non- infected patients compared to the infected group (97.1% vs. 75.0%, $p=0.004$). The trans femoral amputation rate was nearly three-fold in the infected group (8.3% vs. 2.9%, $p=0.36$). Estimated 5-year survival with functional knee joint was higher in the non-infected group ($p=0.03$) (4). The amputation rate reported by Warren et al (3) was considerably higher (23.1%); the same authors reported a high rate of arthrodesis (19.2%). Kwiecien et al (20) retrospectively reviewed 73 patients with TKA. The first group (patients with preexisting defects requiring reactive flap reconstruction) had a higher rate of implant reinfection compared to the second group (patients with no preexisting soft tissue defects but with extensive debridement during revision TKA requiring immediate flap coverage) (58% vs. 27%, $p<0.05$). The first group had a higher rate of amputations (25% vs. 0%, $p<0.05$) and subsequent prosthesis revisions (2.2 vs. 0.9, $p<0.05$). Functional joint was preserved in 54% and 80% of cases, respectively. Mean gain in range of motion and quality of life were significantly better in the second group (20).

Colen et al (2) commented that patients referred to their institution with complicated periprosthetic wounds were significantly more likely to lose their knee than patients treated only within their system. Patients with multiple prior knee operations before definitive soft tissue reconstruction had significantly decreased rates of prosthesis salvage and an increased risk of amputation. Knee salvage significantly decreased with positive joint cultures and particularly at the time of definitive reconstruc-

tion, which also trended toward an increased risk of amputation (2). Tetreault et al (14) investigated a number of risk factors to which failure could possibly be attributed, with failure defined as recurrent or new periprosthetic joint infection or inability to reimplant TKA prosthesis. With the patients available ($n= 27$), treatment failure was not associated with age, sex, BMI, Charlson comorbidity index, diabetes mellitus, smoking status, coronary artery disease, number of knee arthrotomies before flap coverage, extensor mechanism rupture, prior completed two-stage revision, area of skin defect, surgical service that performed the flap, knee procedure being performed at the time of the flap, spacer type or growth of staphylococcus aureus, Gram-negative rods or antibiotic-resistant bacteria ($p>0.004$ for each) (14). There was a trend toward failure when flap coverage was performed at the same time as antibiotic spacer placement or exchange compared with at the time of irrigation and debridement or replantation of prosthesis, but this did not reach statistical significance (14). Other authors, based on small(er) patient series identified the growth of multiple organisms, a history of smoking and the presence of methicillin-resistant staphylococcus aureus on wound cultures as factors predicting a poor outcome, whereas age <30 , the absence of comorbid conditions and a favorable microbiological profile predicted success (21). Colen et al supported the notion that in revision TKA, prompt soft tissue reconstruction improves the likelihood of success, and protracted surgical courses and contamination increase failure and amputation. The same authors showed a benefit when plastic surgeons were early involved in the course of TKA complications (2).

The functional loss and comorbidity associated with the medial gastrocnemius flap is generally minimal for non- high level sports people because of compensation provided by the remaining hemi gastrocnemius (muscle) and the soleus muscle (7, 14). The aesthetic after effects are very acceptable. If there are concerns regarding the aesthetic appearance of the calf, an autologous fat transfer can be further associated with the procedure in order to minimize the cosmetic impact at the donor site (7).

In cases of larger or more proximal skin defects


with deficiency of the anterior capsule and quadriceps tendon, a gastrocnemius flap alone may be of insufficient size. These composite defects affecting the extensor mechanism can be managed with transfer of the vastus lateralis, in conjunction with the gastrocnemius, if necessary (8). Another locoregional muscle option for coverage of knee defects is the distally based pedicled gracilis muscle flap, which is based on minor pedicles from the superficial femoral or popliteal artery (8, 22). It carries a high risk of partial flap loss and is reserved for use when a pedicled gastrocnemius flap seems inadequate and when the patient is not a suitable candidate for a free flap (8). The complication rate after use of a gracilis muscle flap has been reported 55.6% (20).

Fasciocutaneous flaps (pedicled or perforator) are occasionally utilized for cover of, especially, small defects around the knee. They are thin, pliable and easy to contour, however they provide merely cover and lack the necessary bulk and rich vascular supply offered by muscle flaps. Patient 3 of the current series is illustrative of our viewpoint regarding indications for these flaps. Proximally based fasciocutaneous flaps preserve cutaneous innervation and have been advocated for coverage of areas of skin necrosis (23). Healing rate and com-

plication rate after use of fasciocutaneous flaps has been reported 70% to 90% and 19.2%, respectively (22, 24).

Free tissue transfer is occasionally indicated. The most common muscular flaps are the latissimus dorsi and the rectus abdominis flaps (25). The commonest fasciocutaneous free flap is the anterolateral thigh flap (ALT). Free flaps require microvascular expertise; furthermore the duration of the operation, the longer recovery and the higher donor site morbidity (e. g. rectus abdominis) render free tissue transfer a second - line treatment option. It is for the above reasons that free flaps constitute less than 10% of all flaps used in cases of failure of a TKA (22).

Conclusion

The results of this retrospective study support the notion expressed in the literature that the medial gastrocnemius muscle flap remains the first- line treatment of failed total knee arthroplasties (TKAs). Early use of the muscle flap is recommended in order to achieve the best possible outcome. Timely involvement of plastic surgeons seems to be beneficial. 

Conflict of interests

No conflict of interests to declare.

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