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Review Article

Medial and extended medial gastrocnemius muscle flap: a literature review and technical approach

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ABSTRACT

Knee arthroplasty is a worldwide procedure to treat gonarthrosis, it is one of the most performed surgeries by the traumatology and orthopedics service and despite improvements in prosthetic material and refinements in surgical techniques, knee replacement complications can be devastating and can even lead to the loss of the limb. Some of these complications are mediated by factors such as diabetes mellitus, obesity, malnutrition, advanced age and smoking. Tissue loss is frequently secondary to infection or seroma and can affect 1 to 15%. If not treated promptly, the most serious complications occur. Treatment of tissue loss with muscle flaps is the most accepted therapeutic option. The objective of this article is to describe these effective techniques for the treatment of peripatellar defects secondary to complicated arthroplasties and our approach.

Keywords: Gastrocnemius, Flap, Knee, Arthroplasty

INTRODUCTION

Knee replacement is used for the treatment of severe arthritis as an alternative to arthrodesis and for disabling cases and functional limitations. The procedure is best for young, weight-conscious patients who may have limited activity levels, bone reserve, and a life expectancy of more than 10 years. Its main contraindication is an active infection, deficiency of the extensor mechanism, severe neuropathic arthropathy, osteomyelitis or muscular insufficiency or excessive occupational demand in advanced age. The gastrocnemius flap was described in the 1970s by Craw et al and has recently been reused due to new knowledge regarding harvest possibilities.

Tissue loss is frequently secondary to infection or seroma and can affect 1 to 15%. If not treated promptly, the most serious complications occur. Treatment of tissue loss with muscle flaps is the most accepted therapeutic option. The objective of this article is to describe these effective techniques for the treatment of peripatellar defects secondary to complicated arthroplasties and our approach.[1]

ANATOMICAL BASES

The description of a distally based flap of the medial head of the gastrocnemius, vascularized thru a distal pedicle given by the posterior tibial artery. Studies have shown that this flap and the distal pedicle although several techniques have been used to cover tissue loss of the lower third of the thigh using medial gastrocnemius.

The medial and lateral head of gastrocnemius muscle are in the superficial posterior compartment of the leg; its origin is from the medial and lateral condyles of the femur respectively. Both muscles join the distal soleus tendon to give rise to the Achilles tendon, which inserts into the posterior region of the calcaneus. Medial gastrocnemius usually is longer than the lateral head.[2] The medial portion of the gastrocnemius extends up to 5 cm above the medial malleolus and lateral portion extends 10 cm above the

distal level of lateral malleolus. Two heads can be seen in the proximal portion of the leg, in addition the medial sural cutaneous nerve arises from the popliteal fossa in the center of the two heads, which serves as an anatomical reference to identify the midline. The deep portion is more difficult to identify since it is covered by fascia.[3]

Each head is supplied by independent branch of the popliteal artery. The artery in its distal portion has a variable caliber and it is not always possible to mobilize the flap. The gastrocnemius flap is classified as type 1 in Mathes and Nahal. The medial and lateral sural arteries arise from the popliteal artery around the knee joint and supply the gastrocnemius muscle heads respectively, sometimes it comes along with a with an accessory artery. These arteries are 2-3 mm in diameter. Enter the muscle on its deep surface along with a larger vein that is 3-5 mm. There are also small perforating arteries joining both heads where they are in contact with both heads and some entering in the medial head through its medial border coming from Soleus muscle.[4]

This unique vascular supply from the median sural artery allows the gastrocnemius muscle to be completely separated from its distal portion and rotated over the proximal portion of the vascular pedicle to be positioned at the site of the defects.

INDICATIONS AND PITFALLS

Coverage of the patellar region represents a challenge for the plastic surgeon.

Reconstruction must preserve joint function and mobility while preventing dehiscence. The gastrocnemius muscle flap is considered the workhorse for soft tissue reconstruction in the patellar area, effectively providing coverage in both post-traumatic and prosthetic situations.[5]

The gastrocnemius flap is especially useful in covering soft tissue defects in the patellar region that cannot be closed primarily or with skin grafts since a broader coverage by prosthesis is required. Chronic disruption of extensor mechanisms with and without prosthesis. Exposure of infected knee prosthesis. Exposure of bone, cartilage, or joint capsule that cannot be covered with a local flap and recreate a functional knee extension mechanism for the knee.[6]

Contraindications include patient´s bad general conditions, an infected and purulent wound, as well as poor general condition of the patient with malnutrition or uncontrolled metabolic diseases. An individualized contraindication is the need to cover a wound more than 15 cm away from the joint.

SURGICAL TECHNIQUE

As already mentioned, the gastrocnemius flap can be used in peripatellar lesions that require soft tissue coverage. If the lesion has an infectious component, DAIR therapy should be started. The DAIR (Debridement, antibiotics, irrigation and implant retention) can be used for up to 6 weeks to prepare the wound bed.

This includes removal of skin margins, synovectomy, and implant removal (cyanoacrylate or polythene insertion) (Figure 1). Antibiotics directed by cultures and the infectious disease service, as well as prosthetic material loaded with antibiotics and antimicrobial dressings to improve the wound environment until quality cultures are negative. Delayed reimplantation and flap coverage in one surgical time.[7]

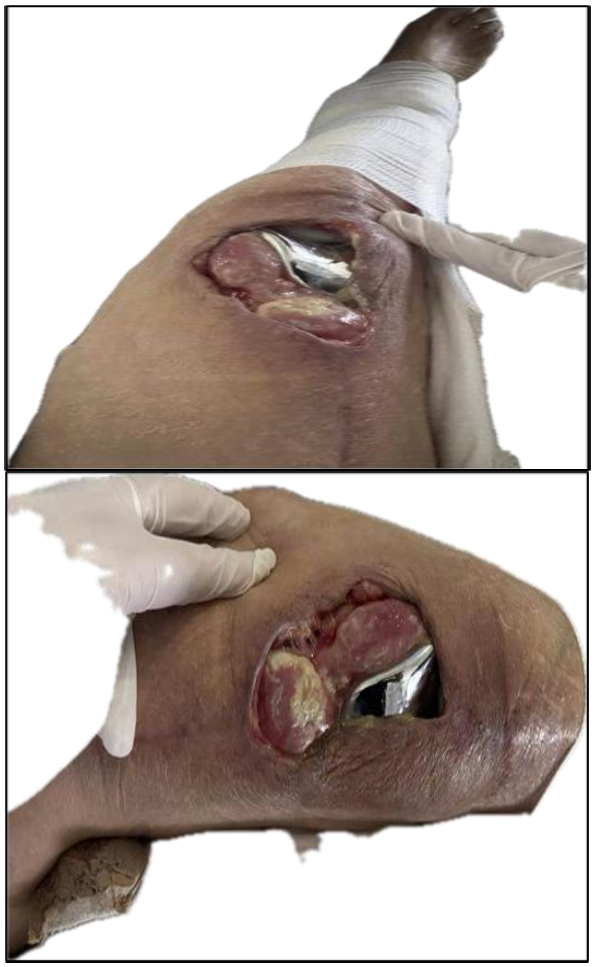

Figure 1: Knee replacement with infection and soft tissue lost exposing knee implant.

When harvesting a medial gastrocnemius flap the patient is placed in a supine or lateral position with the injured limb upwards. A vertical medial, midline posterior incision, or lateral external. This incision is recommended to be made up to 10 cm above the ankle (Figure 2).[8] The fascia of the superficial posterior compartment is dissected along its entire length (Figure 3). The gastrocnemius muscle is then separated from the soleus and released from superficial to deep (Figure 4). At this point, blunt dissection with hemostasis verification is recommended. A large retractor is needed to retract the posterior tissues.[9]

Figure 2: Pre-incision marking.

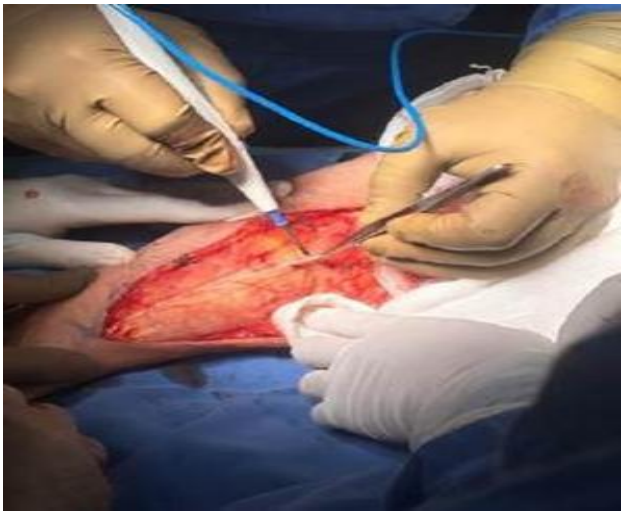

Figure 3: Dissection of the superficial posterior compartment fascia.

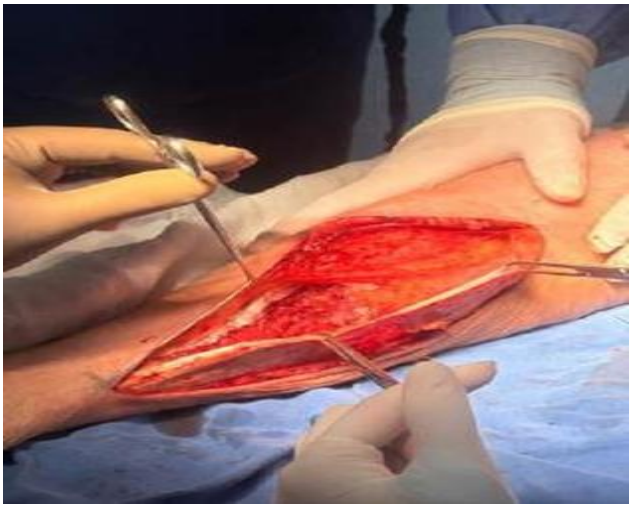

Figure 4 Gastrocnemius muscle separated from soleus.

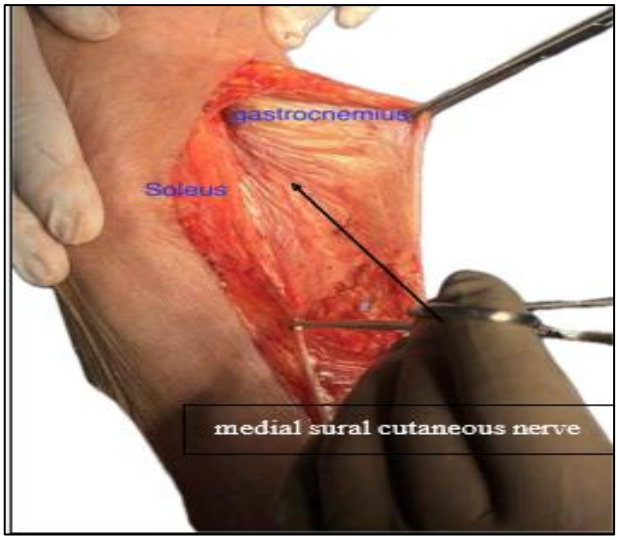

Figure 5: Relationships of medial sural cutaneous nerve.

The two heads of the gastrocnemius muscle are identified proximally, considering anatomical relationships such as the medial sural cutaneous nerve emerging from between these two structures (Figure 5). During dissection, caution must be exercised to avoid injury to the artery and vein. Distally, the fascia of both gastrocnemius muscles joins together, which can make dissection difficult in this plane. A careful inspection of the raphe helps distinguish both fibers, which run in different directions.

The raphe is released longitudinally with electrocautery, starting proximally at the muscle belly and proceeding to its distal insertion (Figure 6). The flap is then separated distally from the soleus fascia (Figure 7). A hemisection of the Achilles tendon can be performed to include it in the flap to bring more tissue to the reconstruction. The dissection can be extended proximally along the muscle's belly to its origins on the femoral condyles, increasing its rotation and adding up to 5 cm to its total length. In this plane, excessive tension should be avoided to avoid damaging the neurovascular bundle. Primary closure is performed at the donor site (Figure 8).

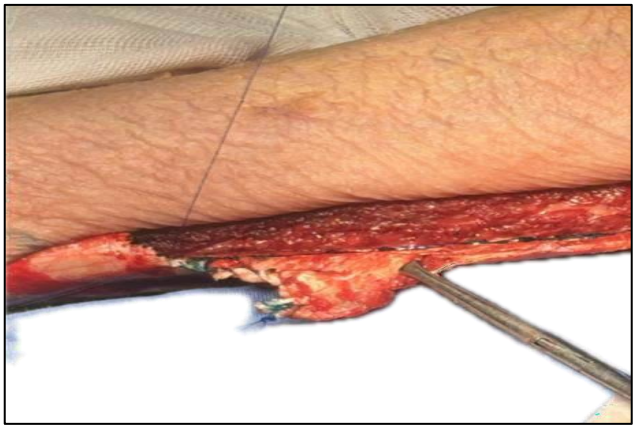

Figure 6: Raphe released longitudinally.

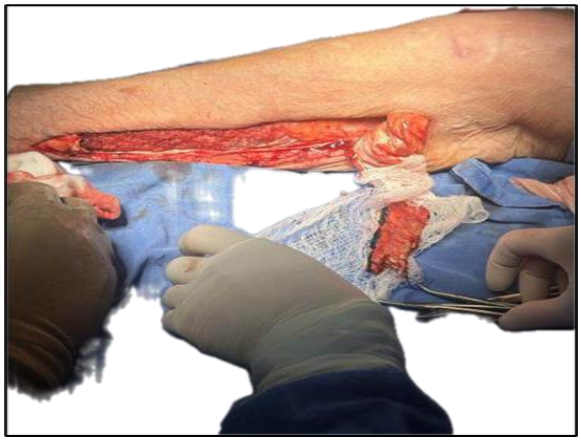

Figure 7: Flap separated from soleus fascia.

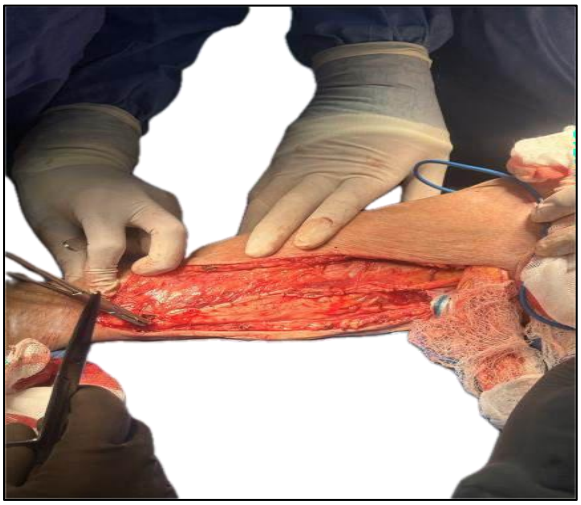

Figure 8: Primary closure at donor site.

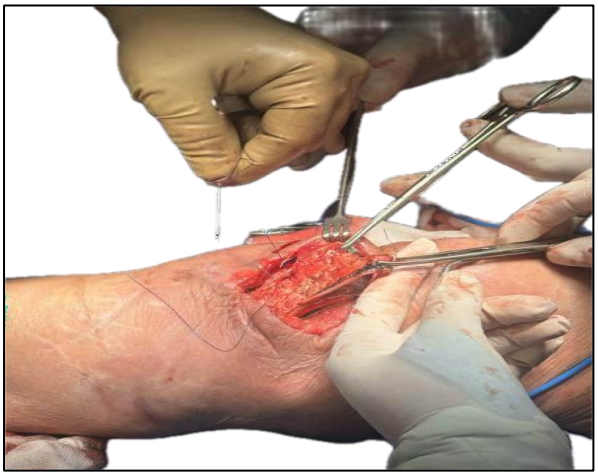

Figure 9: NPD colocation and injury faced and fixed on all its edges.

Finally, primary closure of the medial wound is performed, preferably with absorbable monofilament material in layers and placing a negative pressure drainage (NPD) (Figure 9 and 10). Once the flap has been rotated to the injury site, the injury is faced, and the flap is fixed on all its edges. At this point, it is advisable to place another NPD if the surgeon considers it necessary.

POSTOPERATIVE CARE

Postoperative care may vary depending on the initial indication for the flap. If a skin graft was harvested, an advanced dressing or negative pressure device may be used for wound closure. After 7 days, the dressing or negative pressure device is removed for skin graft review.

Immobilization of the limb is recommended for up to 2 weeks to minimize stress on the flap, especially if a skin graft was placed. After complete wound healing, physical therapy is implemented to promote range of motion and progressive weight bearing.

If the flap has been performed accompanied by reconstruction of the extensor mechanism, it is recommended to immobilize the limb for up to 8 weeks to allow consolidation of the flap and graft before starting rehabilitation therapy.

Figure 10: Complete wound healing after 2 weeks.

DISCUSSION

Reconstructive protocols for both orthopedic and oncological processes in the proximal tibial and

peripatellar region are complicated and require a well-planned approach with pre-surgical preparation using the DAIR system and the control and reduction of comorbidities.

The reliability and usefulness of the gastrocnemius flap classify it as the workhorse for closing these wounds, with some side effects such as a 7.3% decrease in walking speed. During uphill walking, patients had a shorter stride to reduce the demand on the posterior calf muscles.[11] These morbidities, from this team's perspective, are only significant in high-performance athletes, who can even recover full function with adequate physical therapy and training. In other patient groups, these changes are minimal and can be reduced with physical therapy. Infections associated with implants and prostheses represent a real limb threatening complication and represents a challenge to achieve adequate soft tissue coverage, Wound debridement and irrigation has been referred to as one of the pillars in the management of soft tissue defects.[12] Vascularized soft tissue also impacts in order to reduce the rates of infection vascularized soft tissue around the implants critically impacts on the reconstruction as they provide blood flow to the area, allowing delivering systemic antimicrobial agents, immune cells, and antibodies.[13] Saaiq and Zimri reported that along with irrigation and debridement, they also utilized vacuum-assisted closure in wounds that were contaminated prior to proceeding with surgical management.[14]

Hohmann et al determined that most patients undergoing post-traumatic knee reconstruction with the gastrocnemius flap were successfully able to ambulate after the procedure resulting in better recovery and restoration of lifestyle.[15]

CONCLUSION

Although the gastrocnemius flap is a workhorse in the context of patellar region reconstruction, it is sometimes insufficient to reach superolateral and suprapatellar defects. Prosthesis survival is up to 59.6% with proper management using the DAIR protocol and with adequate post-surgical management. The factors primarily associated with flap failure and prosthetic loss are peripheral arterial disease, untreated infection, body mass index greater than 30, and malnutrition. In case of flap loss, subsequent management directly affects the patient's life, such as arthrodesis or above-knee amputation, so proper planning is of vital importance.

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