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Gastrocnemius Musculocutaneous Chimeric Flap- A Study On The Use Of Differential Movement Of Muscle And Skin

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ABSTRACT

Background: Gastrocnemius muscle flap is commonly used flap for reconstruction of defects around the knee. Defects bigger than the width of the flap would require a second flap or a free flap. We have tried to use the gastrocnemius musculocutaneous flap using differential movement of the muscle and skin to improve the area of the defect that can be covered.

Aim: To study the differential movements of skin and muscle of the gastrocnemius musculocutaneous flap.

Methodology: It was a retrospective case record analysis at a tertiary care hospital conducted between Jan 2016 to Dec 2019. We had 5 cases who underwent the gastrocnemius musculocutaneous flap with differential movement of the muscle and the skin. We used the skin which was laterally advanced, propelled at varying angles to cover the defect.

Results: We had 5 cases with the flap. All the flaps survived. We had propeller flaps in 4 cases and lateral advancement in 1 case. All our flaps survived.

Conclusion: Gastrocnemius Musculocutaneous flap can be better utilized with a chimeric principle and using the differential movement. This allows better movement and increases in surface area of the flap. The flap is easy to harvest, ability to cover large surface area, no dog ears as in Musculo-cutaneous flaps, movement of the fascio-cutaneous flap by advancement, or propel the flap if a single perforator can reliably support the vascularity.

Keywords: *Gastrocnemius Musculocutaneous flap, propeller flap, advancement flap*

1. INTRODUCTION

Defects around the knee are common with large number of two-wheeler related road traffic accidents (RTAs). The most commonly used flap to cover a defect around the knee is the gastrocnemius muscle flap. The medial belly of the muscle is larger and about 7cm wide, on being transposed to the knee or the upper leg, it can cover a defect with 7cm length defect. To improve the area that can be covered, the lateral belly of the muscle can be used. The gastrocnemius muscle can be used as a musculocutaneous flap, but conventional gastrocnemius musculocutaneous flap pose difficulty in movement at the base. The bulky base can be overcome by islanding the fascio-cutaneous part. The skin in case of the gastrocnemius are supplied by the perforators. Hence, we can base the cutaneous part solely on the perforators with minimum contact with between the muscle and the skin. By this modification, the mobility of the cutaneous part is increased. The gastrocnemius muscle flap is supplied by medial and the lateral sural vessels from the popliteal vessels. The skin overlying the muscle are supplied by the perforators from the muscle. The fascio-cutaneous part can be harvested up to 5cm from the medial malleolus and 7cm from the lateral malleolus when a gastrocnemius Musculo-cutaneous flap is harvested (1). Traditional teaching, support that the muscle and the skin needs to be in contact along the length, to preserve the vascularity. With the use of the medial sural artery flaps and the perforator flaps, flaps have been based on a perforator from the sural vessels. in one of the studies, during

the dissection of the medial sural artery flap, it has been found that a flap of 13x8 cm could be harvested based on a single perforator from the medial sural vessel.[2]. Anatomical studies on the sural vessels and perforators have demonstrated that there are two rows of perforators from the medial sural artery, and the number of perforators along the lateral row is more; bigger and constant than the medial row of perforators, While the perforators from lateral sural artery is not constant (3,4]. In the present study, we have used the gastrocnemius Musculo-cutaneous flap with minimal contact between the muscle and skin, and are presenting the findings of its use.

2. MATERIALS AND METHODS

It is a retrospective case record analysis of the patients who have undergone the pedicled chimeric Gastrocnemius fascio-cutaneous flap between Jan 2016 to Dec 2019. All the patients had given their informed consent. The study was performed as per the World Medical Association Declaration of Helsinki. The age, sex, defect size and site, flap size and number of perforators in the flap, flap success, complications, if any, were recorded. After debridement and wound optimization, the procedure was planned. Preoperative doppler was used to identify the perforators. A midline exploratory incision was used to elevate the fascio-cutaneous flap and identify the perforators and confirmed that it was a musculocutaneous perforator from the gastrocnemius. The muscle belly and the island of the fascio-cutaneous flap were elevated based on the sural vessels. The flap was transferred to the defect. The skin was transposed or advanced or propelled to cover as per the needs. The feasibility of the movement and adequacy of vascularity was confirmed by temporarily clamping the perforators. The muscle was used as a flap, as well as a carrier of the skin. The donor site was covered with skin graft. When a lateral belly gastrocnemius Musculo-cutaneous flap was harvested, care was taken not to injure the peroneal nerve.

3. CASE STUDY

Case 1

A 27 years female patient with road traffic accident, sustained injury around the knee and presented with non-healing ulcer of 4 weeks duration. She underwent debridement. The wound was 13 cm in length vertically and 6 cm horizontally. A medial belly gastrocnemius Musculo-cutaneous flap was raised and transposed to the defect. The flap had 2 perforators, the muscle belly was used to cover the leg, and the fascio-cutaneous flap was used to cover the knee. The fascio-cutaneous part was advanced laterally from the muscle to cover the defect. The donor site was skin grafted. Wound healed without any complications.

In case one, the length of the defect was more than the defect that could be covered by the muscle alone. By dissecting the muscle and basing only on the perforators, we could laterally advance the skin.

Case 2

A 35 years male patient who presented with road traffic accident. He had injury over the lower limb with bone exposed in the middle third of the leg and fracture over the lower third of the leg. The gastrocnemius muscle territory was out of the zone of injury. We raised a gastrocnemius fascio-cutaneous flap and the skin was propelled to the defect based on a single perforator. The wound healed well.

Case 3

A 30 years old male patient with RTA had a wound over the knee and the upper third of the leg with bone exposed. He underwent debridement and cover with a medial gastrocnemius fascio-cutaneous flap. We encountered 3 perforators from the muscle to the skin, after confirming the adequate vascularity, we divided the upper and the lower perforators and retained the middle perforator. The belly was used to cover the exposed fracture. The fascio-cutaneous flap was propelled 60 degrees, to cover the knee. The donor site was covered with skin graft. There was dehiscence of the lateral end of the flap for which we used the lateral belly of the gastrocnemius flap. Wound healed without any further problems.

Case 4

A 28 years old male patient with RTA and wound over the knee and upper tibia fracture. He had undergone plating for the fracture, but the overlying skin necrosed. He underwent debridement and plates were replaced by external fixators. We used a lateral belly gastrocnemius Musculo-cutaneous flap. The sural nerves and the peroneal nerves were preserved during dissection. A single perforator from the muscle to the skin, was preserved, the belly was used to cover the facture tibia and the cutaneous part was propelled 60 degrees and covered over the knee. Wound healed without complications.

Case 5

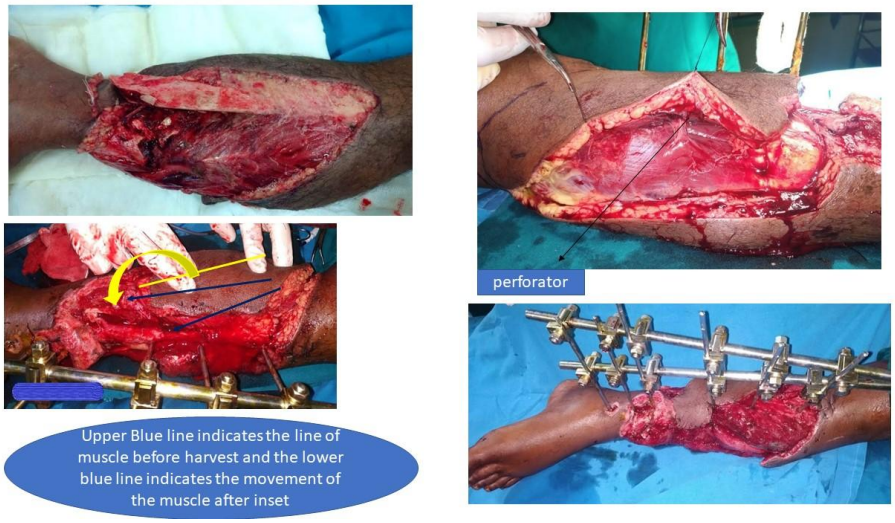
A 12 years old girl with osteosarcoma of the tibia, had undergone excision and bone graft. She presented with wound over the tibia and implant exposure after 3 months. She underwent debridement, the plates were retained and wound was covered with medial belly gastrocnemius Musculo-cutaneous flap. A single perforator going to the skin from the muscle was preserved. The muscle belly was used to cover the two thirds of the implants. The fascio-cutaneous flap was propelled 45 degrees to cover the knee and rest of the implant. Wound healed without any complications.

Table 1: Case description

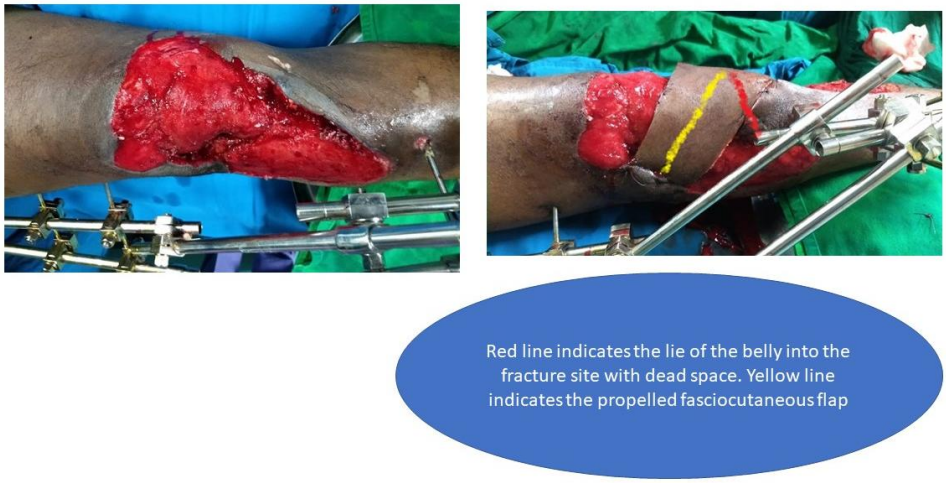
Slno.	Age/sex	Defect size	Flap size and belly	Movement of the flap	complications
1	27/f	13 cm vertically and 6 cm horizontally	19cm X 8cm Medial belly gastrocnemius Musculo-cutaneous flap	Belly transposed to shin and skin advanced laterally above to cover the knee	Nil
2	35/m	15 cm vertically and 7 cm horizontally	19 cm x8cm Medial belly gastrocnemius Musculo-cutaneous flap	Belly was transposed 30 degrees to the bone and the fascio-cutaneous flap was propelled 180 degrees to the defect.	nil
3	30/m	17cm vertically and 8 cm horizontally	20cm x 8 cm Medial belly of gastrocnemius Musculo-cutaneous flap	Belly was transposed to the exposed fracture and fascio-cutaneous was propelled 60 degrees to cover rest of the defect.	Wound gaping on the lateral side of the wound, lateral belly of gastrocnemius muscle used to cover the defect
4	28/m	12 cm vertically and 6 cm horizontally	16cm x 8cm lateral belly of gastrocnemius Musculo-cutaneous flap	Belly was transposed to the tibia, fascio-cutaneous propelled 60 degrees to cover the knee	Nil
5	12/f	13 cm vertically and 5cm horizontally	17cm x 6 cm medial belly of gastrocnemius musculocutaneous flap	Belly was transposed over the implant and fascio-cutaneous flap propelled 45 degrees to cover the knee	Nil

CASE 1

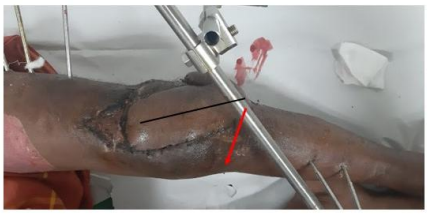
CASE 2



CASE 3



CASE 4



Black line indicates the facio-cutaneous flap transposed. The red line indicates the lie of the muscle over the fracture.

CASE 5

Red line indicates the lie of the muscle over the partially covering the implant. The black line indicates the fascio-cutaneous transposed to cover the knee and the implant

4. DISCUSSION

Small defect around the knee, gastrocnemius muscle flap is a good choice. The width of the gastrocnemius muscle is 7cm. when we use the flap for knee or the upper leg, the flap can cover a defect that is equal to its width. By placing the muscle obliquely and by scoring the muscle fascia, we can improve the area covered marginally. The lateral belly of the gastrocnemius can be used simultaneously to cover a bigger defect, but can decrease the power of the plantar flexion of the foot. The use of Musculo-cutaneous flap increases the reach of the flap, but the width would remain the same. The non-islanded musculocutaneous flap has a bulky base, which decrease the movement and aesthetically poor. The islanded flap could only improve the reach of the flap, but the surface area of the flap remains the same. Applying the chimeric principle on the gastrocnemius Musculo-cutaneous flap, we can improve the movement of the flap and as well as the surface area of the flap. The muscle belly can work as a flap, with good vascularity can provide cover to the fracture sites as well as infected wounds. The muscle also works as carrier of the skin being connected with the perforator. With decreased contact between the muscle and the skin, the movement of the skin is more efficient. The flap is conventionally used to cover the upper third leg, knee and lower part of the thigh as muscle flap.

Gastrocnemius muscle flap is commonly used to cover the defects over the upper third or the knee (5). The middle third of the leg is covered by fascio-cutaneous flaps based superiorly or inferiorly, soleus, tibialis anterior and other flaps. Each have their restrictions with respect to reach and the size. The free flaps are used to cover large defects and where local flaps are not feasible. However, the surgery time, need for expertise, learning curve has made the use of free flaps less frequently. The gastrocnemius chimeric musculocutaneous flap if applied to the defect is likely to reach the lower third of the leg and proximally beyond the lower third of the thigh. Nikhil et al were able to cover the thigh defects with gastrocnemius

musculocutaneous flap up to 20 cm from the knee joint line. They have included all the perforators and islanded the flap (6). The flap can be effectively used if the flap is not in the zone of injury. In cases where the middle third or the lower third are in the zone of trauma, the flap will not reach the middle third of the leg. In such a circumstance, we can use the musculocutaneous flap with muscle acting as carrier and the skin propelled will improve the reach of the flap as we have been able to do it in case 2. The muscle belly worked to cover the exposed bone in the middle third and as well as a carrier. The 30- degree movement of the muscle to the defect helped in a better inset of the flap. In cases where it is infected or when the vascularity needed is more, the belly can be preferentially used and the skin can be used where mobility is needed. We have used the belly similarly over the fracture site in case 3, 4, and skin over the knee. The perforator is said to be robust if it is 1mm in diameter, pulsations are seen and 1cm in size. Alexandru et al, Koshima et al have documented to have raised a large flap 28x13cm and 19x 13cm based on a single perforator (7,8). However, there is no consensus as to how big a flap can be supported on a single perforator. We have used the flap on a single perforator after confirming the adequacy of the perfusion by temporarily clamping the perforators. This will ensure the safety of the flap. In the present series, in case 3, a flap of 20 x8 cm was used on a single perforator. Authors have described and stressed on the dissection around the perforators, and the strands could contribute to venous complications. [9] whenever the chimeric principle is used and the defect demands increased movement, the use of propeller technique would be prudent. However, in defects which would need lesser movement of the skin, we can retain more than a single perforator.

The movement of the cutaneous part could be an advancement either distally or towards the side. If we are able to find a single robust perforator, we can propel the cutaneous component. Anatomically, the leg is inverted conical in shape. This presents with a larger surface area of the flap in the upper leg. This advantage presents with larger surface area to work with. This was used in case 5, where the upper part was used to cover the knee. When the flap is used conservatively, this part tends to stay at the bridge and would not help in reconstruction. We have found a perforator from the muscle in all our cases. The perforators used in the present series, were in the middle and lower part of the muscle. The pre-operative doppler and exploratory incision helps us not to commit to the flap. If we cannot find a perforator, we can use both the bellies of the gastrocnemius muscle, abandon, identify the sural vessels and use a free flap to cover the defect. The flap is able to cover larger area than a single belly of gastrocnemius muscle, easy to harvest, less time consuming, less morbid than the free flaps. However, the aesthetic result appears to be poor. The patients however were not concerned regarding the appearance.

5. CONCLUSION

Gastrocnemius Musculocutaneous flap can be better utilized with a chimeric principle using a differential movement. This allows better movement and increases in surface area of the flap. The flap is easy to harvest, ability to cover large surface area, no dog ears as in Musculo-cutaneous flaps, movement of the fascio-cutaneous flap by advancement, or propel the flap if a single perforator can reliably support the vascularity.

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