

# McCraw and Arnold's Atlas of Muscle and Musculocutaneous Flaps



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Global-HELP  
Publication

# GASTROCNEMIUS MUSCLE AND MUSCULOCUTANEOUS FLAPS

## ANATOMICAL CONSIDERATIONS

### *Surface Markings*

Each gastrocnemius muscular head can be vividly outlined by forcibly flexing and extending the foot. The two muscles are separated by an imaginary line in the posterior calf where a "stocking-seam" would normally be. The medial head is clearly the larger of the two muscles.

### *Origin and Insertion*

The muscle originates from the femoral condyles and inserts into the Achilles tendon some five centimeters proximal to the soleus muscular insertion. The two heads of the muscle are partially fused in the midline of the calf where the course of the sural nerve represents the imaginary "stocking-seam" separation. At the level of the Achilles tendon, the gastrocnemius and soleus muscles are densely adherent to each other over a distance of about five centimeters. The isolated function of one head of the gastrocnemius muscle is totally expendable. Normal ambulation can also be expected after the sacrifice of the soleus muscle and one head of the gastrocnemius muscle.

### *Adjacent Muscles*

The soleus muscle lies directly beneath the gastrocnemius muscle and the Achilles tendon. The plantaris tendon is identified on the surface of the soleus muscle in the plane between the soleus muscle and the medial head of the gastrocnemius muscle. The lateral compartment musculature is separated from the lateral head of the gastrocnemius muscle by the lateral intermuscular septum.

### *Vascular Pattern*

The gastrocnemius muscle is the definitive example of a muscle with a single proximal, dominant vascular pedicle. The sural artery is a branch of the popliteal artery which passes directly into the proximal portion of both heads of the gastrocnemius muscle. The sural artery arborizes in the proximal one-third of each muscle, enabling one to either trim or "split" the distal and peripheral gastrocnemius muscle at the time of transposition. The posterior calf skin is supplied by direct

musculocutaneous perforators proximally and by the deep fascia distally. The medial gastrocnemius myocutaneous flap can be carried to a point five centimeters above the flare of the medial malleolus. The lateral myocutaneous flap can be carried to a point ten centimeters above the flare of the lateral malleolus. Fasciocutaneous flaps of comparable size can be outlined in the calf, but their safe dimensions are presently ill-defined. Even though exceedingly lengthy fasciocutaneous flaps can be raised in the posterior calf, their viability is enhanced by preserving the direct musculocutaneous perforating vessels from the underlying gastrocnemius muscle.

### *Motor Nerve*

Popliteal nerve.

### *Sensory Nerve*

Sural and saphenous nerves.

## USES

Although the gastrocnemius muscle can be used either as a muscle flap or a musculocutaneous flap with equal ease, it is almost always employed as a pure muscle flap because of the donor site considerations. Either the medial or lateral head of the gastrocnemius muscle (or both heads) can be used to cover the difficult areas of the upper tibia, the knee joint, and the popliteal fossa. The primary application of the medial head of the gastrocnemius muscle is for coverage problems in the proximal one-third of the tibia, but the soleus muscle is more commonly used for defects of the middle one-third of the tibia. The medial gastrocnemius myocutaneous flap can also be used for middle one-third defects, but the donor defect requires a skin graft for closure. Generally speaking, it is preferable to transpose the gastrocnemius muscle as a pure muscle flap since the skin-grafted muscle offers a durable surface. The muscle flap can also be tailored at the time of inset to provide an appropriate contour restoration.

The musculocutaneous flap is usually employed as a fasciocutaneous flap (without elevating the muscle) to repair defects of the middle and lower tibia. It is occasionally useful as a cross-leg flap, particularly in re-

construction of the contralateral Achilles tendon area. The deep fascia of the leg is always included with the distal cutaneous segment, and half of the Achilles tendon can be carried safely with the myocutaneous flap to reconstruct the opposite Achilles tendon. Bilateral myocutaneous anterior advancement flaps of both the medial and lateral gastrocnemius heads provide excellent mid-tibial coverage with a very acceptable posterior calf "stocking-seam" donor site. One other application of the musculocutaneous flap is the distal V-Y advancement into the Achilles area. The V-Y musculocutaneous flap is elevated as a pure "island" flap after the muscular origin has been divided from the femur. Release of the muscular origin advances the distal tip of the cutaneous segment for an additional three to four centimeters. This simple maneuver can obviate the need for a "free" flap or a cross-leg flap for the small Achilles tendon defect.

## REGIONAL FLAP COMPARISONS

The medial and lateral heads of the gastrocnemius muscle cover similar areas, but the medial head is approximately twice the size of the lateral head. This anatomical difference should be recognized when dealing with a sizable defect. The only other muscle which can give similar upper-third tibial coverage is an "island" soleus muscle flap. The standard soleus muscle flap is more often used for defects of the middle-third of the tibia because of its accessibility and ease of transfer. Bilateral gastrocnemius myocutaneous flaps are ideally suited for lengthy pretibial defects which are less than four centimeters in width. Massive upper-half defects of the tibia usually dictate the use of a soleus muscle flap in combination with a medial gastrocnemius muscle flap.

## DISADVANTAGES

Even though it might be expected, the use of one head of the gastrocnemius muscle does not cause any detectable functional loss. Neither should the combined use of the medial head of the gastrocnemius muscle and the soleus muscle cause a noticeable functional loss, except in the athletic person. The skin-grafted donor site of the gastrocnemius musculocutaneous flap offers a significant esthetic disadvantage, particularly in women.

## ADVANTAGES

Of all the muscles in the lower extremity, the gastrocnemius is certainly the most comfortable and reliable muscle to transpose. Its proximal, dominant blood supply is protected in the popliteal fossa and is difficult to injure. In fact, it is seldom seen in the process of trans-

position because simple separation of the two heads of the gastrocnemius muscle is usually sufficient to effect an adequate muscle transposition. If more length is needed, the origin of the muscle can be separated from the femur, and the muscle can be converted into a true "island" flap. Because of the distinct arborization of the dominant vasculature in the proximal one-third of the muscle, the muscle can be trimmed at the time of transposition to accommodate the defect precisely. The muscle can also be split in half both to obliterate a cavity and to correct a surface defect. The fascia on either side of the muscle can be "scored," as is done with the galea, or it can be excised to "expand" the muscle and allow it to be spread over a wider area. When the muscle is used to correct a low-grade infection, it is always advisable to remove this fascia to expose the raw muscular surface. The muscular fascia is also routinely removed to facilitate the "take" of a skin graft on the muscle flap.

Bilateral, bipedicle musculocutaneous flaps can be advanced together into long and narrow anterior tibial defects. This dissection is usually done from the anterior approach, but the midline separation of the muscular heads can be done more precisely through a "stocking seam" incision. The posterior access incision is usually skin grafted, but it is possible to close it primarily if the anterior tibial defect is less than four centimeters in width.

## COMPLICATIONS, PITFALLS, AND DONOR SITE

Because the gastrocnemius muscle flap is such a hardy flap, the infrequent surgical disappointments are usually caused by the operator and not by the muscle. For instance, even minor errors of surgical technique will cause failures in dealing with osteomyelitis of the tibia, because a 95% successful correction of the infection often equates with a 100% failure. This is usually related to an inadequate debridement of the bone, an incomplete obliteration of the dead space, or an imperfect immobilization of the inset muscle. Like most muscle flaps the gastrocnemius muscle is extremely sensitive to external pressure. It should never be tunneled beneath a "tight" skin bridge. In fact, external pressure has been the only cause of muscle flap necrosis in our experience.

When dissecting in the popliteal fossa, one should always be cognizant of the adjacent nerves. The important common peroneal nerve is intimately involved with the lateral head of the gastrocnemius muscle and can easily be injured. The tibial nerve is readily identified in the midline of the popliteal fossa between the two heads of the gastrocnemius muscle. Distally, it is important to protect the posterior tibial nerve since it lies in close proximity to both the soleus muscle and

medial head of the gastrocnemius muscle. Even the seemingly dispensable sural nerve should be preserved because the loss of sensation on the lateral aspect of the foot can be bothersome.

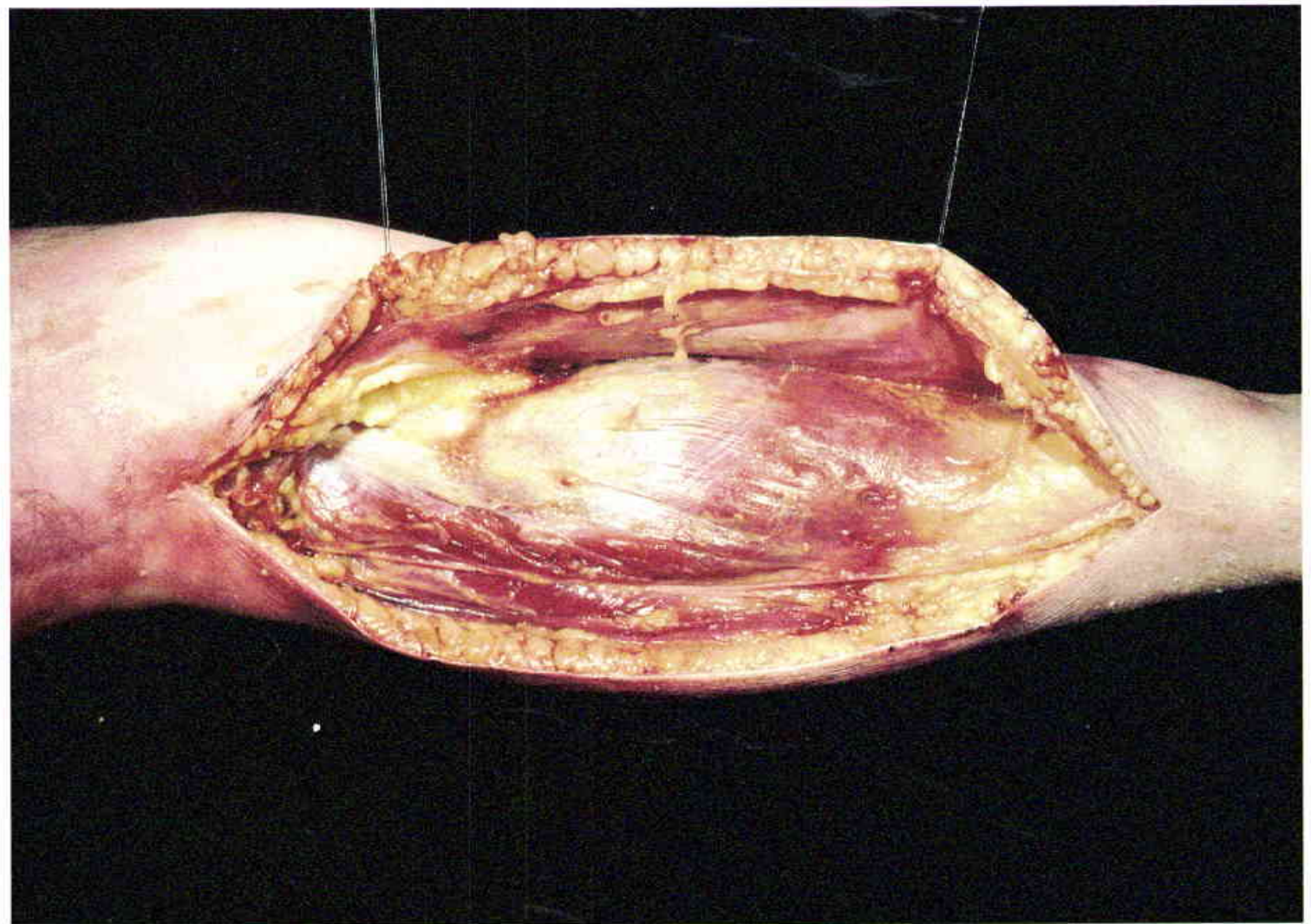
The gastrocnemius musculocutaneous cross-leg flap takes at least twice as long to gain a new blood supply, when compared to the standard cross-leg flap. This seems to be related to the robust blood supply which exists in the musculocutaneous unit and its lesser “need” to obtain a new blood supply from the recipient location. For this reason the flap should not be divided in a single stage, and its viability should be tested with fluorescein prior to the final separation of the legs. This is done by placing a tourniquet on the donor (flap) leg and then administering intravenous fluorescein. If the inset flap fluoresces, one can presume that this is the result of “local” blood supply, not the inherent flap blood supply.





1

Cadaver dissection of the gastrocnemius muscle using a "stocking-seam" incision.

2

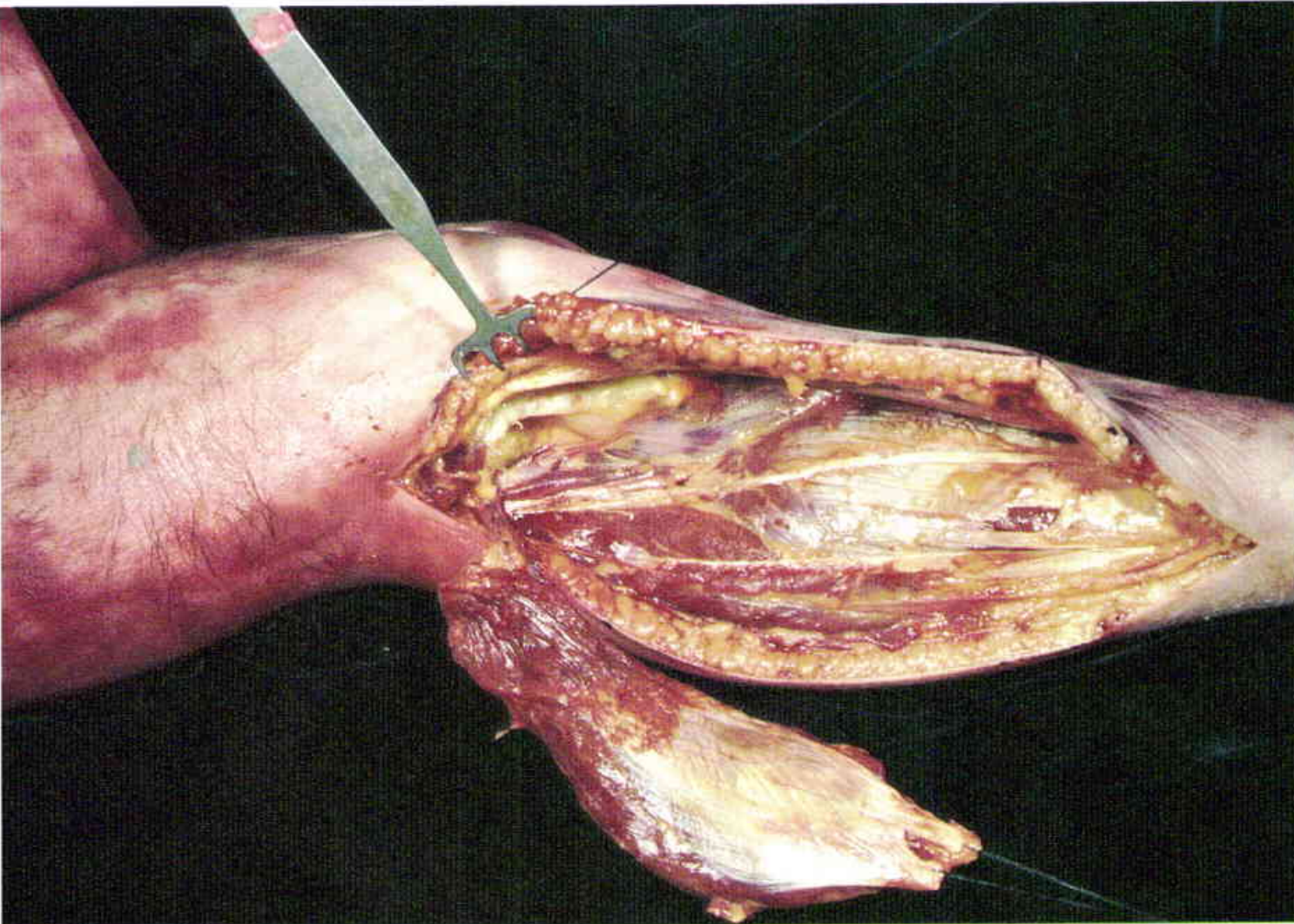
View of the medial head of the gastrocnemius muscle with the sural nerve at its lateral border.



3

The medial head of the gastrocnemius is elevated with sutures after the muscle fascia has been removed from its external surface.

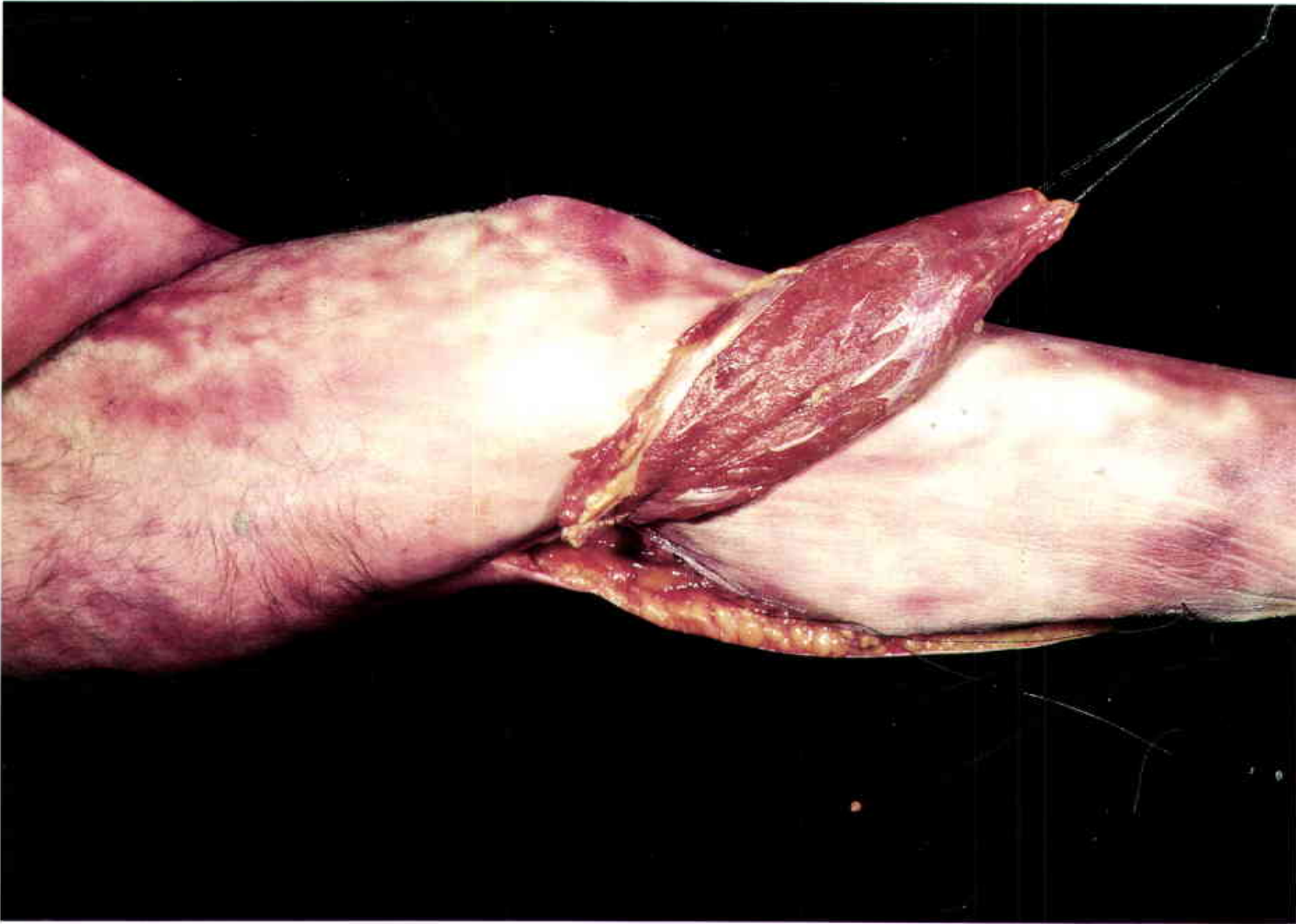




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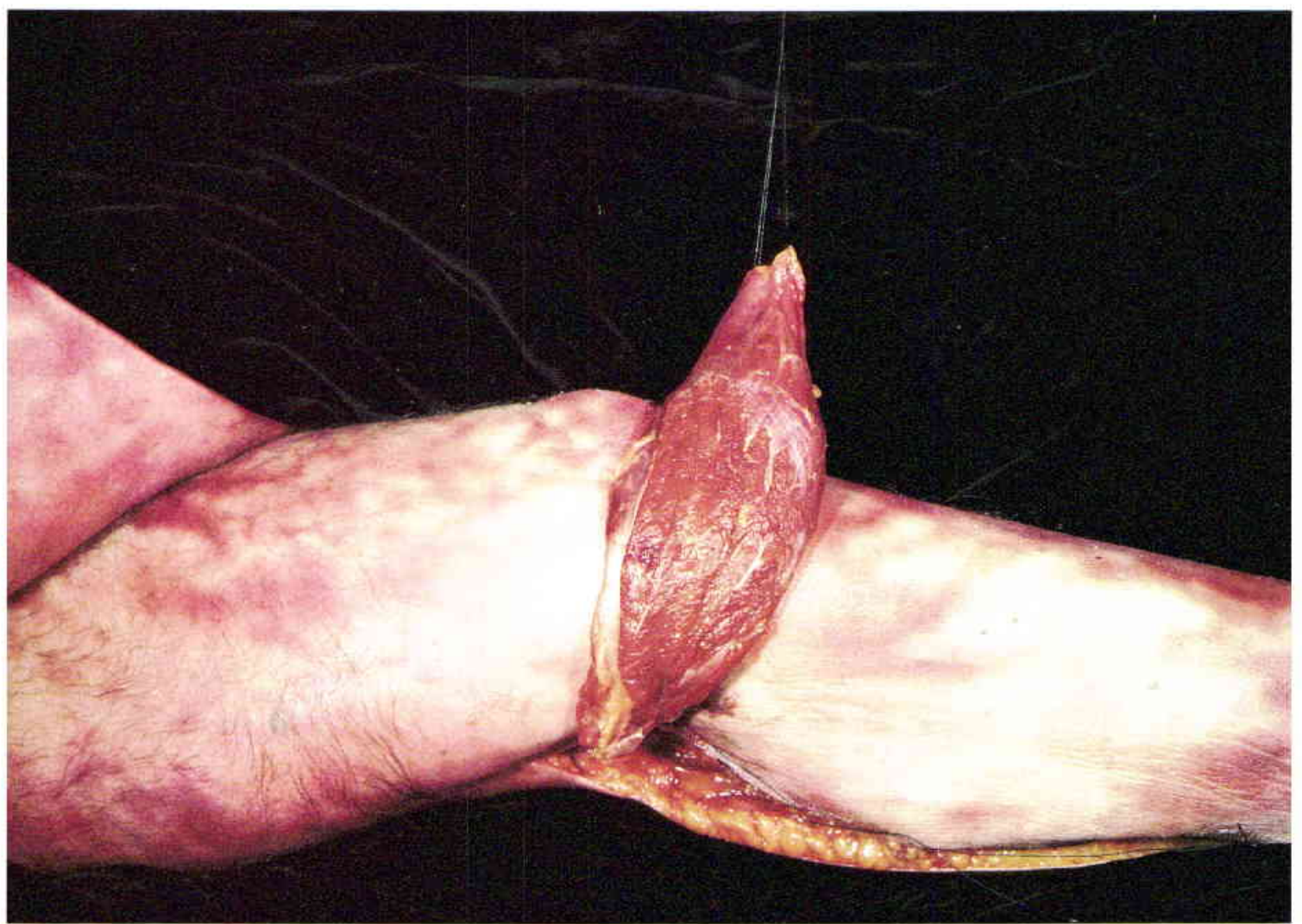
The medial head is converted into a true "island" flap by division of its origin from the femur. Note the dense fascia on the undersurface of the muscle. This fascia can be "scored" or completely excised to "expand" the area of muscle coverage.





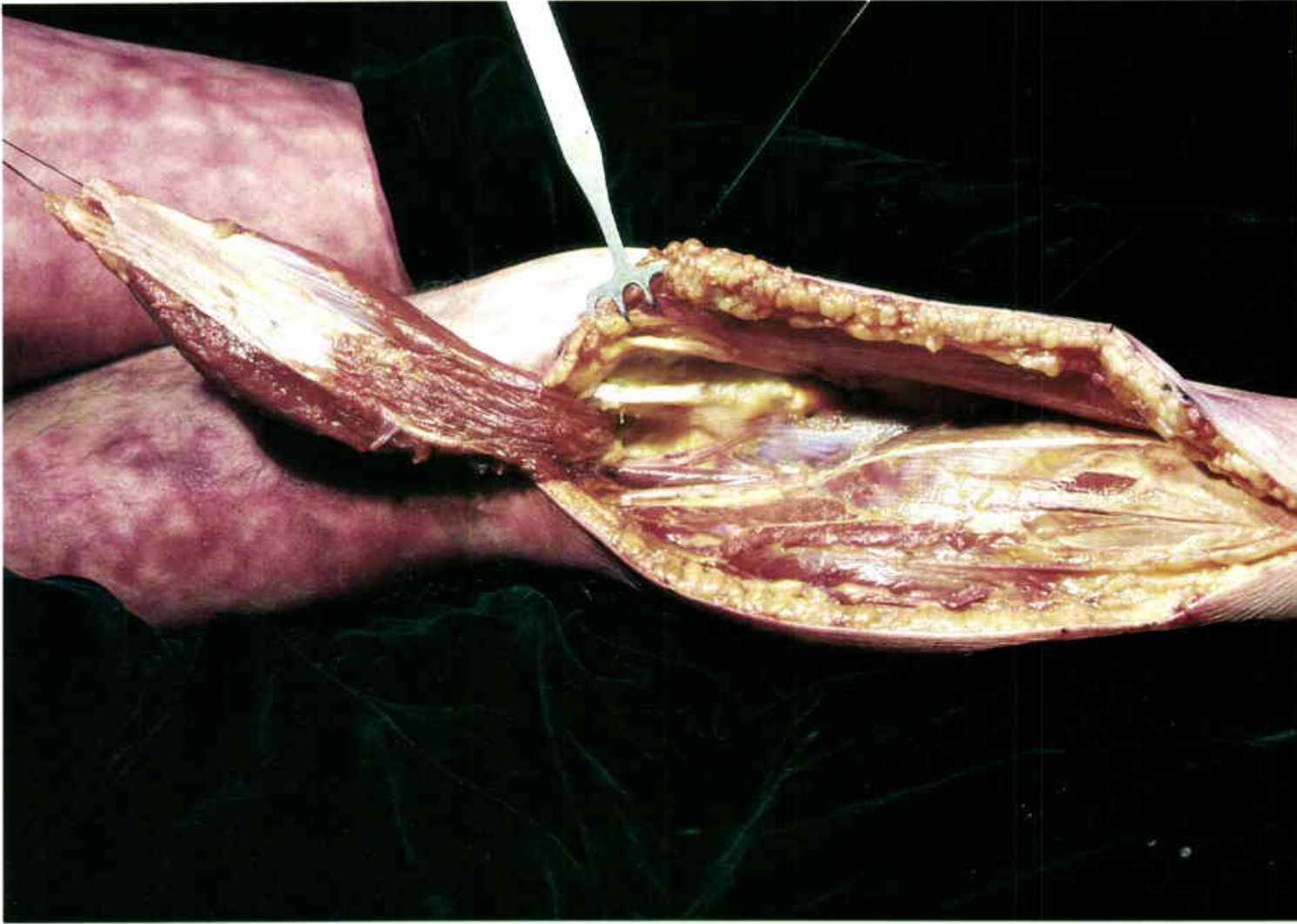
5

Muscle coverage of the upper one-third of the tibia by the "island" gastrocnemius muscle flap.



**6**

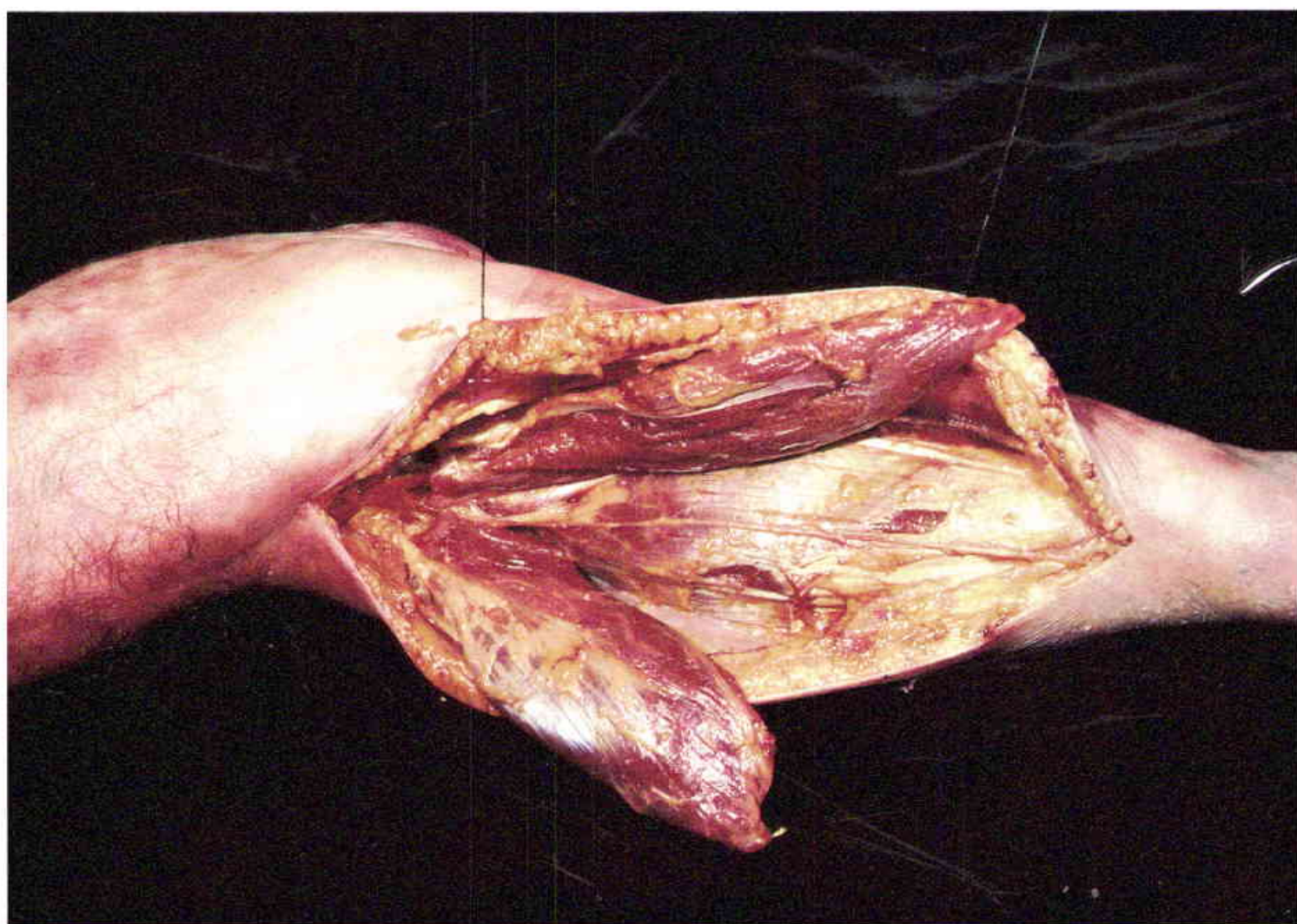
Both the tibial tubercle and the patella are easily covered by the medial head.



7

The transposed muscle flap reaches well above the patella, which lies at the level of the retractor.





8

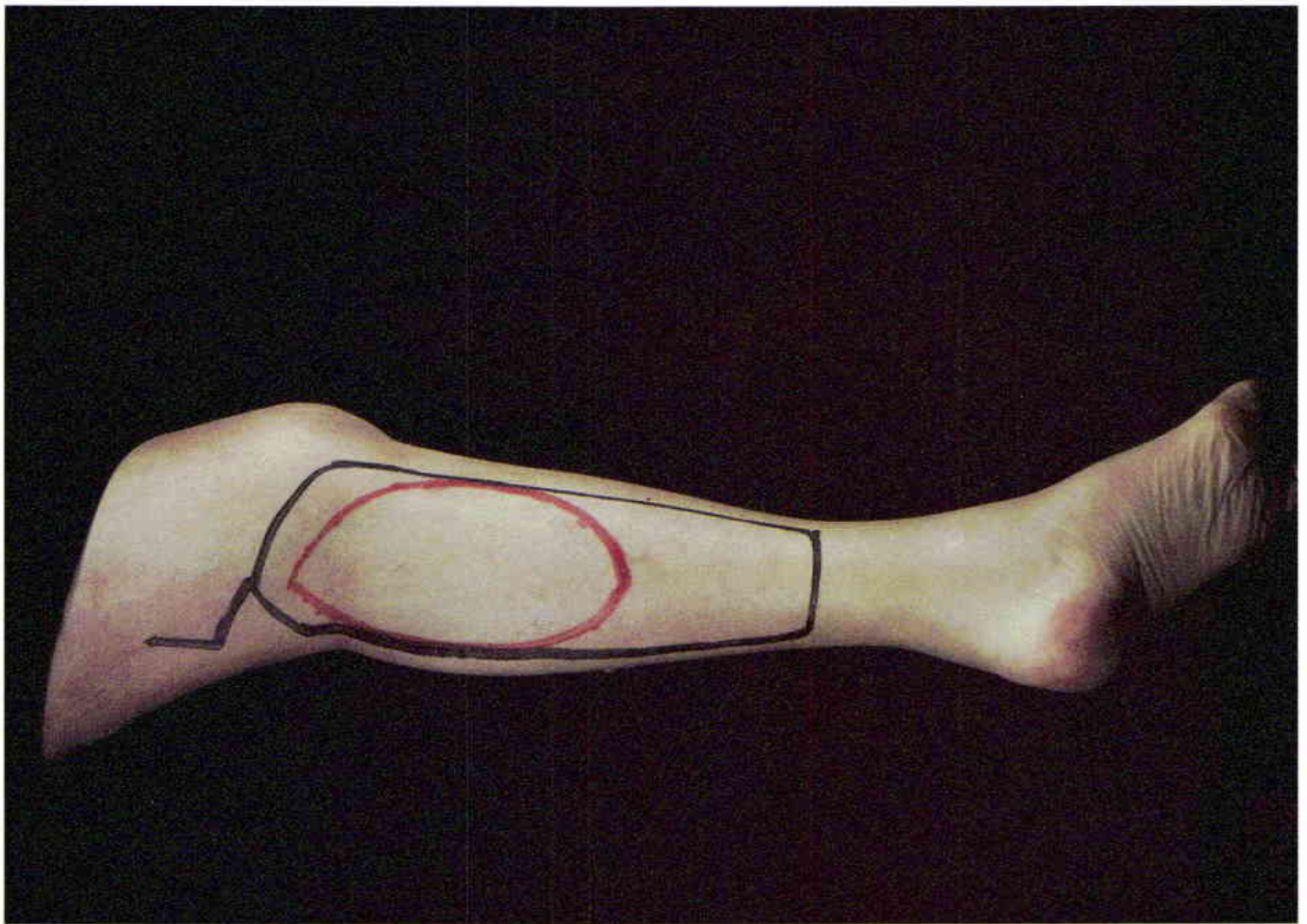
Elevation of both heads of the gastrocnemius muscle through a "stocking-seam" approach. Note the intact sural nerve on the surface of the soleus muscle (in the midline) and the plantaris tendon anterior to this.



9

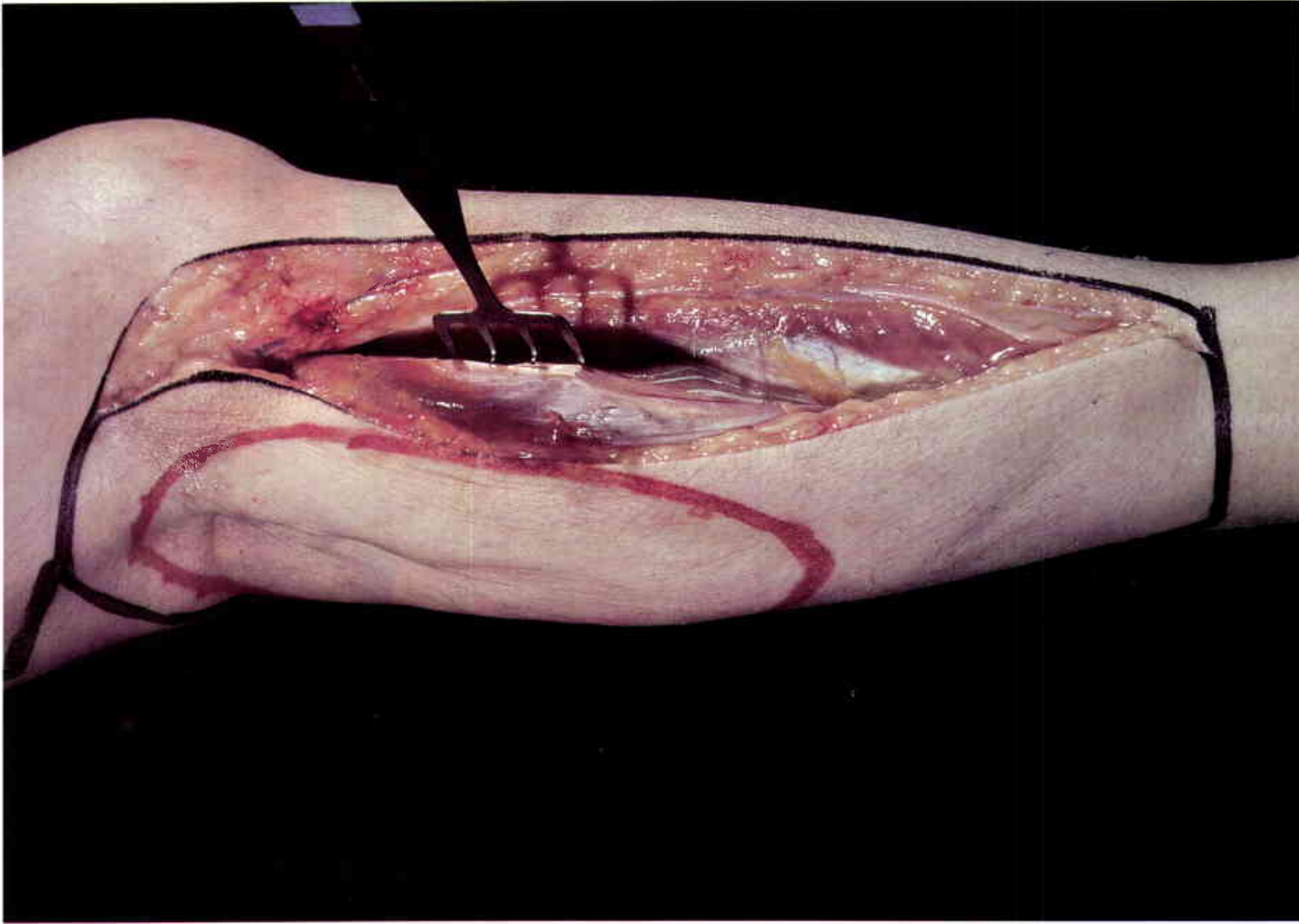
Anterior view of the medial and lateral heads of the gastrocnemius muscle transposed into the patellar area. The medial head is the larger of the two heads.



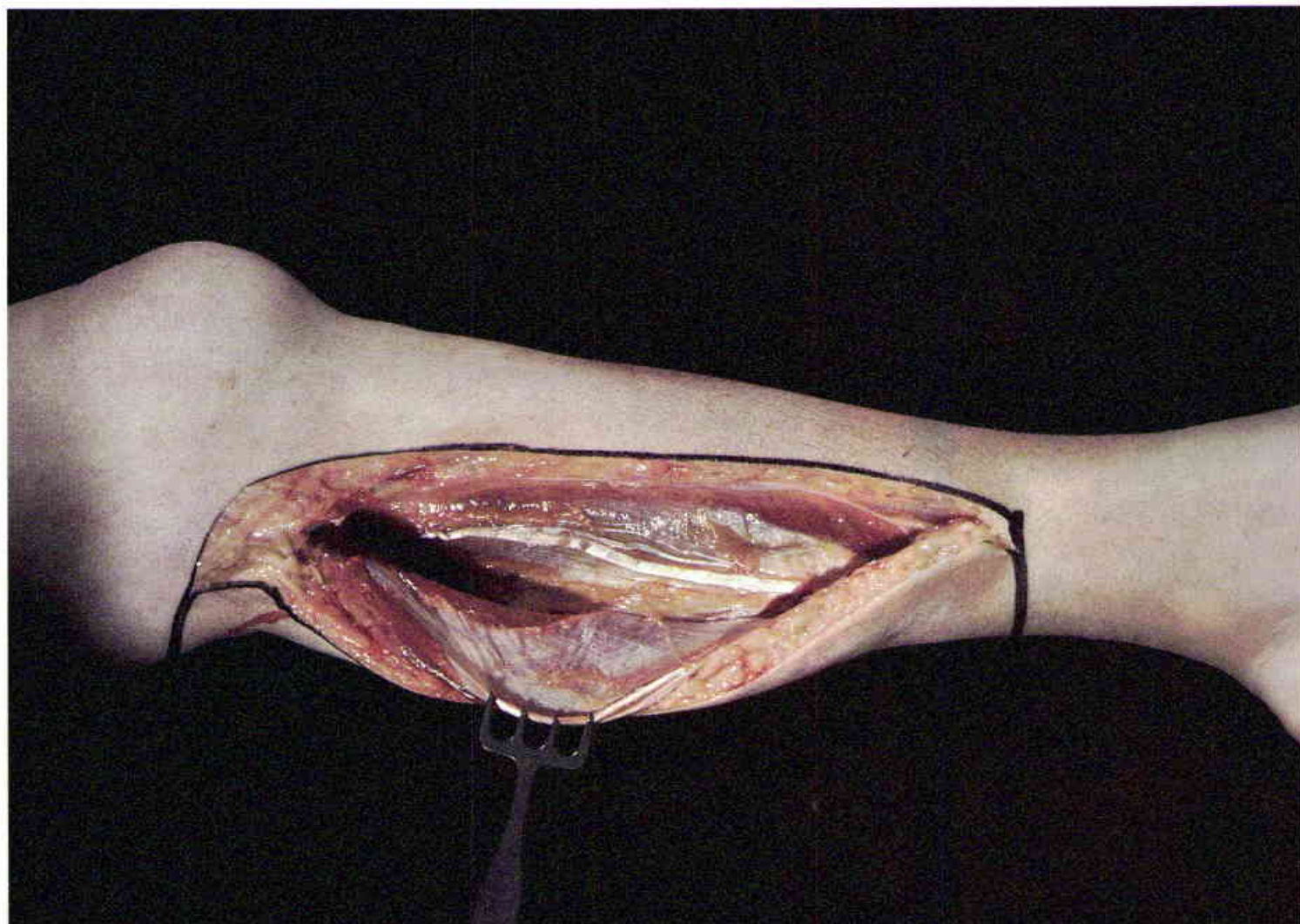
**10**

The medial gastrocnemius myocutaneous flap is outlined in black with an optional popliteal incision marked for division of the muscular origin. The anterior border of the flap parallels the medial margin of the tibia, and the posterior margin is near the midline of the calf. The distal flap margin extends to a point approximately five centimeters above the "flare" of the medial malleolus.



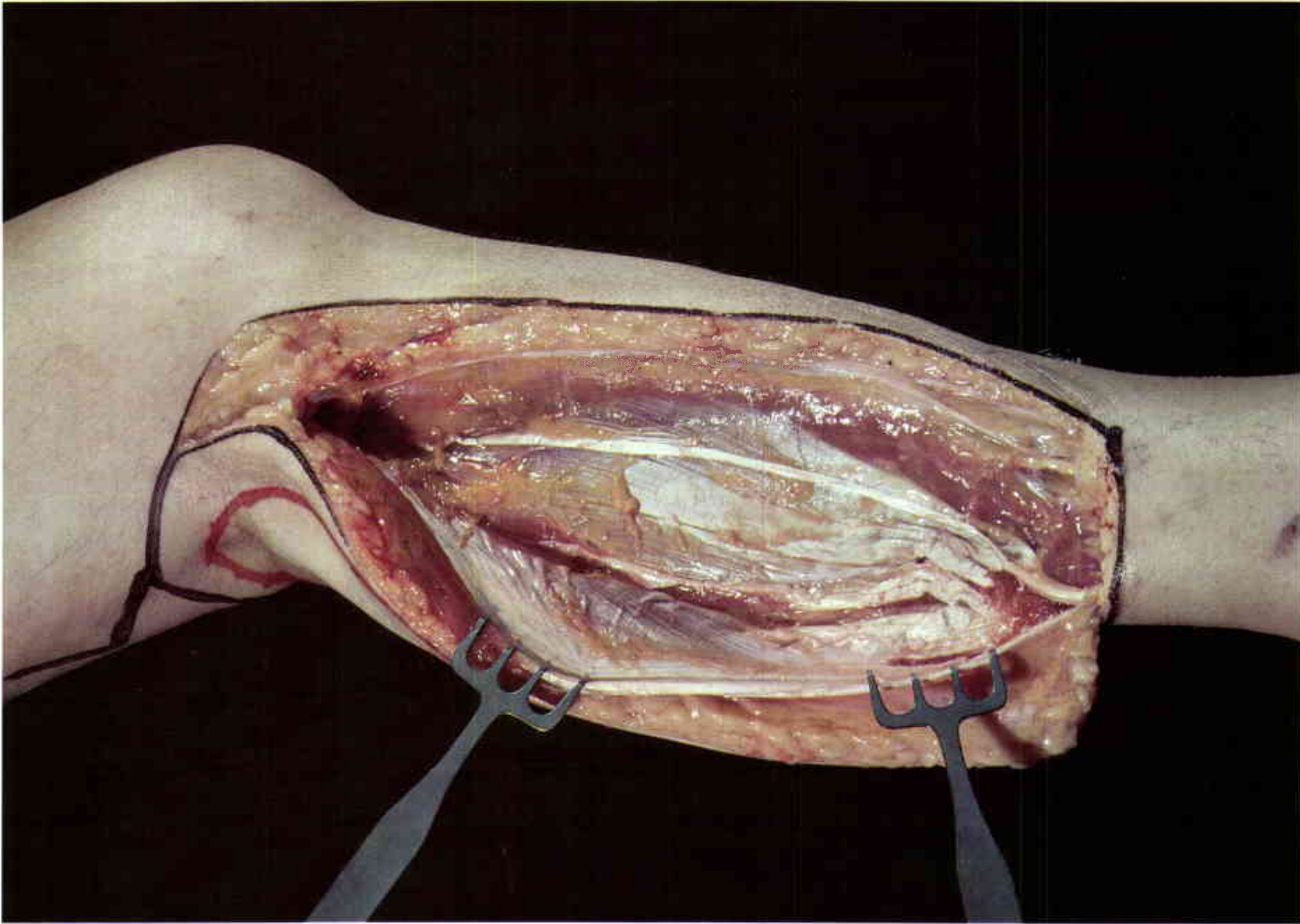
**11**

The separation between the gastrocnemius and soleus muscles is first identified proximally, and the dissection is then carried distally. The medial head of the gastrocnemius muscle is retracted away from the adjacent soleus muscle with the "face lift" retractor.



12

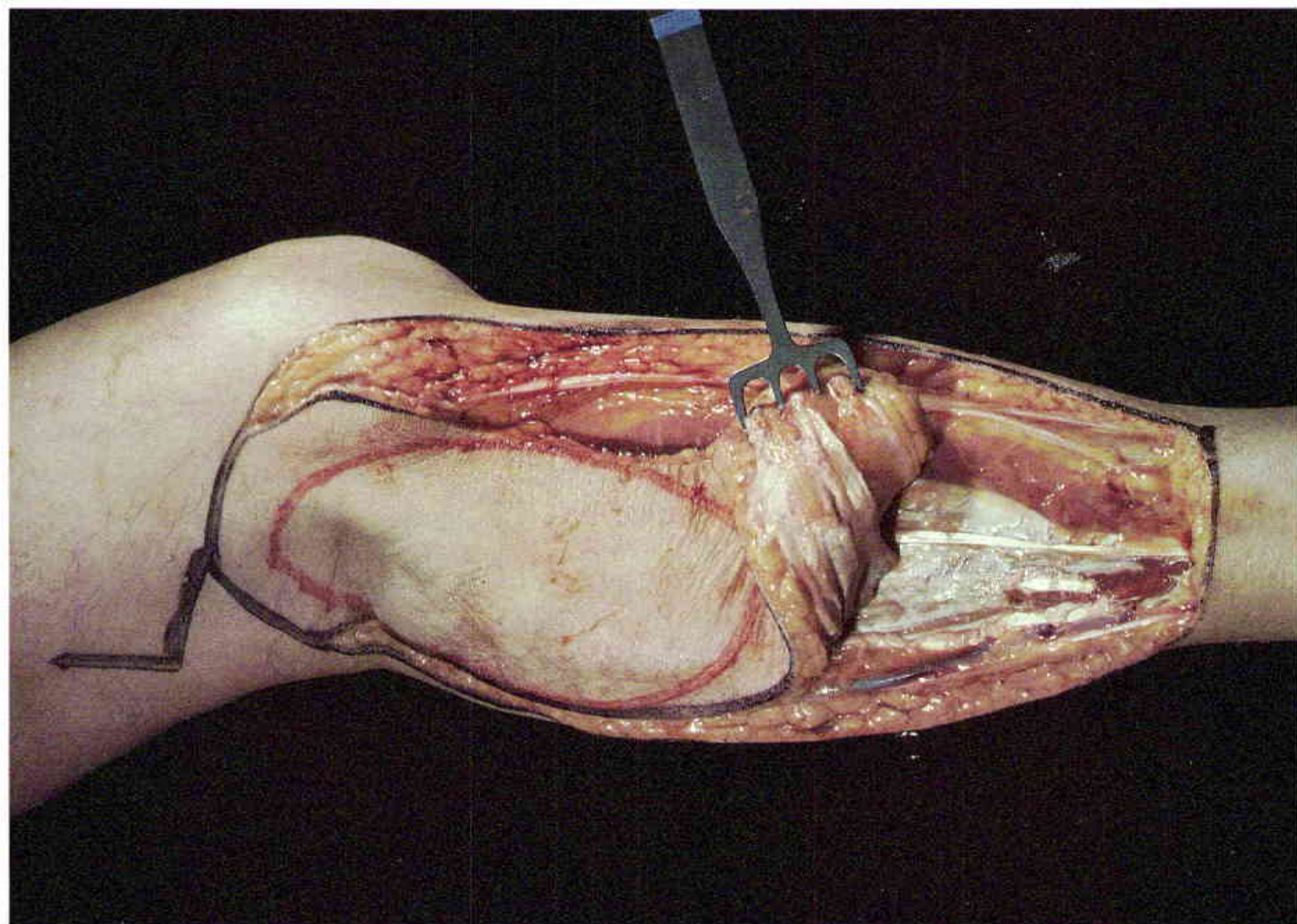
The medial head of the gastrocnemius muscle and the deep fascia of the calf are retracted. The separation between the medial and lateral heads of the muscle can be found from this anterior approach, but it is more accurately identified using a posterior approach.



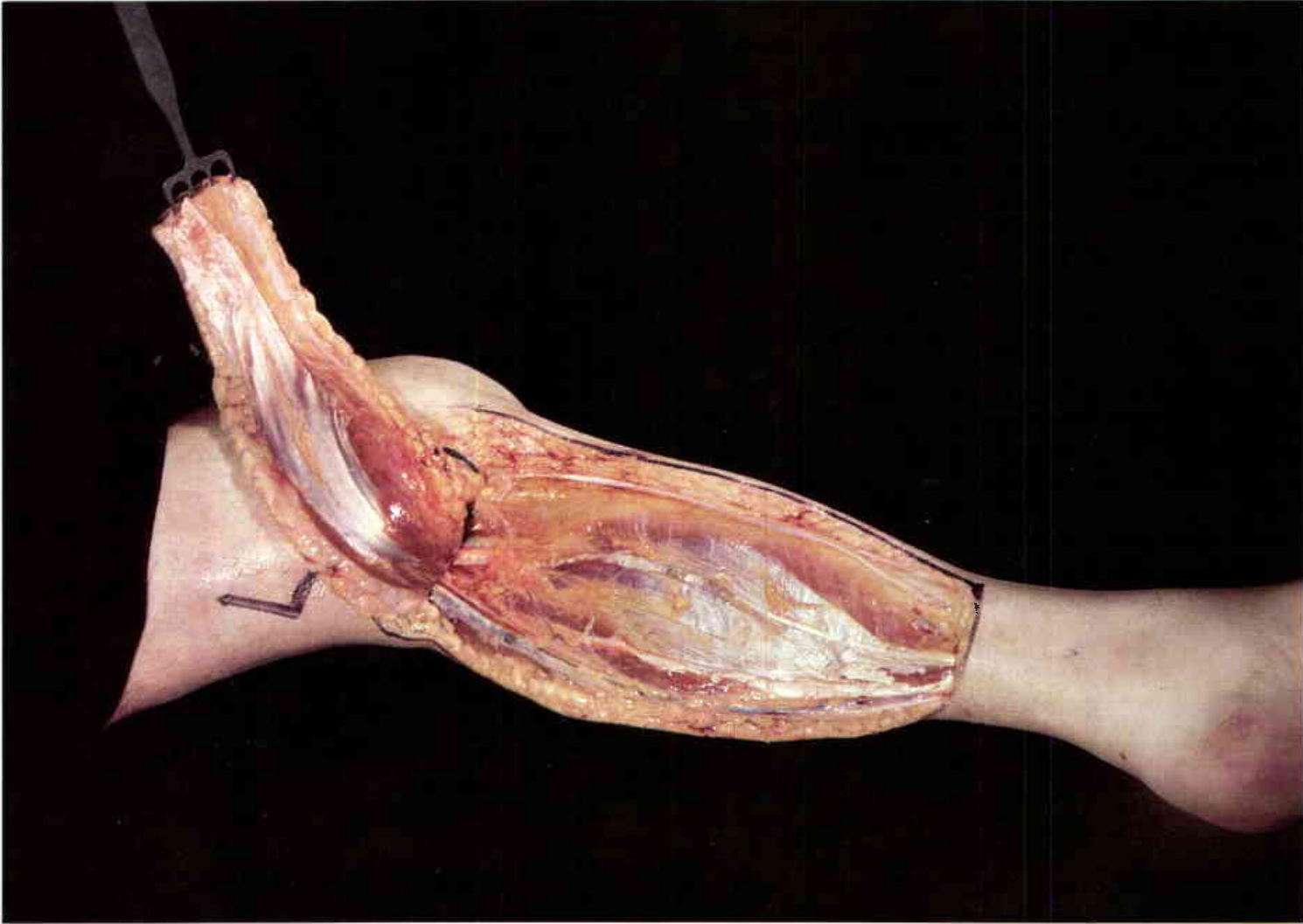
13

The areolar plane between the gastrocnemius and soleus muscles is bluntly dissected down to the level of the Achilles tendon. At this point the two muscles become fused and must be sharply separated. Note the plantaris tendon on the surface of the soleus muscle.



**14**

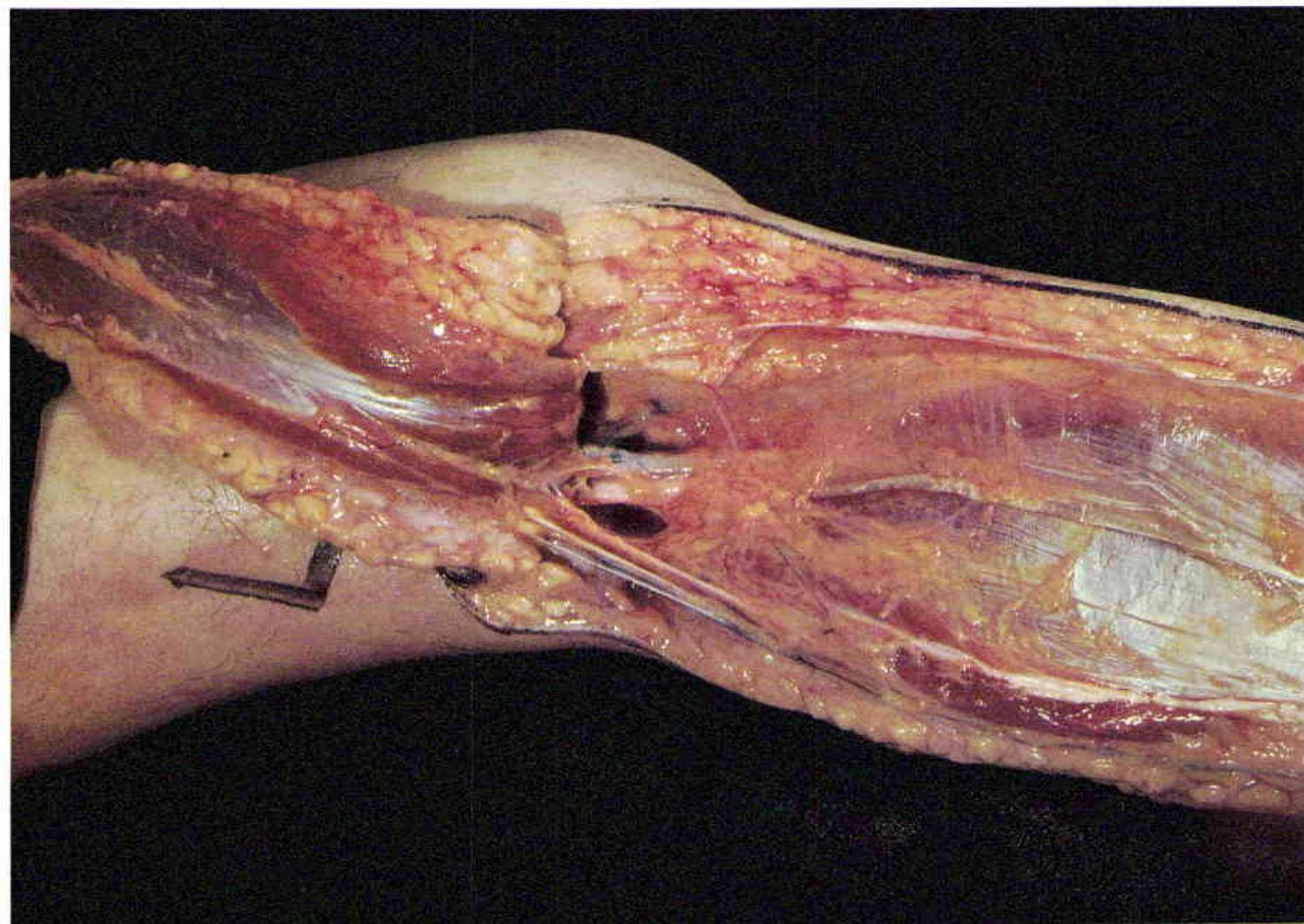
The deep fascia of the calf is always included with the cutaneous segment of the gastrocnemius myocutaneous flap. A portion of the Achilles tendon can also be included with the flap without harming its physical strength. The lesser saphenous vein and the sural nerve are identified posteriorly, but are not included with the flap.



15

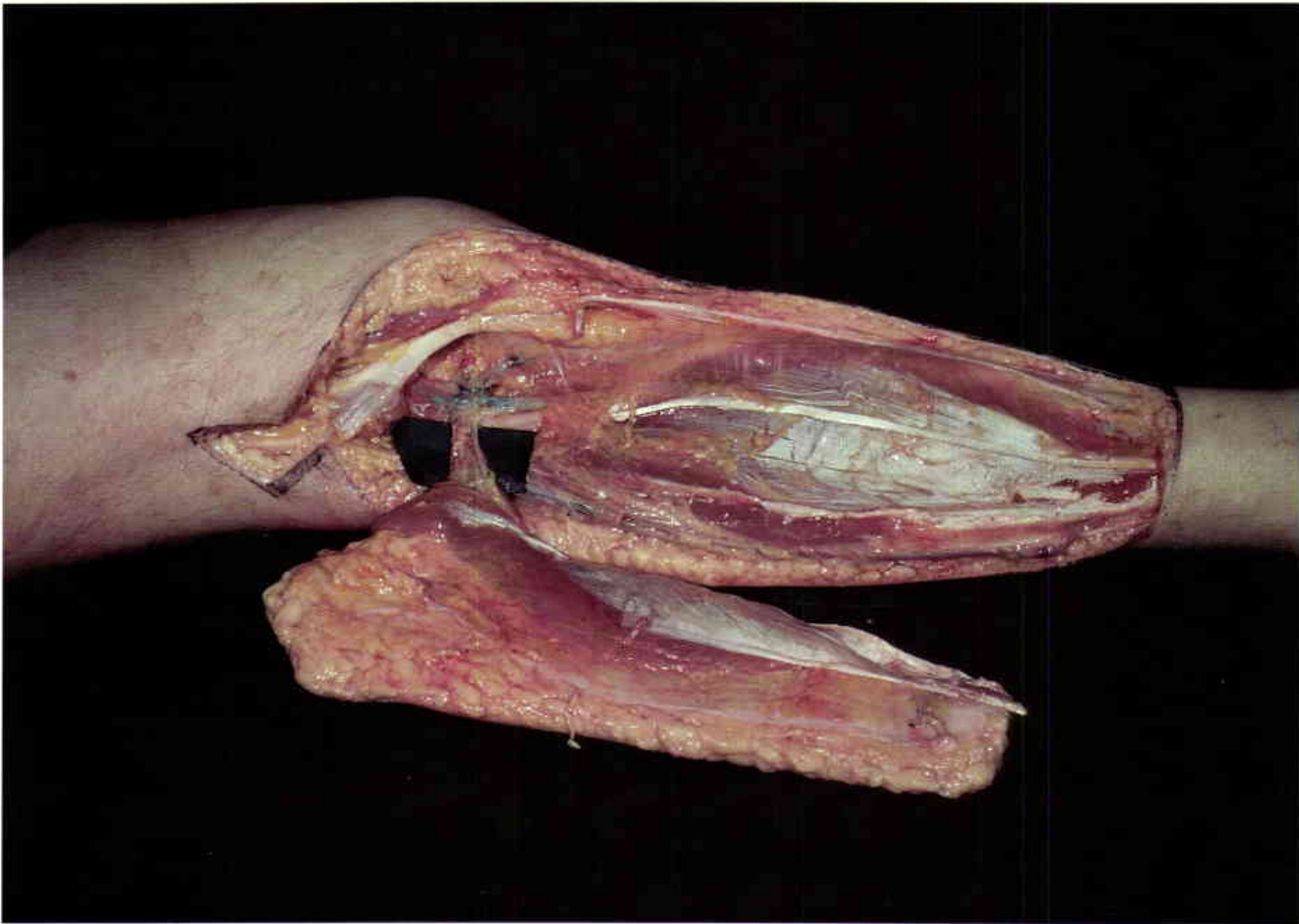
The medial gastrocnemius myocutaneous flap is elevated up to the level of the muscular origin. When only the distal half of the cutaneous segment is needed for coverage it can be safely raised as a pure fasciocutaneous flap.



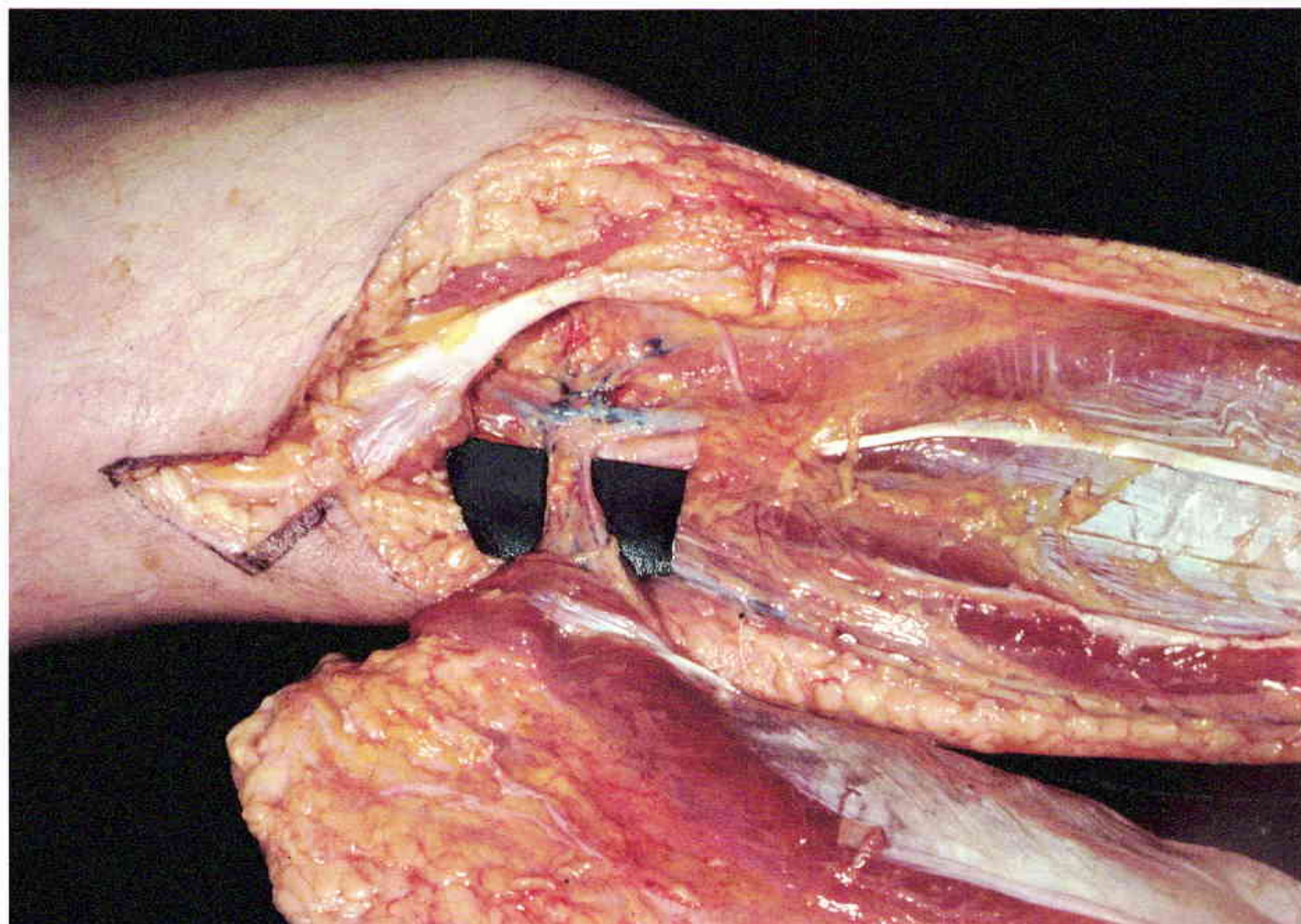
**16**

Close-up view of the popliteal neurovascular structures. The sural nerve and lesser saphenous vein are seen posteriorly.



**17**

Demonstration of the "island" medial gastrocnemius myocutaneous flap. Black felt is used to outline the neurovascular bundle. Division of the muscular origin from the femur will increase the distal excursion of the flap by three to four centimeters without harming its viability.



18

Close-up view of the popliteal neurovascular bundle after the muscular origin has been divided. Note the pes anserinus ("goose's foot") tendinous expansion just anterior to the popliteal vessels.



19  
Pretibial coverage as a fasciocutaneous  
flap without elevation of the gastrocne-  
mius muscle.





20

Suprapatellar extension of the medial gastrocnemius myocutaneous flap. The "island" medial gastrocnemius muscle flap will also cover this same area.



21

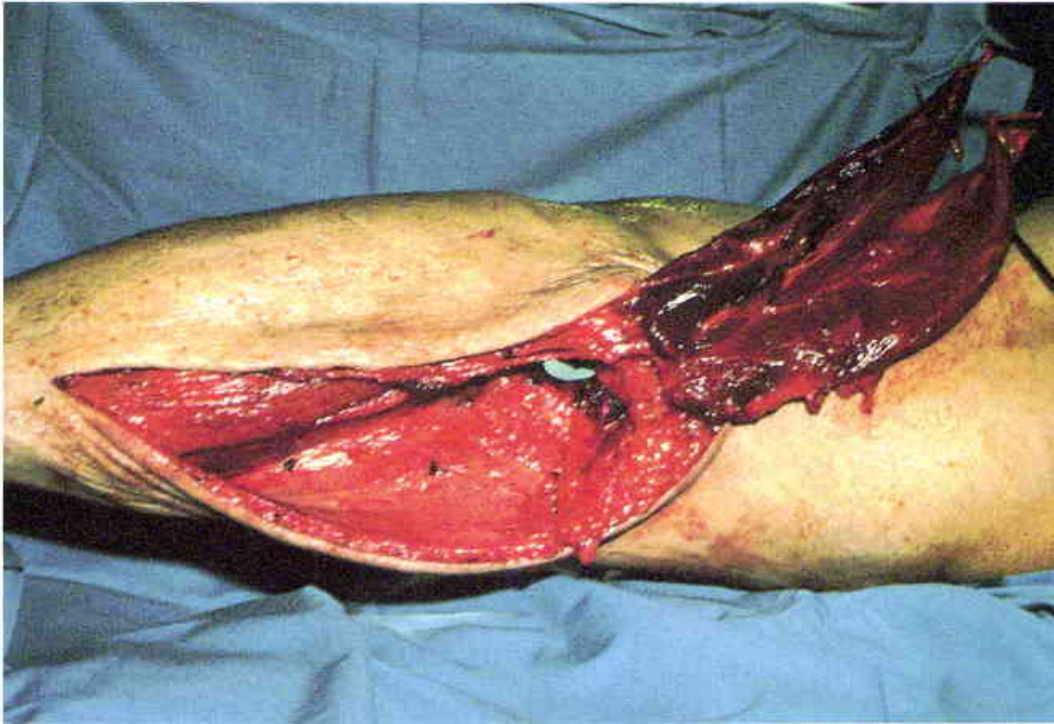
Sixty-eight-year-old retired professional football player who had undergone three total knee prosthetic replacements. Each attempt had failed because of osteomyelitis. A previous knee fusion was successful, but this large pretibial osteomyelitic defect remained. (Case of P.G. Arnold)



22

Both heads of the gastrocnemius muscle were mobilized as pure "island" flaps through a posterior "stocking-seam" incision. Note the larger size of the medial head.





23

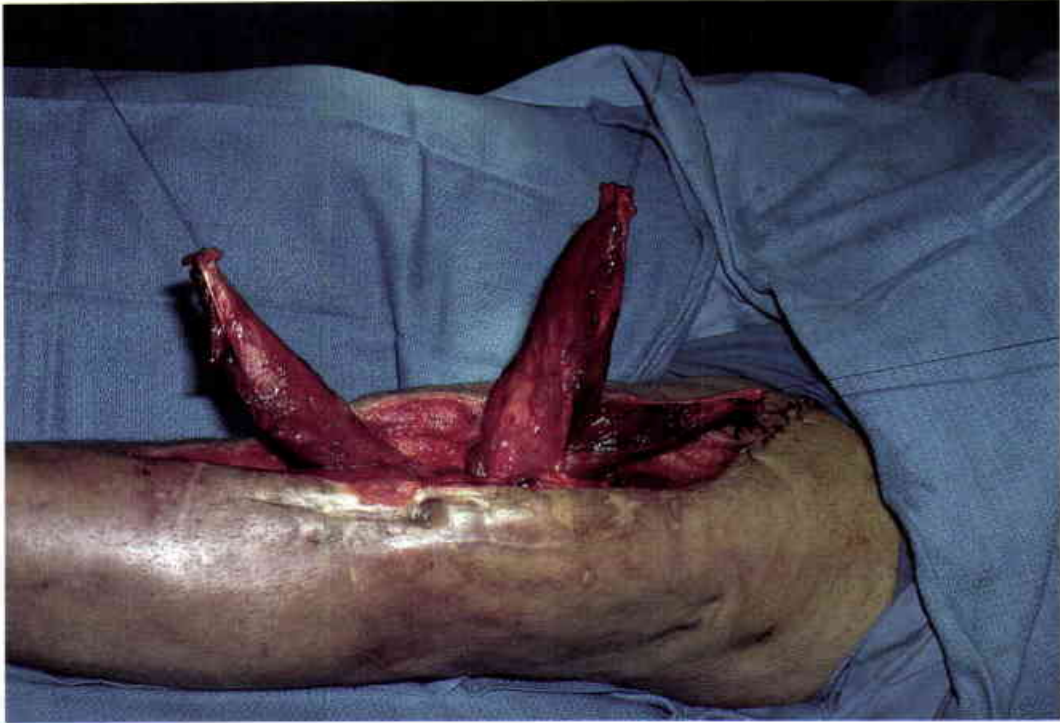
A "window" was made in the fused knee joint so the two gastrocnemius muscles could be directly transposed into the pre-tibial wound.



24

X-ray of the fused knee joint and the "window" created for the muscle transposition. The unsightly knee fusion was stable and allowed normal weight bearing.





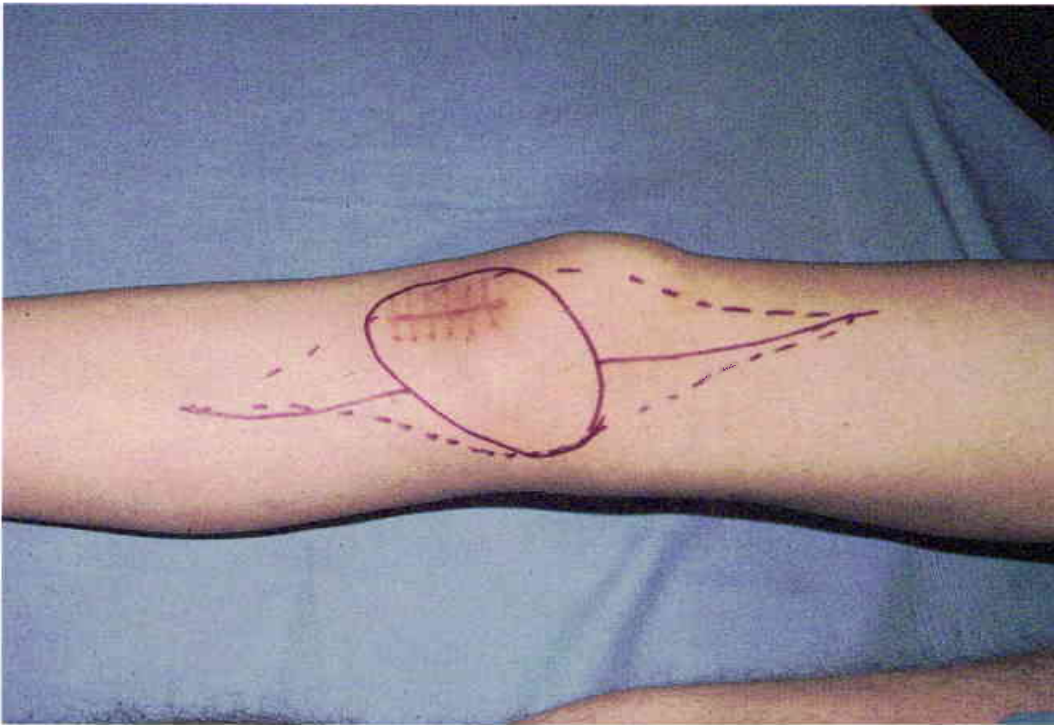
25

The medial and lateral heads were both "split" to fill the marrow cavity defect as well as cover the exposed tibial surface. The larger medial head is seen proximally in the pretibial wound.



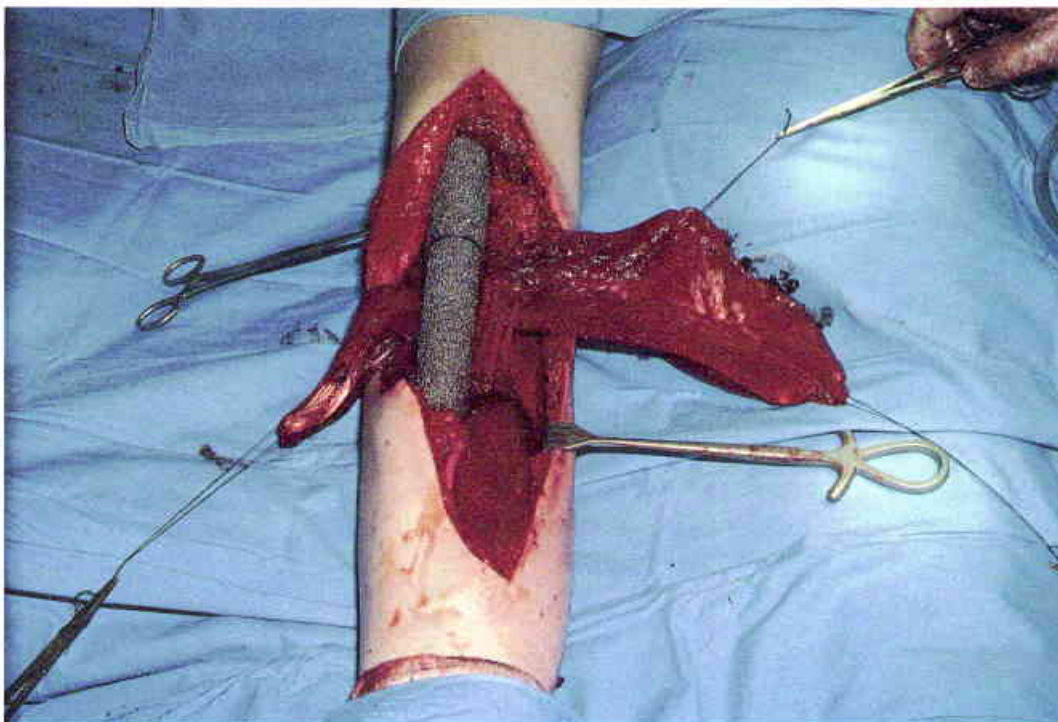
26

Healed muscle flaps at three years. The osteomyelitis has not recurred and the patient is active and ambulatory.



27

This young man had a biopsy-proven osteogenic sarcoma of the proximal tibia.  
(Case of P.G. Arnold)



28

The distal femur and the proximal tibia were widely excised, and the knee joint was replaced with a fibrometallic prosthesis. Both heads of the gastrocnemius muscle are elevated. The two muscle flaps will be used to cover the prosthesis and to nourish the surrounding bone grafts.



29

The two heads of the gastrocnemius muscle were wrapped around the fibrometallic prosthesis and the bone grafts in a "barber pole" fashion. The onlay bone grafts were used to prevent rotation of the prosthesis.



30

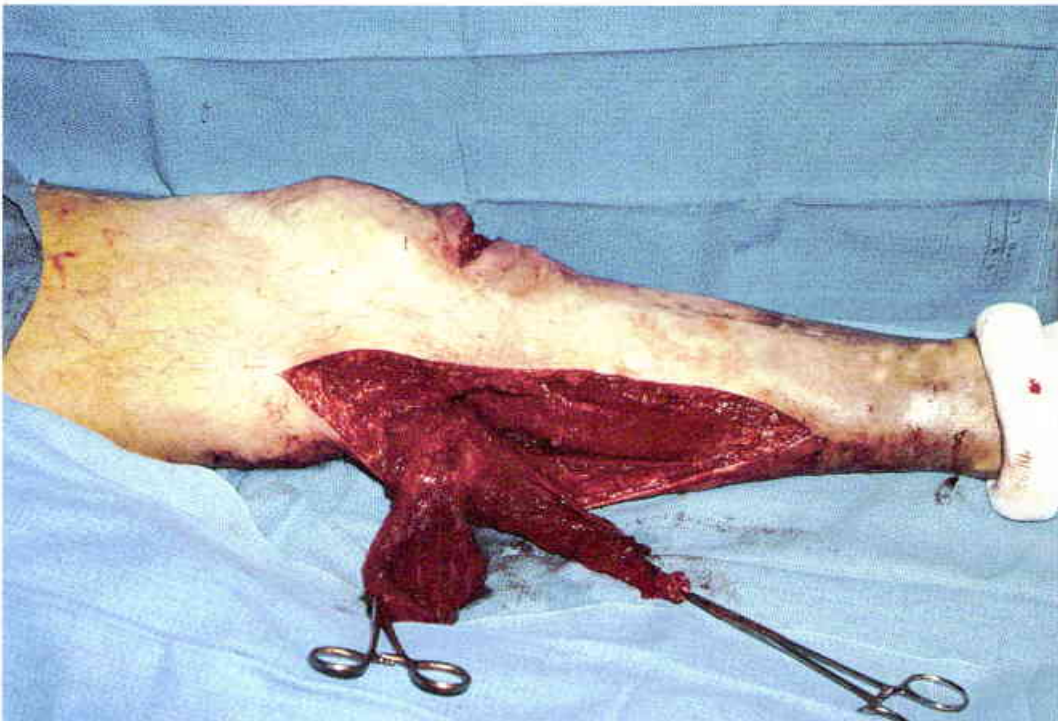
The skin-grafted medial and lateral gastrocnemius muscle flaps have provided excellent coverage of the bone-grafted metallic prosthesis for five years. The patient is fully ambulatory.





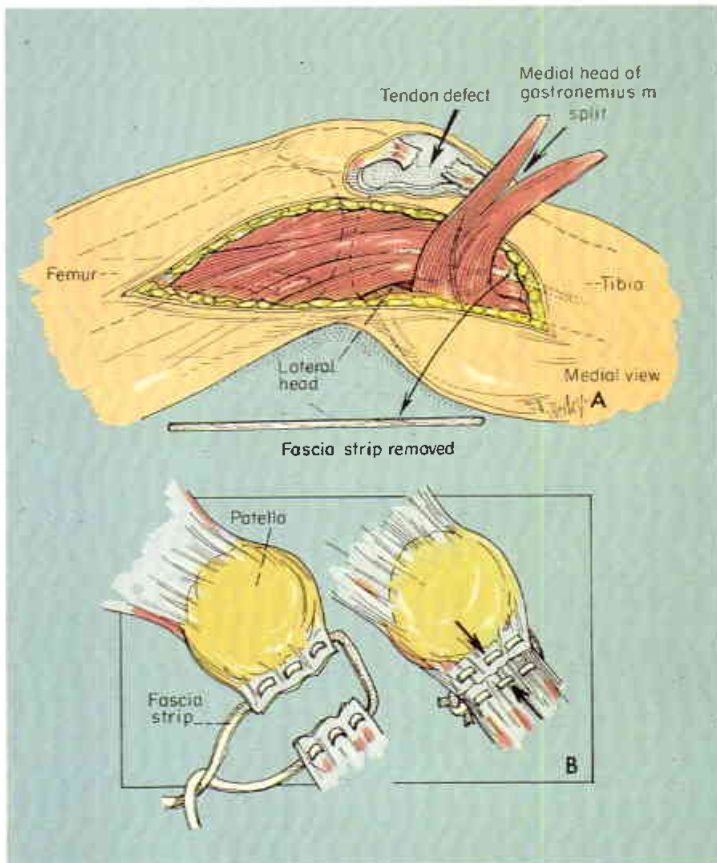
31

This fifty-three-year-old man sustained a major burn of the leg, which was allowed to heal secondarily during childhood. Trauma to the knee resulted in an infrapatellar abscess which destroyed the lower patellar tendon mechanism. (Case of P.G. Arnold)



32

The medial head of the gastrocnemius muscle was "split." The larger segment of the medial head was used to obliterate the osteomyelitic cavity. The remaining muscle was used to bolster the secondary patellar tendon repair, which was accomplished with a plantaris tendon graft.



33

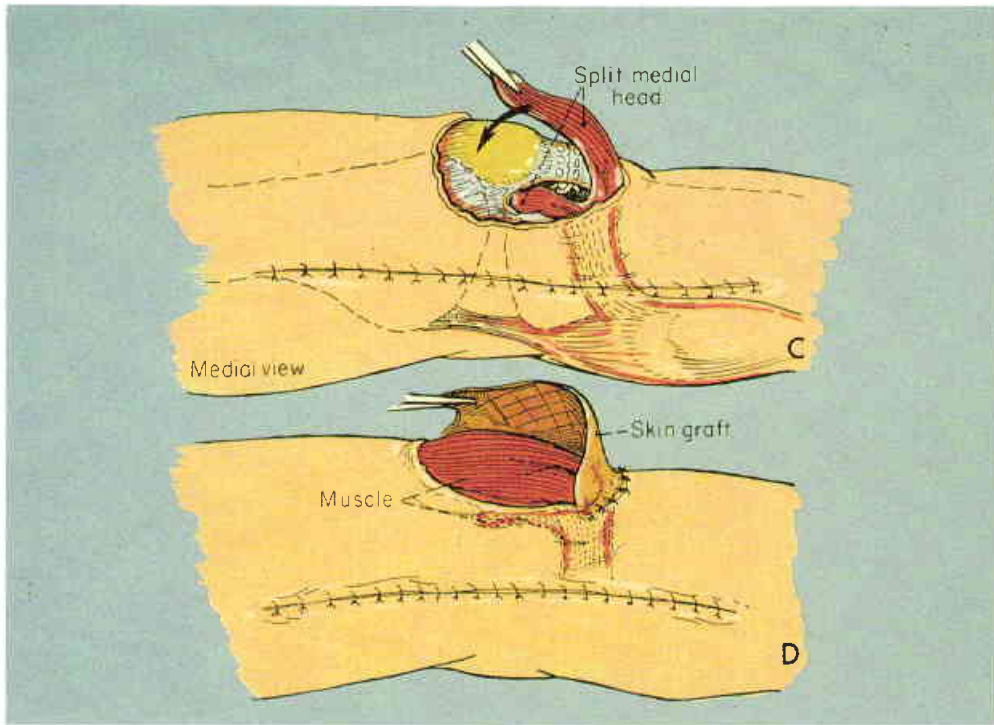
Illustration of the "split" gastrocnemius muscle and the patellar tendon repair.



34

The reconstructed infrapatellar tendon became the "meat" in the sandwich of the "split" medial head of the gastrocnemius muscle.





35

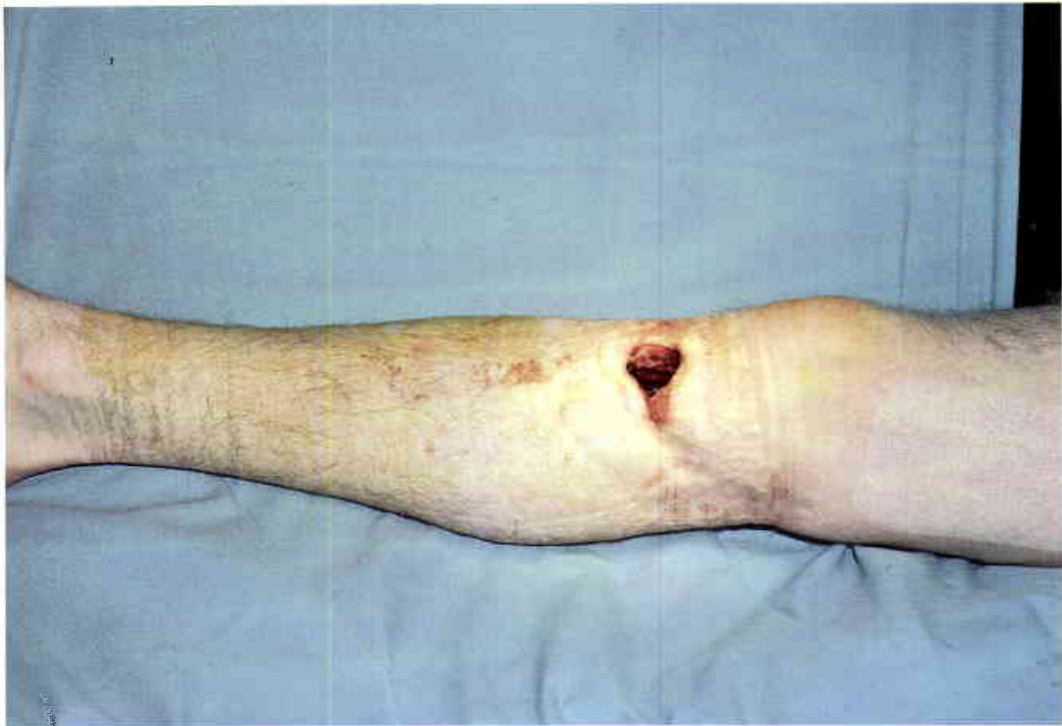
Illustration of the "split" medial gastrocnemius muscle, which surrounds the tendon repair.



36

The wound healed without incident. The active range of motion is demonstrated by this double exposure.



**37**

Osteomyelitis of the proximal tibia in a forty-five-year-old man following a shot-gun injury. There is a small but significant bony defect following the wound debridement. (Case of P.G. Arnold)

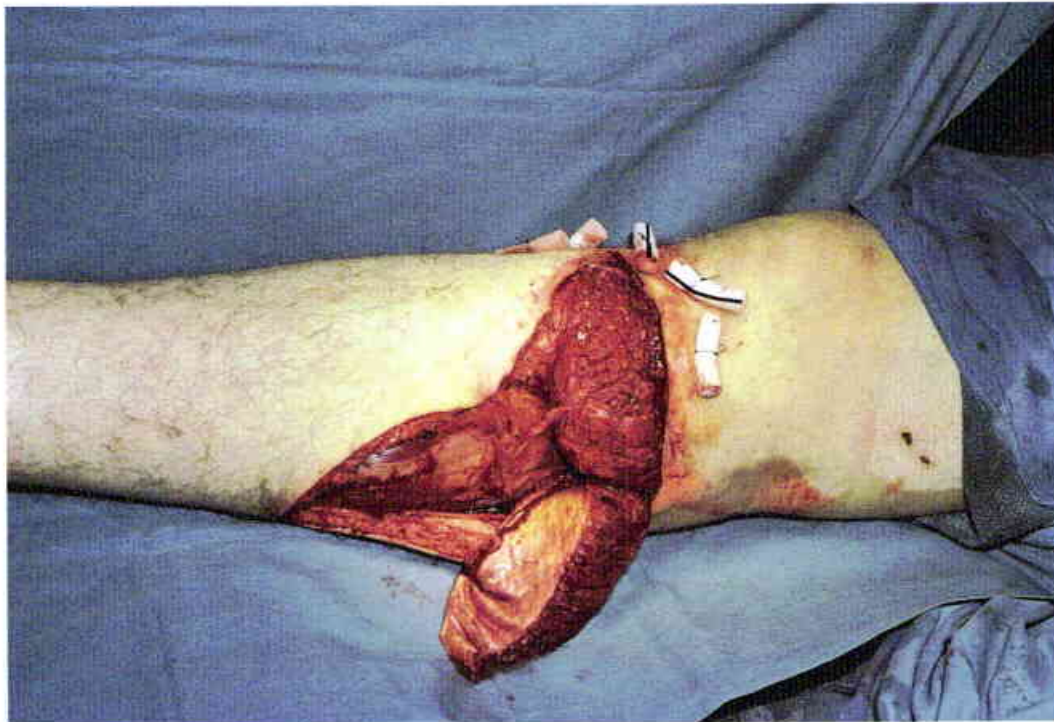
**38**

Tibial defect following the sequestrectomy.



39

The mobilized medial head of the gastrocnemius muscle is clearly too large to fit the circumscribed pretibial bony defect.



40

The medial head was "split" into two segments. Only part of the muscle was needed for the bony defect. The remaining gastrocnemius muscle was returned to the donor site.



41

The gastrocnemius muscle flap was initially trimmed to improve the contour. Appearance of the transposed muscle flap at the time of skin grafting.



42

Appearance at six months. The patient is fully ambulatory, and the wound has remained healed for six years.





43

Twenty-four-year-old man with osteomyelitis of the upper tibia. Note the vertical skin scar just medial to the tibial wound. (Case of P.G. Arnold)

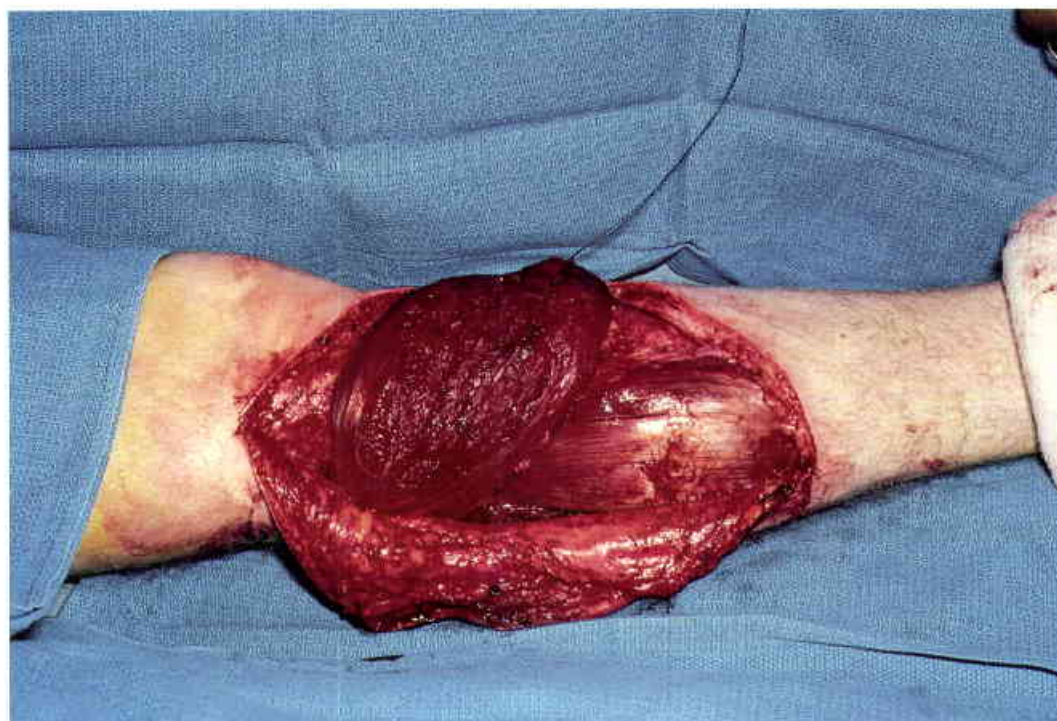


44

The medial head of the gastrocnemius muscle is separated from the underlying soleus muscle and denuded of its muscular fascia. A portion of the distal fascia, which normally attaches to the Achilles tendon mechanism, was retained to hold sutures.



45  
Elevated medial gastrocnemius muscle flap. The deep muscle fascia has also been removed.



46  
Gastrocnemius medial head transposed over the pretibial defect. The soleus muscle is seen beneath the gastrocnemius muscle.





47

The muscle was sutured into place with through and through sutures tied over cotton rolls. The muscle flap was skin grafted two days later.



48

Appearance of the wound at six weeks. The wound has remained healed for four years.

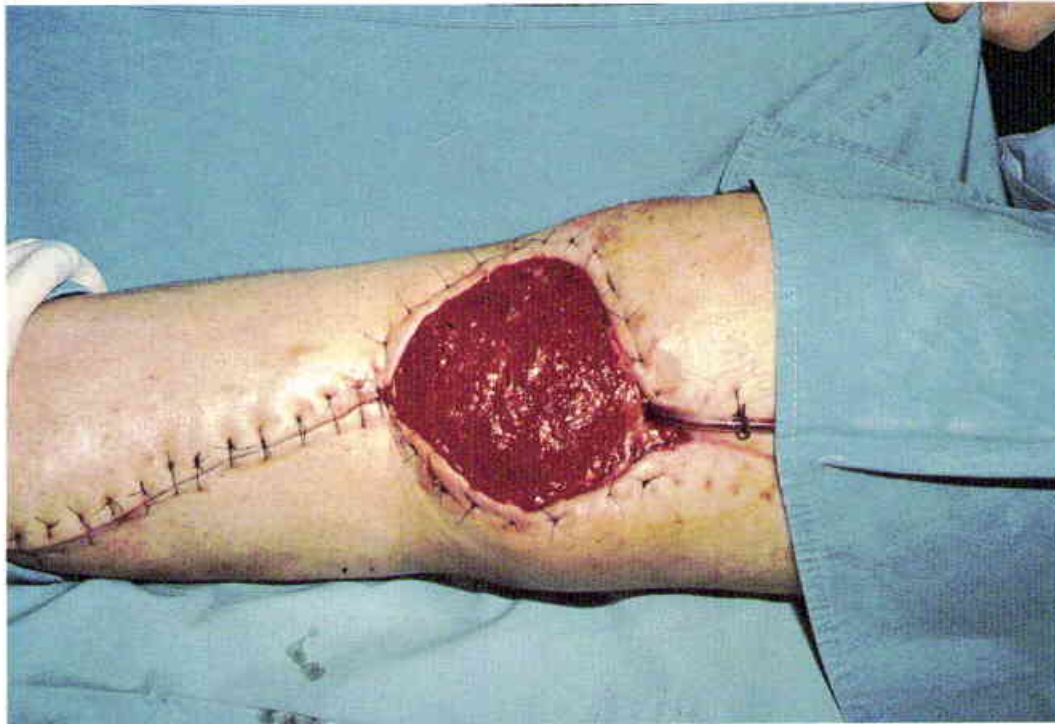


**49**

This giant cell tumor of the upper tibia was treated by curettage and immediate bone grafting. The wound became acutely infected and the bone grafts were lost. (Case of P.G. Arnold)

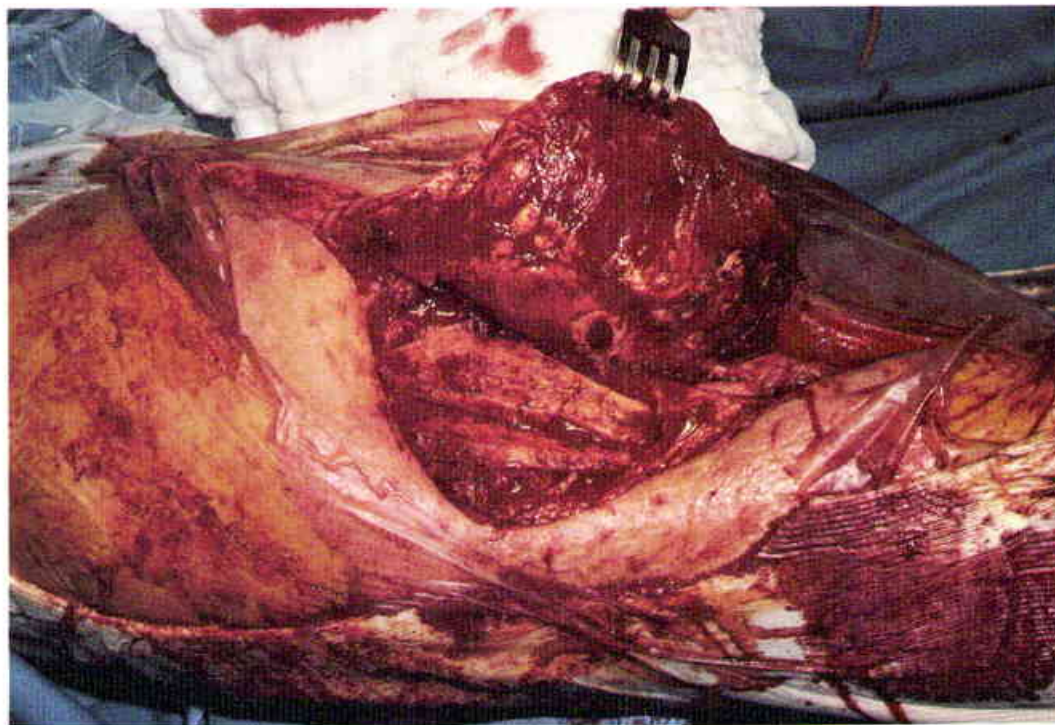
**50**

X-ray appearance of the bony defect of the tibia.



51

The medial head of the gastrocnemius muscle was rotated into the tibial defect. Healing muscle flap at the time of delayed skin grafting.



52

Eight weeks later, the medial gastrocnemius muscle flap was reelevated, and iliac bone grafts were used to fill the tibial cavity.



53

Three years following the secondary bone grafts. The upper tibia was completely reconstituted.



54

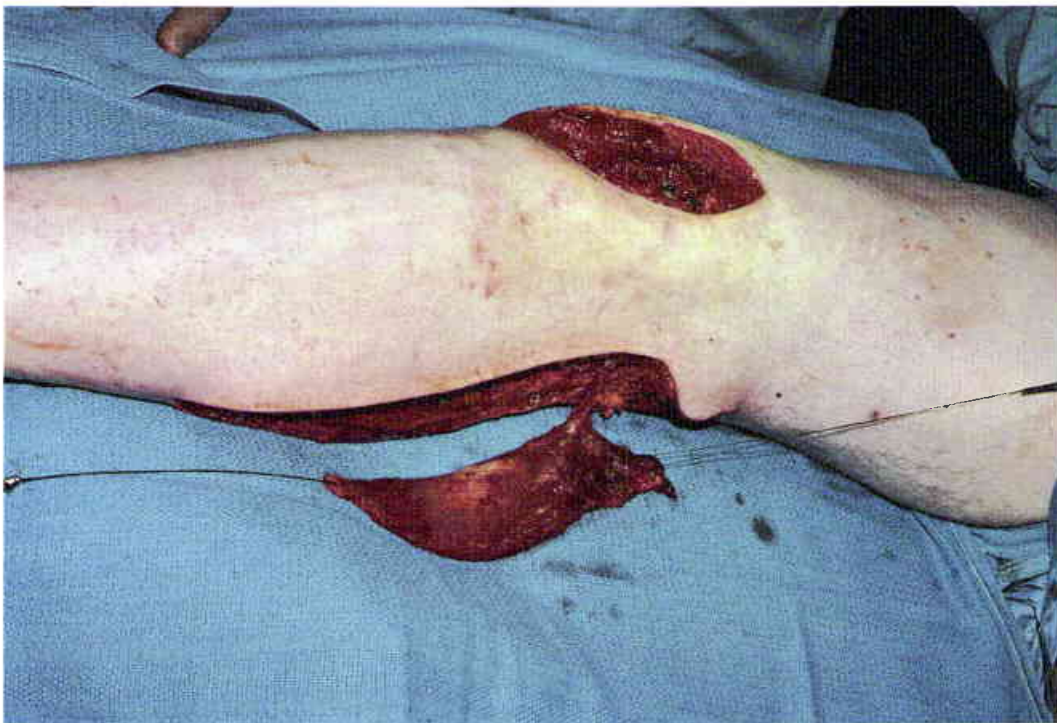
Appearance of the leg at five years. The patient has normal knee motion and is pain free. The reconstruction has remained stable for ten years.





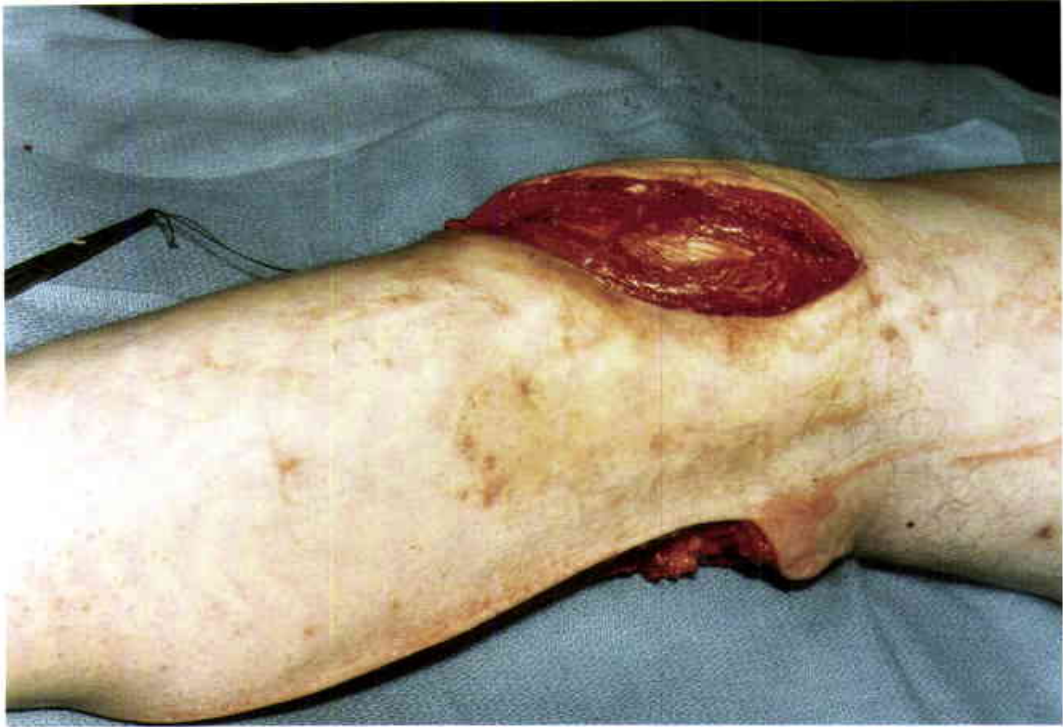
55

Avulsion injury to the anterolateral aspect of the knee. The debridement included the capsule of the knee joint and the lateral stabilizing ligaments. (Case of P.G. Arnold)



56

After the wound was clean, the lateral head of the gastrocnemius muscle was mobilized as a pure "island" muscle flap.

**57**

The lateral head of the gastrocnemius muscle was passed beneath a generous skin bridge and immediately inset. The deep muscular fascia was used to replace the joint capsule and the lateral ligamentous structures of the knee.

**58**

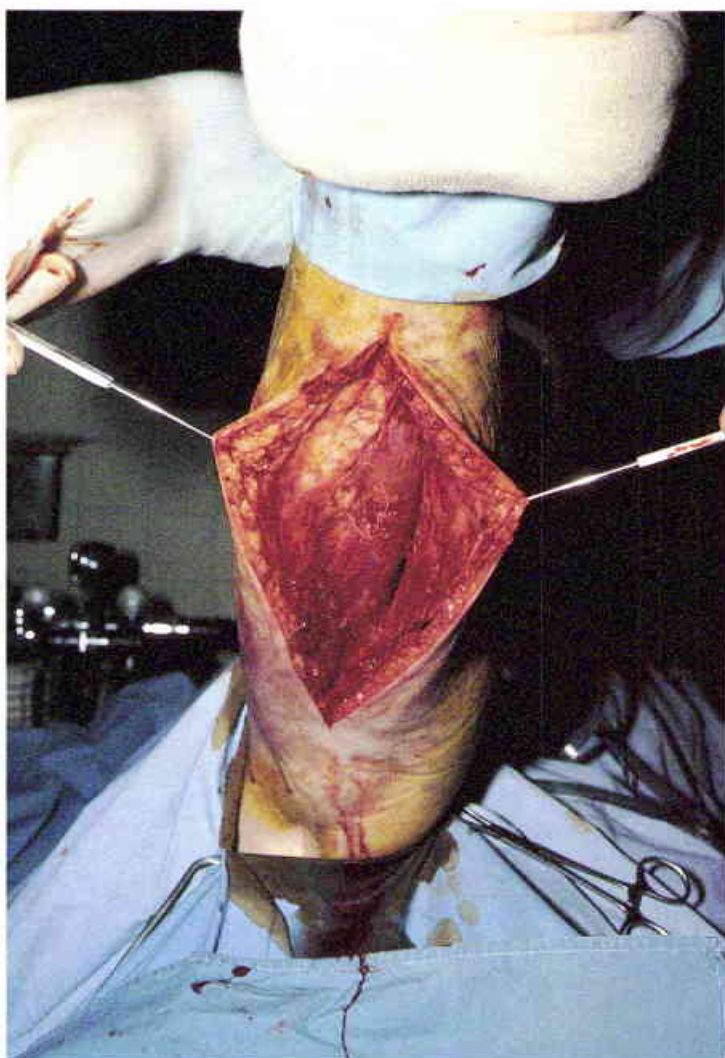
Stable knee joint at six months. The wound has remained healed for six years.





59

Sixty-two-year-old man with long-standing osteomyelitis involving the central two-thirds of the anterior tibia. The pretibial defect was ideally suited for bilateral gastrocnemius advancement flaps. (Case of P.G. Arnold and S. Eisengart)



60

A "stocking-seam" incision was used to separate the two heads of the gastrocnemius muscle, which were left attached to their overlying skin. The deep dissection was carried beneath the gastrocnemius muscle and the deep calf fascia. The bipedicle myocutaneous flaps were finally advanced into the pretibial defect by dividing the gastrocnemius muscular insertion at the Achilles tendon.





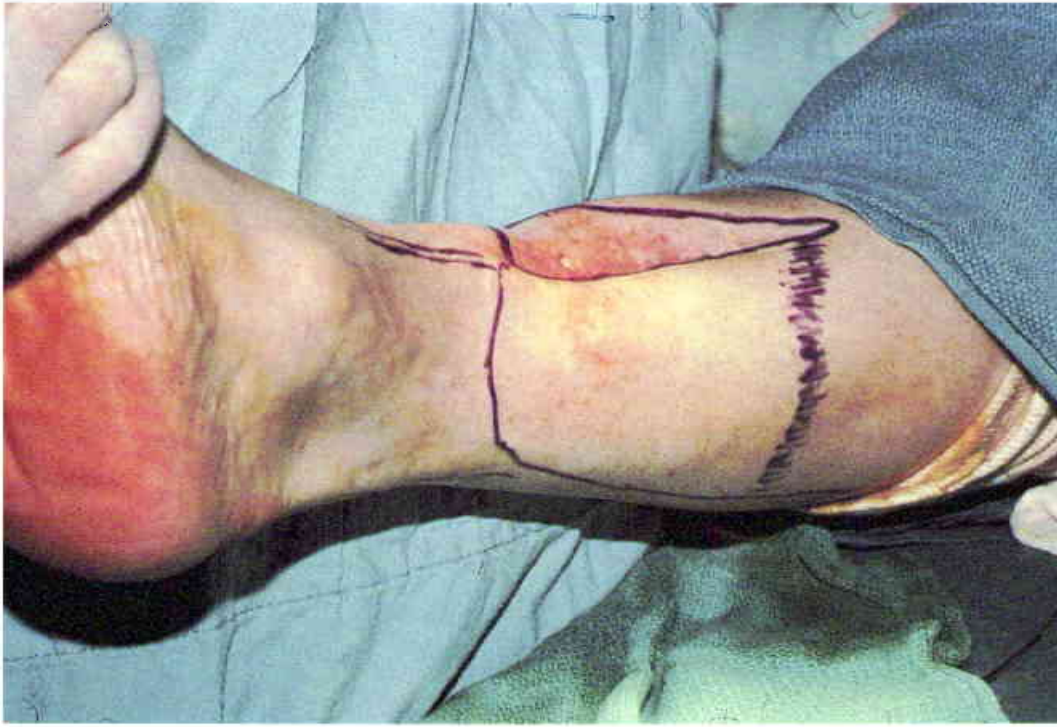
61

Skin-grafted "stocking-seam" donor site. Ambulation was not affected by the anterior transposition of the entire gastrocnemius muscle.



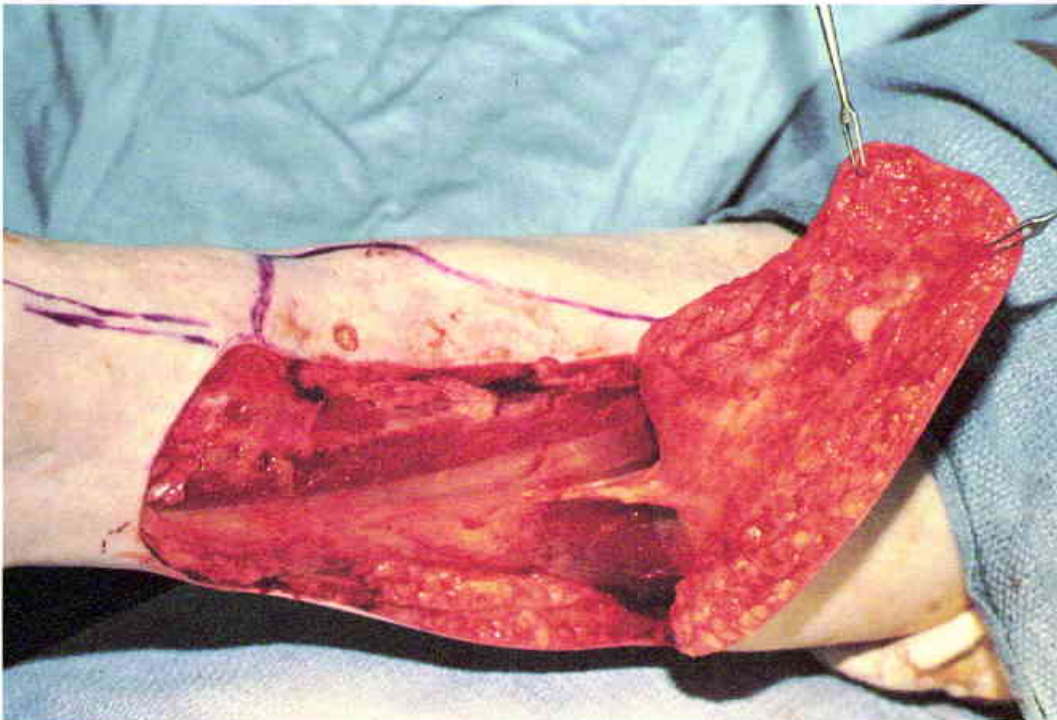
62

The bipedicle gastrocnemius myocutaneous advancement flaps were closed primarily over the pretibial defect. The wound has remained healed for eight years.



63

Minimal pretibial osteomyelitis surrounded by an area of atrophic epithelium in a forty-five-year-old female. A medial gastrocnemius fasciocutaneous flap is outlined. (Case of J.B. McCraw)



64

The fasciocutaneous flap is elevated away from the underlying soleus muscle but left completely attached to the medial head of the gastrocnemius muscle. Note the prominent vessel passing from the gastrocnemius muscle to the fasciocutaneous flap.

**65**

Anterior view of the low pretibial flap coverage.

**66**

Medial view of the transposed flap. Although the appearance of the skin-grafted donor site is not good, it is smaller than the pretibial defect which was repaired.



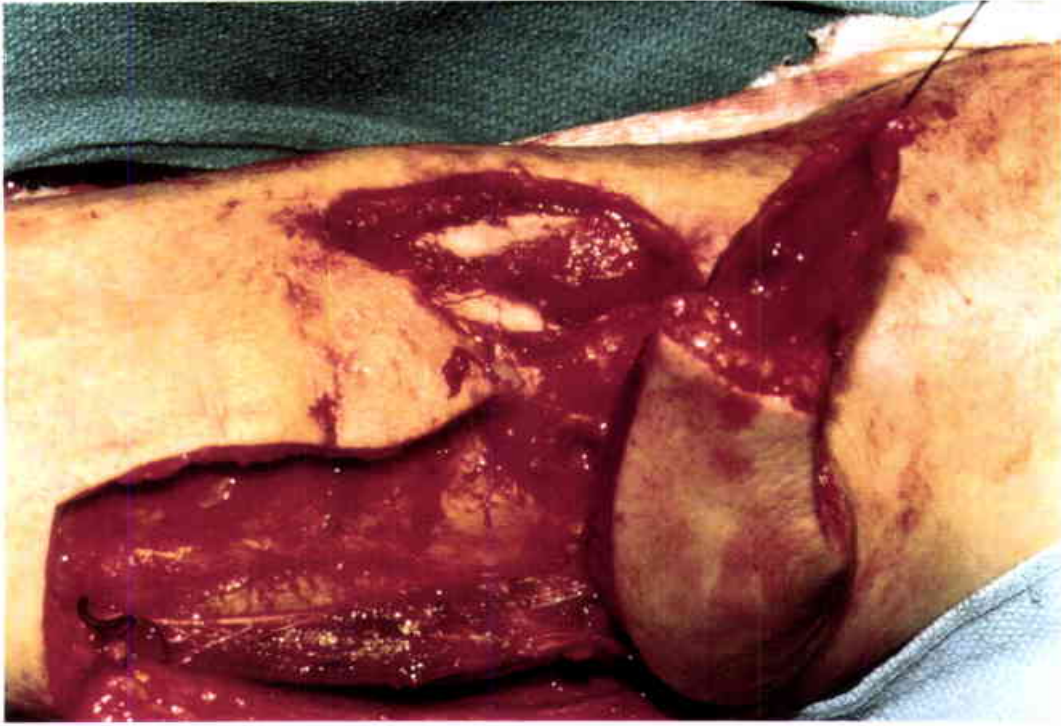
67

Nineteen-year-old man who sustained a shotgun wound at close range in a hunting accident. The tibial osteomyelitis went untreated for a period of six months. (Case of J.B. McCraw)



68

A small medial gastrocnemius myocutaneous flap is outlined. The cutaneous segment was included so the pellet-filled skin could be replaced at the time of the bony debridement.



69

The medial head of the gastrocnemius muscle was "split" and tailored to fit the tibial defect. The muscle was used to eradicate the bony dead space, and the overlying skin of the flap was used for surface cover.



70

Eighteen months following surgery. The wound has remained healed for nine years. The donor site on the posterior calf is acceptable.

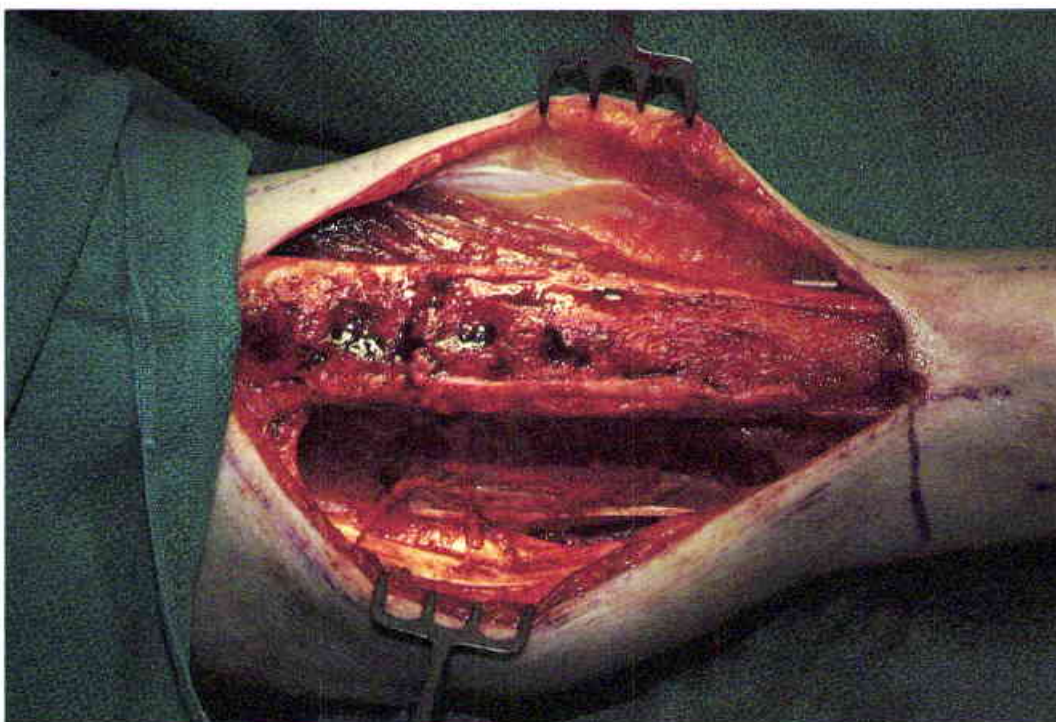




71

Seventy-one-year-old patient with a sixty-nine-year history of osteomyelitis of the central tibia from a systemic staphylococcal infection as a child. The patient was

otherwise healthy and physiologically very young. Bipedicled gastrocnemius myocutaneous flaps are outlined. (Case of J.B. McCraw)



72

Debrided tibia and elevated gastrocnemius myocutaneous flaps. Excellent exposure of the deep surface of both heads of the gastrocnemius muscle was obtained without resorting to a posterior calf incision in this narrow (three centimeter) pretibial defect.





73

Both the medial and lateral gastrocnemius myocutaneous units were advanced to the anterior midline and approximated.



74

This early postoperative view demonstrates a "flap blister" at a point above the medial malleolus, which corresponds to the distal margin of a standard medial gastrocnemius myocutaneous flap. This "watershed" area confirms the distal limits of the superiorly based flap, even when it is employed as a bipedicle flap.



75

Lateral view at eight years. The osteomyelitis has not recurred and the patient is able to ambulate normally.



76

Anterior view at eight years. This type of closure offers a truly esthetic result without harming the leg function.





77

Fifty-six-year-old man who developed a wound breakdown in the mid-pretibial area and the ankle, following a Gortex<sup>®</sup> bypass graft to the posterior tibial artery. The Gortex<sup>®</sup> graft is exposed in the mid-

calf but not in the ankle area. An above-knee amputation would have been necessary if the exposed vascular graft could not have been salvaged. (Case of J.B. McCraw and R.T. Gregory, Jr.)



78

Arteriogram of the Gortex<sup>®</sup> graft and the posterior tibial artery runoff. No trifurcation vessels were identified by arteriography. This finding is discomforting, but it does not necessarily mean that the gastrocnemius muscle cannot be elevated as a muscle flap.





79

Medial gastrocnemius myocutaneous flap elevated to cover the Gortex<sup>®</sup> graft in the midcalf. The ankle wound was skin grafted since the Gortex<sup>®</sup> graft was not exposed in this area.



80

Healed flap and skin-grafted donor site at one year. Note the areas of depigmentation in the flap which represent second degree loss of skin from postoperative papaverine treatment. Papaverine protects muscle at the expense of skin by closing down the muscular perforators to the skin. The patient returned to work as a mechanic.





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