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Harvesting Large Fascia Lata Sheaths: A Rational Approach

ABSTRACT—This article describes an "S"-shaped incision for the open approach of harvesting wide sheets of fascia lata with reference to the important anatomical landmarks. Forty-three patients required dural replacement in cases of tumors, trauma, or cerebrospinal fluid leak involving the anterior skull base. The extended anterior subcranial approach to the skull base was used for all patients. Early functional status of the operated limb in seven of the patients treated first was assessed by physical examination and then by means of the computerized Kinetic Communicator (Kin-Com; Medex Diagnostics, Canada) dynamometer. None of these patients suffered any significant immediate complications and had good results at the preliminary functional assessment. All other patients were evaluated clinically for functional deficits of the operated lower limb to further assess its morbidity. The technique described herein was shown to enhance the ease and control of fascia lata harvesting. It affords low complication rate and donor limb morbidity. Donor limb morbidity did not have any deleterious effect on the patients' normal daily activities and only became apparent during strenuous physical activity.

Allogeneic grafts and other synthetic materials have been successfully used in dural grafting procedures. However, autologous resources including temporoparietal fascia, pericranium, peritoneum, and fascia lata provide an optimal substitute.[1] The use of fascia lata is the source of choice especially when ample tissue is needed. Despite its widespread application, we are aware of only one publication in which the procedure has been outlined in detail.[2] We have devised an orderly approach to the harvesting of large fascia lata sheaths that is now being used routinely by our interdisciplinary team.

Since 1993, we have favored the subcranial approach to the antero-median skull base in cases of tumor extirpation, combined fronto-naso-orbital and skull base fractures, and in cases of recurrent cerebrospinal fluid (CSF) fistula repair.[3] This is a versatile approach that allows a broad exposure to the entire anterior skull base from the ethmoidal labyrinth roof to the clivus medially and to both orbital roofs laterally. This surgical technique was initially described by Raveh et al[4–6] and is being implemented for brain tumors and head trauma. The dura overlying the lesion is resected as part of the procedure for skull base tumors. Multiple dural tears are frequently observed in cases of high velocity trauma when fronto-naso-orbital fractures involve the skull base. Thus, a reliable water-tight reconstruction of the anterior skull base is mandatory in these cases and this is consistently achieved through fascia lata grafting (Fig. 1).

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Figure 1. Immediate postoperative CT scan of a patient who underwent the extended subcranial approach for traumatic extensive fronto-naso-orbital fracture repair. Note the large fascia lata sheath (arrow) overlying the brain with a Gelfoam patch on top (gray zone). Note also the re-aligned fronto-orbital bony segment in front.

ANATOMY

The lower extremity is circumferentially encased and reinforced by the connective layers and septae, that is, the superficial and deep fascial system and the crural septae. The superficial fascial system has a thin single layer or multiple fascial layers anchored to the dermis and the deep fascia by a network of thin septae. The superficial fascia is adherent to the iliac crest and gluteal fascia in males and females, respectively, and tends to be prominent posteriorly.[7]

The fascia lata or the deep fascia of the thigh includes the thigh from the superior margins of the bony pelvis to the knee joint. The fascia gives rise to three thickened intermuscular septa that define the thigh's compartments and through which it is anchored to the femur. The fascia is thickest laterally and proximally and thinnest at the medial thigh. Laterally, the fascia is thickened and forms a thick band, the iliotibial tract. Aside from enveloping and anchoring the tensor fascia lata and the gluteus maximus muscles to insert at the lateral condyle of the tibia, the iliotibial tract is a firm structure and can be regarded as a ligament stretched between the ileum and the tibia. The fascia is thickened also distally around the knee joint, particularly around the iliotibial tract insertion, and is strengthened by transverse fibers originating from the lower parts of the vasti muscles.[8,9]

SURGICAL TECHNIQUE

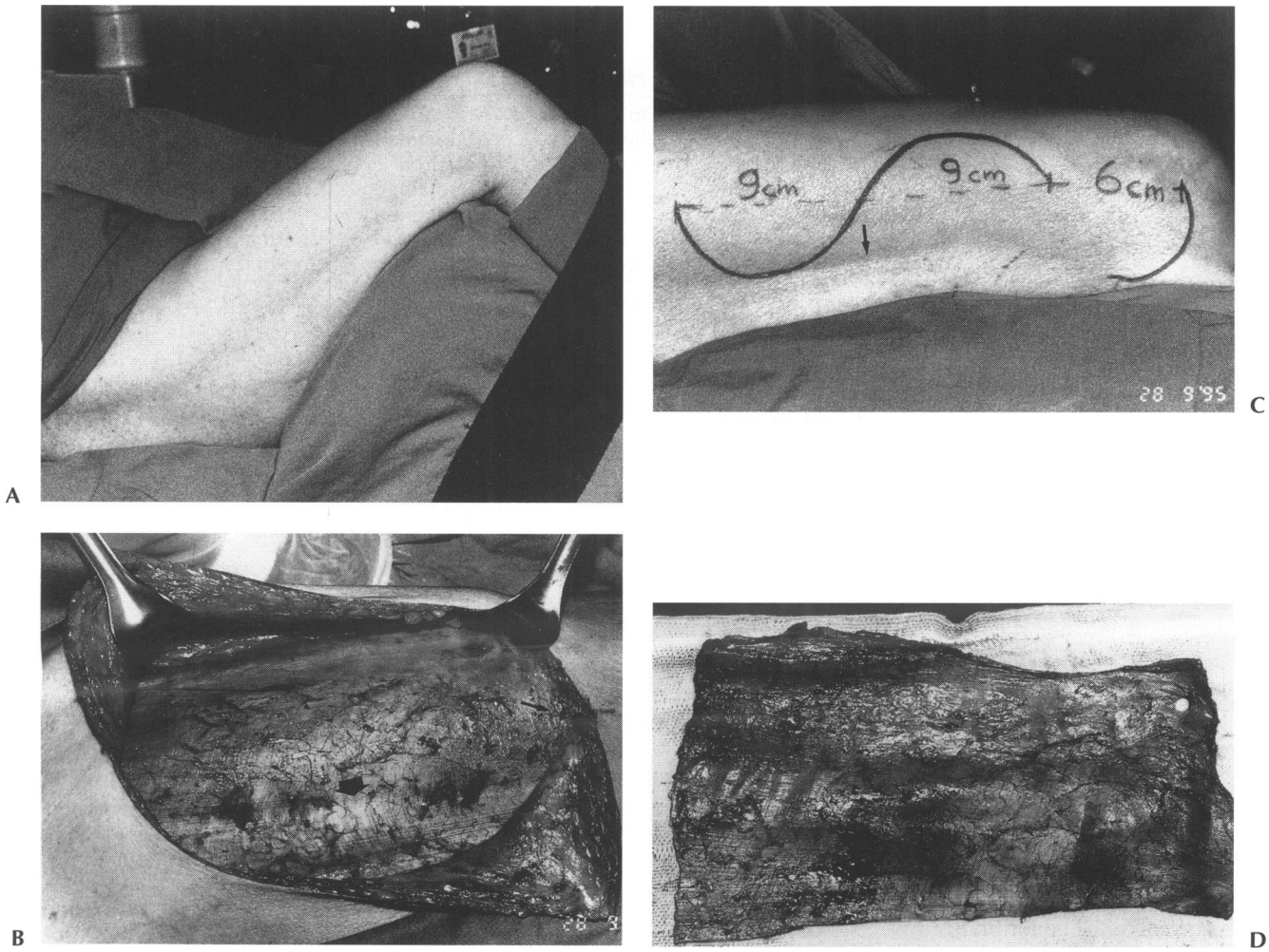
With the patient lying in a supine position, the thigh is flexed to a level that allows knee flexion of 90° while being supported from below with packed drapes. The leg is fixed to the table at 15° adduction of the hip joint. In this position, the fascia tightens while the indentation of the lateral intermuscular septum skin becomes evident, thereby clarifying the donor-site territory (Fig. 2A).

An "S"-shaped incision line is marked 6 cm proximal to the lateral femoral condyle with its axis directed toward the hip joint centered over a mid-lateral thigh line. The proximal peak of the incision line curves posteriorly in apposition with the distal one while both measure 9 to 10 cm at the base and are 4 to 5 cm in amplitude (Fig. 2B). Using this design, the scar, being positioned laterally, is less noticeable. Because a small-sized graft can obviously be harvested through a shorter incision line, it should be drawn anterior to the lateral intermuscular septum and proximal to the lateral femoral condyle similarly centered over the mid-lateral thigh line. Recently, we have elected to use a 10 to 12 cm incision line of 3-cm amplitudes located at 8 to 9 cm proximal to the knee joint. This modified incision enables the harvest of a 10 × 20 cm fascial sheath.

The skin flaps are sharply elevated above the fascia lata and reflected laterally. The sheath is outlined 3 to 4 cm anterior to the lateral intermuscular septum, that is, anterior to the iliotibial tract and 5–6 cm above the knee joint (Fig. 2C). A transverse incision is made through the fascia distally while two-tissue forceps are used to hold and fasten the fascia. The fascial sheath is cut longitudinally with slightly opened tips of scissors by simply pushing them along the fibers. A parallel transverse incision is made proximally upon reaching the desired length of the graft.

Thus, a 20 × 10 cm of fascial sheath can be harvested easily without interfering with the iliotibial tract and the transverse decussating fibers around the knee joint (Fig. 2D). The need for a larger sheath size is met by extending the dissection proximally in the thigh up to the junction of the upper and middle thirds. This landmark corresponds approximately with the distal end of the tensor fascia lata muscle.

After harvesting, the graft is draped with a wet dressing until used. The fascial defect is left unreconstructed, and the skin is closed in layers using subcutaneous interrupted 4/0 Vicryl sutures and skin staples. A vacuum drain is left in place for 24 to 48 hr or until draining less than 25 to 30 cc.



A B C D

Figure 2. Operative sequence of fascia lata harvesting. (**a**) Positioning of the patient's leg, lateral view. (**b**) Incision line marking and measurements on the lateral thigh with relation to the anatomic landmarks. Note the indentation of the lateral intermuscular septum (arrow) and the outline of the lateral femoral condyle (distal curved line). (**c**) Fascial donor-site area showing the ilio-tibial tract (wide arrow) with its thickened and longitudinally oriented fibers and the distal transverse fibers of the fascia at 5–6 cm above the knee joint (narrow arrow). The donor-site area is bordering these anatomical structures in such a way as not to disrupt it, yet the good exposure gained by the incision allows the extension anteriorly and proximally in the thigh. (**d**) Fascia lata graft of 18 × 9 cm after harvesting with its outer surface outward. The hole at the fascia is an opening for a musculo-cutaneous perforator at the distal thigh above the knee joint at the anterior corner of the graft.

PATIENTS AND METHODS

During the 54-month period from 1993 to 1998, 43 patients underwent dural grafting procedures for various etiologies. These included 21 tumor ablations, 18 cases of traumatic and iatrogenic anterior skull base defects, and 4 cases of infectious inflammatory diseases involving the anterior skull base. The extended anterior subcranial approach was performed in all the cases, and large fascia lata sheaths were required for multilayer reconstruction of the dura. The grafts' dimensions varied from 5 × 15 cm to 10 × 20 cm.

A functional study was conducted on 7 patients to evaluate the technique's morbidity of the operated limb. It focused on immediate postoperative complications noted at the time of in-hospital stay and early functional status of the operated limb. The patients' age ranged from 30 to 72 years and they were studied 2 to 10 months following the operation. Five patients were operated for tumor resection and 2 patients needed dural seal due to post-traumatic CSF leak.

Early functional status was studied by physical examination concentrating on physical findings and by the computerized Kinetic Communicator (Kin-Com;

Table 1. Main Findings of the Physical Examination of the Study Patients

No.	Age (y)	F.U.T. (Mo.)	Scar	Pain	Hip ROM	Knee Stabl.	LCNT	Herniation (cm)
1	71	8	normal	0	full	Maintained	normal	0
2	72	9	normal	0	limited	Maintained	normal	+1
3	63	7	adhesion	4	limited	Impaired	abnormal	+5
4	40	7	adhesion	5	full	Maintained	normal	+4
5	63	10	normal	0	full	Maintained	normal	−2
6	52	10	normal	0	full	Maintained	normal	+2
7	30	2	adhesion	2	limited	Maintained	normal	+1

F.U.T. = Follow-up time; Knee Stabl. = knee stability; LCNT = lateral cutaneous nerve of thigh; y = years; and mo. = months.

Medex Diagnostics, Canada) dynamometer to measure muscle strength. The principal physical examinations included evaluation of scar quality (i.e., hypertrophic, atrophic, contracture); local pain evaluation using the Visual Analogue Scale by McGill; hip range of motion (ROM) measurement for extension, adduction (Ober test—iliotibial tightness), and external rotation; knee varus and valgus stress tests and anterior laxity (Lachman test); the lateral cutaneous nerve of thigh (LCNT) test for meralgia paresthetica; and checking for quadriceps muscle herniation (measurements taken at 5, 10, 15, 20, and 25 cm above the lateral femoral condyle with the patient at upright position).

The Kin-Com dynamometer was used to measure the momentum of the quadriceps muscle at concentric and eccentric contractions. All Kin-Com measurements were taken at a 30° angular velocity. The above tests were also applied to the nonoperated limb that served as a control to the donor limb.

The remaining patients were evaluated clinically on serial follow-up visits at the outpatient clinic and the findings were recorded in their charts. The postoperative clinical evaluation focused on the patient's complaints about the donor limb, that is, pain, functional deficit on walking and stair climbing, and cosmesis. Each patient was also examined for scar deformity (i.e., quality and contracture) and tenderness to local touch and pressure, and for any gait limitation.

RESULTS

None of the patients suffered from any immediate postoperative complication except for one case of small wound dehiscence that was attributed to early removal of the skin staples associated with the agitated state of the patient at that time.

The main early postoperative physical findings of the patients included in this functional study are listed in Table 1. Knee stability was found impaired in 1 patient with less than 5° tolerance having been produced at the varus and valgus positions. Discrepancy of lower limb circumference, as a marker to the degree of muscle herniation, was found more than 2 cm in 2 patients and this was regarded as being large and noticeable.

Computerized measurements of the quadriceps muscle power difference by the Kin-Com dynamometer are listed in Table 2. These are represented as the percentage reduction in muscle power. Measurements for muscle power at concentric and eccentric contractions are shown separately. All the donor lower limbs were on the right-hand side.

Due to the small number of patients in this functional study, our results were not analyzed for their statistical significance.

Patients who were not included in the study group were evaluated by the data obtained from their outpatient charts from which subjective or objective findings were retrieved. None of the patients had reported having any functional deficit in carrying out their daily activities or any deformity in the donor limb.

DISCUSSION

Skin incisions that are commonly used for obtaining sheaths of fascia lata can be categorized into three groups; longitudinal, curvilinear, and transverse. The first two approaches require long incisions that run along the lateral aspect of the thigh to allow adequate exposure of the fascia. The curvilinear type incision had

Table 2. Kin-Com Measurements for Quadriceps Muscle Power

No.	Operated Limb	Quadriceps Power Difference* Concentric (%)	Eccentric (%)
1	Rt.	45	8
2	Rt.	7	14
3	Rt.	210	191
4	Rt.	22	17
5	Rt.	2	4
6	Rt.	3	5

*The difference in quadriceps power of the operated limb relative to the nonoperated one is represented in percentages. It was calculated from the Kin-Com dynamometer measurements in Newton-meter units. Kin-Com dynamometer measurements for patient no. 7 were not taken.

also been used as a relatively short one, delineating a semicircular skin flap raised above the fascia.[10] Although they minimize skin involvement, transverse incisions—either as a single lateral mid-thigh approach or two short parallel incisions—require blind dissection, especially when harvesting large sheaths. All three main surgical approaches had been reported to involve various complications, such as hematoma and seroma formations, necrosis at the skin wound edges, pain and paresthesia around the scar, and muscle herniation through the fascial defect. Unfortunately, these reports lack incidence rates.[11–14]

The present "S"-shaped incision line provides good exposure for a well-defined surgical field that conveniently meets large graft size requirements without exerting undue tension on the skin edges. By avoiding blind and blunt dissection, the occurrence of postoperative bleeding is reduced to a minimum while adequate drainage aids in eliminating its accumulation.[12,14] The incision line that is planned with relation to the key structures of the fascia is readily supported with the proposed limb position and landmarks. The iliotibial tract and the peri-articular fascial structures that are left uninterrupted enable the conservation of range of motion and stability of the hip and knee joints.

Only 1 patient had suffered partial wound dehiscence. This followed the early removal of the skin staples while the patient was agitated and disoriented because of his head trauma in addition to improper suturing. The skin staples are usually removed after 10 days and the incision is reinforced with skin tapes. The routine two-layer skin closure was also performed in this case.

The findings on physical examination in the study group were within the normal range for most of the parameters that were investigated except in one case (patient No. 3). This 63-year-old female had a genu valgus deformity that had resulted in gonarthrosis greater in the left knee, thereby causing her to overuse the opposite limb. This premorbid finding can be attributed to the patient's knee instability, although it may not necessarily be the reason for the positive LCNT test. Injury to the distal branches of the lateral cutaneous nerve of the thigh might be the result of either direct injury or adhesion to the underlying scar. Overusing the right lower limb by this patient caused a relative muscular hypertrophy at this side leading to a variance in thigh circumference of more than 4 cm at two levels that was matched by the measurements of muscle power. The functional study conducted by Dubiel and Wigren[11] found a 50% rate ($n = 57$) of large-muscle herniation after harvesting fascia lata, albeit the reference measurements were not given. Large muscle herniation, that is, > 2 cm, was found in 2 (28.5%) patients of our study group; however, this is statistically insignificant. Other noteworthy findings in this study are the slightly limited hip ROM in 3 patients that can be attributed to the scar morbidity in at least two cases.

The isokinetic Kin-Com dynamometer is a substantial aid in the reliable assessment of muscle function because its measurements can be accurately reproduced. The reliability of the Kin-Com is based on controlling the angular velocity of the joint and the external resistance. Comparative measurements of both knee joints that indicate decrement of muscle power on one side can be regarded as being significant if they are 30% or more.[15] By applying this value as the threshold, only one patient was noted to have a significant reduction of 45% in the power of the quadriceps muscle for the concentric torque. Local pain evoked by the tested maneuver also has an inhibitory role in using the muscle at its maximal capability, although this explanation does not apply to the latter case. A certain amount of muscle power reduction that was noted in other patients can be attributed to the partial regeneration the fascia[9,16] that impedes uniform and reproductive muscle contractions opposing an intact fascia. However, for most of the patients in our study group, the fascia lata had already reached its maximal capacity to regenerate after 6 months.[16] Therefore, further improvement in muscle performance can be anticipated with the diminution of local tenderness as the scar matures and the invaluable assistance of physical therapy.

Our main objective in undertaking this study was to establish the technique's morbidity and analyze it. Due to the high cost and inconvenience to most of the patients, we have chosen to limit the number of patients who were recruited to the study group and only use the follow-up data for the others. Although the data we present here are partly based on a small group of patients, we are encouraged to continue using this approach and felt our findings worth reporting.

In conclusion, the technique presented herein for the harvesting of large fascia lata sheaths consistently resulted in a low morbidity rate. Controlled harvesting of large fascia lata sheaths is facilitated by an "S"-shaped incision, and avoids immediate postoperative complications while preserving the important anatomic structures. Careful attention to the location of the donor site results in early minimal functional disability that does not seem to affect the daily lives of the patients.

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