Harvest of Autologous Clavipectoral Fascia for Use in Duraplasty: Cadaveric Feasibility Study

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Abstract: Techniques and materials for repair of dural defects following neurosurgical procedures vary. Given higher complication rates with nonautologous duraplasty materials, most authors strongly recommend autologous grafts. To expand the arsenal of possible materials available to the neurosurgeon, we propose the use of autologous clavipectoral fascia as an alternative donor for duraplasty. Eight embalmed adult cadavers underwent dissection of the pectoral region. A 12-cm curvilinear skin incision was made 2 cm inferior to the nipple in males and along the inferior breast edge in females. Dissection was continued until the clavipectoral fascia was encountered, and a tissue plane was developed between this fascia and the deeper pectoralis major muscle. Sections of clavipectoral fascia were used for duraplasty in the same specimens. In all specimens, removal of clavipectoral fascia was easily performed with tissue separation between the overlying fascia and underlying muscle. Only small adhesions were found between the fascia and underlying muscle, and these were easily transected. No obvious gross neurovascular injuries were identified. Large portions of clavipectoral fascia were available, and at least a 10 × 10-cm piece (average thickness, 1.2 mm) was easily harvested for all specimens. Clavipectoral fascia shares characteristics with materials such as pericranium and fascia lata that have been used successfully in duraplasty, and most importantly, it is autologous. Theoretically, using clavipectoral fascia would reduce the risk of muscle herniation. It offers an alternative source for autologous dural grafting when other sources are unavailable or exhausted. Clinical experience with this fascia is warranted.

Key Words: Duraplasty, dural graft, dural substitute, fascia lata, clavipectoral fascia

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Techniques and materials for repair of dural defects following neurosurgical procedures are varied. A wide variety of materials have been proposed for use in duraplasty including autologous (pericranium, fascia lata, temporalis fascia), nonautologous (dura, placental membranes, fascia, pericardium), xenogenous (bovine and porcine), and synthetic-based grafts. Each of these materials has been associated with its own advantages and complications, and none has been definitively determined as superior for the repair of dural defects. Some proposed characteristics of an ideal graft substance include a lack of inflammatory response or neurotoxicity, lack of adherence to the underlying brain, inexpensive, easily available, and easily sutured so as to provide the possibility for a watertight closure.[1]

Nonautologous dural grafts have been associated with numerous complications including hemorrhage, bacteria and virus transmission, transmission of prion disease such as Creutzfeldt-Jakob disease, foreign body reaction, systemic immune response, excessive scarring, slower healing, premature graft dissolution, and wound dehiscence.[2–4] According to a report on guidelines for preventing Creutzfeldt-Jakob disease spread, issued by the World Health Organization in 1999, the use of cadaveric human dural grafts should be avoided.[5] Given higher complication rates with nonautologous materials for duraplasty, most authors advocate that every attempt should be made to harvest an autologous graft for use in duraplasty.[2]

Theoretically, autologous grafts meet most of the characteristics considered ideal for duraplasty in that they are inexpensive, nontoxic, nonimmunogenic, rapidly integrated into native tissues, flexible, strong, and easily sutured. In an effort to expand the arsenal of possible autologous duraplasty materials available to the neurosurgeon, we propose the concept of using autologous clavipectoral fascia for duraplasty (Fig. 1).

MATERIALS AND METHODS

After placement in the supine position, 8 embalmed adult cadavers underwent dissection of the left (n = 4) and right (n = 4) pectoral regions. Five specimens were male, and 3 were female, with a mean age at death of 47 to 89 years (74 years). An approximately 12-cm curvilinear skin incision was made 2 cm inferior to the nipple in males and along the inferior edge of the breast in females. Dissection was carried down through the tela subcutanea until the clavipectoral fascia was encountered. A tissue plane between this fascia and the deeper pectoralis major muscle was established with blunt dissection. With circumferential skin retraction, sections of clavipectoral fascia were harvested, and the skin closed with sutures. Measurements of harvested fascia were made. Next, depending on the site of clavipectoral fascia harvest, a craniectomy was performed with an oscillating bone saw (half occipital and half frontoparietal craniectomies). The exposed dura mater was opened with scissors, and an approximate 5 × 5-cm piece of dura

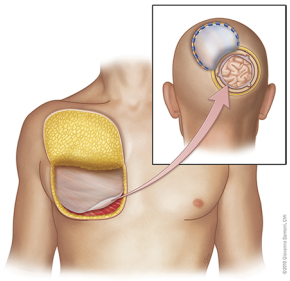

FIGURE 1. Artist's rendition of using the clavipectoral fascia for duraplasty.

FIGURE 3. Figure 2 shown during clavipectoral fascia harvest.

for occipital craniectomies and 10 × 10-cm piece for frontoparietal craniectomies removed. The previously harvested clavipectoral fascia was then used for duraplasty using 5.0 polydioxanone suture.

RESULTS AND DISCUSSION

In all specimens, removal of clavipectoral fascia was easily performed with easy tissue separation between the overlying fascia and underlying muscle (Figs. 2 and 3). Only small adhesions were found between the fascia and underlying muscle, and these were easily transected with dissecting scissors. No obvious gross neurovascular injuries were identified. No specimen was found to have signs of previous surgery or disease to the areas dissected. Following harvest of the clavipectoral fascia, the skin was easily closed. Using a 12-cm curvilinear skin incision, large portions of clavipectoral fascia were available for harvest. Harvesting of at least a 10 × 10-cm piece was achieved for all specimens. The average thickness was 1.2 mm (range, 1–1.5 mm). Duraplasty was performed in each specimen without incident.

Dural closure is essential in most neurosurgical procedures as the dura provides a barrier against superficial infection and prevents both bleeding into the cerebrospinal fluid (CSF) and egress of the CSF into the superficial tissues. There is a growing body of literature to support the use of autologous dural grafts whenever possible.[2,6] The relatively high incidence of complications[3,6,7] related to allogenous and xenogenous dural substitutes has led to the development of numerous synthetic materials for use in duraplasty. Sade et al[1] retrospectively reported a series of 439 meningiomas in which dural repair was completed using the synthetic dural graft DuraGen (Integra LifeSciences, Saint Priest, France) and specifically evaluated each case with respect to complications related to closure technique and/or closure material.[1] The incidences of postoperative CSF leak and graft-related inflammatory infectious complications were 0.4% and 2.3%, respectively.[1] Although the rate of CSF leak seems particularly low, it is important to mention that the majority of these cases were supratentorial craniotomies in which the necessity for achieving a watertight dural closure is controversial. Malliti et al[8] retrospectively compared complications between patients in whom duraplasty was performed with either autologous pericranial graft or Neuro-Patch (a synthetic microporous polyester dural substitute; Aesculap, Inc., Center Valley, PA) and reported an increased incidence of both deep wound infection (15% vs 5%) and CSF leak (13% vs 1.6%) in the Neuro-Patch group as compared with the pericranial graft group. There have also been reports of local inflammatory reactions, effusions, and aseptic/chemical meningitis related to the use of synthetic dural grafts.[9] Tubbs et al[10] reported the use of autologous posterior atlanto-occipital membrane for duraplasty in posterior fossa decompression for Chiari malformations. After a thorough review of the literature for dural substitutes in surgery for Chiari malformations, Abla et al[6] concluded that although definitive data regarding the superior dural graft choice are lacking, when available for harvest, autologous pericranium is associated with decreased rates of aseptic meningitis, wound infections, and pseudomeningocele formation compared with allografts.

FIGURE 2. Cadaveric image noting the skin incision used for clavipectoral fascia harvest.

Thammavaram et al[11] reported 37 cases in which fascia lata was used for duraplasty when there was inadequate regional tissue to repair the dural defect. In their series, no complications were reported in relation to the fascia lata grafting, including CSF leakage, meningitis, and wound infection. Martinez-Lage et al[2] reported a 10.7% incidence of pseudomeningocele formation and a 5.4% incidence of surgical site infection in patients undergoing duraplasty with autologous grafts, including nuchal ligament, pericranium, and temporalis fascia. In their study, no differences were observed between the different types of autologous graft used. Because of the increased rate of graft-related complications, particularly CSF leak in the anterior cranial fossa floor, Gok et al[12] advocated the use of a 3-layer dural repair utilizing both autologous fascia lata and pericranium for repair of dural defects. Fliss et al[13] reported histopathologic examination of fascia lata grafts obtained in patients who have undergone a second procedure and demonstrated integration of vascularized fibrous tissue into the graft.

Although the inherent characteristics of autologous material for duraplasty are nearly ideal, the availability of adequate tissue is widely variable depending on the source. Although convenient and accessible through the primary incision, the supply of available pericranium or temporalis fascia may be inadequate, particularly when the dural defect is large. Conversely, fascia lata can provide a large piece of autologous material for grafting but requires a separate incision and can be associated with regional complications including donor-site infection, pain, scarring, and herniation of muscle through the fascial defect.

Clavipectoral fascia shares many characteristics with other materials such as pericranium and fascia lata that have been used successfully in duraplasty. Most importantly, it is autologous. Histologically, the clavipectoral fascia is composed of undulated collagen fibers and many elastic fibers.[14] Stecco et al[14] concluded that, via the clavipectoral fascia, the pectoralis major and minor

muscles should be considered together as a myofascial unit. We found that the harvest of the clavipectoral fascia was relatively simple with only small adhesions to the underlying pectoralis major muscle. Using a 12-cm curvilinear incision, we were able to harvest at least a 10 × 10-cm piece of clavipectoral fascia. Intuitively, with a longer skin incision, larger pieces could be harvested.

Theoretically, using clavipectoral fascia would reduce the risk of muscle herniation due to the significantly decreased intracompartmental pressure within the pectoral sleeve as compared with the anterolateral thigh. In addition, the need for alternative sources for autologous dural substitutes may arise when other sources such as fascia lata have been exhausted. This may be particularly relevant in those patients undergoing multiple surgeries. Compared with fascia lata grafts, the harvest of clavipectoral fascia would ostensibly have less risk of damaging regional anatomical structures. For example, the fascia lata is near the lateral and anterior femoral cutaneous nerves; the femoral nerve, artery, and vein; the drainage site of the great saphenous vein into the femoral vein; and the superficial and deep inguinal lymph nodes. Moreover, the clavipectoral fascia is closer to the head than the anterior thigh; thus, using it for duraplasty would be more practical.

Lastly, patients who are status post breast augmentation or radical mastectomy or who have hardware in the pectoral region (eg, pacemaker, deep brain stimulator, or vagus nerve stimulator batteries) would not be poor candidates for this procedure because of scar tissue and potential harm to the previously mentioned devices.

Based on our study, the clavipectoral fascia may provide an alternative source of autologous tissue for use in duraplasty when other sources are unavailable. Clinical use of this material is now necessary to confirm our cadaveric findings.

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