Rotator Cuff Repair Augmented With Endogenous Fibrin Clot

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Abstract: Despite recent technical advances, rotator cuff repair continues to have a high retear rate. Recent research focused on biologic augmentation of rotator cuff repair with platelet-rich plasma has shown mixed results, and use of an endogenous fibrin clot from either peripheral blood or bone marrow may have advantages over the use of platelet-rich plasma. This technique describes a method to make an endogenous fibrin clot and arthroscopically apply the fibrin clot to the superior surface of the rotator cuff repair site.

Rotator cuff tears are an increasingly common problem that may cause significant pain and disability. Rotator cuff repair is an appropriate option for many patients; unfortunately, a significant number of these repairs retear in the first 6 months. Various factors, both technical and biologic, have been proposed for this high failure rate. Despite recent technical advancements in rotator cuff repair, the biologic limitations of rotator cuff healing result in persistently high retear rates.[1,2] To overcome these limitations, recent research has focused on the use of platelet-rich plasma (PRP). Platelets contain and release a number of growth factors, including transforming growth factor β, vascular endothelial growth factor, platelet-derived growth factor, basic fibroblast growth factor, and epithelial growth factor. Several in vitro studies indicate that PRP may favorably affect tendon healing by increasing collagen gene expression, increasing the production of growth factors, stimulating type I collagen production, promoting cell proliferation and angiogenesis, and enhancing mesenchymal stem cell production.[3,4] Many recent in vivo studies also indicate that PRP may benefit tendon healing.[5] Results of rotator cuff repairs augmented by PRP have been mixed, with some showing lower retear rates[6] and others showing no change in the retear rate.[7,8] Some concerns regarding the use of PRP include the fact that not all PRP preparation processes are alike, appropriate PRP dosing has not been established, and techniques for applying PRP have not been optimized. Prior studies have also shown that repair of tissues with poor healing capacity can be enhanced with the addition of an endogenous fibrin clot obtained from peripheral blood.[9-11] Fibrin clots are a rich source of platelets and, thus, platelet-derived growth factor, which has been shown to aid in tendon healing.[12] A fibrin clot, however, is much more than just a source of platelets. It also serves as a source and reservoir of growth factors, provides a scaffold for cell migration and proliferation, and modulates cell function.[13] Fibrin also has the ability to bind blood-borne matrix proteins such as fibronectin, vitronectin, and thrombospondin, further enhancing the clot's ability to support the healing response.[14] Thus using a fibrin clot at the rotator cuff repair site may biologically affect the healing process in a much broader fashion than the simple application of PRP. One additional benefit of a fibrin clot is that if properly prepared, covalent cross-linking of the fibrin fibrils occurs, imparting structural integrity such that the clot readily holds suture. Recent interest has also been directed toward the use of mesenchymal stem cells from bone marrow to aid tendon healing,[15] and bone marrow may also be used to make a fibrin clot. This article describes a technique for

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making an endogenous fibrin clot from either peripheral blood or humeral head bone marrow and for application of the fibrin clot to the superior surface of the rotator cuff repair site.

TECHNIQUE

The patient is prepared in routine fashion for arthroscopic rotator cuff repair. Simultaneously, 30 mL of the patient's blood is obtained through venipuncture by the anesthesiologist and placed into a sterile fibrin clot–forming container (ClotMaster Hula Cup; Pierce Surgical, Stowe, VT). Alternatively, 30 mL of bone marrow can be aspirated from the anchor tunnel in the humeral head and the aspirate placed into the same sterile fibrin clot–forming container. The container cover is then placed on top of the cup with the sintered glass cylinder in the fully depressed position such that it is in contact with the bottom of the cup. A surgical technician then swirls the cup in a circular fashion for 10 minutes (Video 1). A fibrin clot will form around the cylinder, leaving the platelet-poor plasma in the cup. The fibrin clot is then kept in the cup until needed. After diagnostic arthroscopy and associated arthroscopic surgery, the rotator cuff is mobilized as necessary. The greater tuberosity is then debrided but not decorticated. Before repair of the rotator cuff is performed, 2 No. 0 Vicryl sutures (Ethicon, Somerville, NJ) that will be used to dock the clot are passed across the cuff tear in simple fashion with a suture passer (Scorpion; Arthrex, Naples, FL) such that 1 suture is in the anterior aspect of the tear and 1 in the posterior aspect. Both ends of the docking sutures are then passed out through anterior and posterior portals, respectively (Video 1). The rotator cuff is repaired to the tuberosity by use of triple-loaded 5.5 mm polyetheretherketone suture anchors (Parcus Medical, Sturgeon Bay, WI). This will leave 1 strand of each of the No. 0 Vicryl docking sutures exiting laterally out from under the cuff at the tendon-bone interface. These 2 docking sutures are brought out through a 10-mm flexible lateral cannula (PassPort Cannula; Arthrex), with care taken so that they are not twisted in the process. The Hula Cup is opened, and the fibrin clot is slid off the glass cylinder; it will have a doughnut configuration (Fig 1). The doughnut is flattened, and one of the No. 0 Vicryl docking sutures is tied to one end of the fibrin clot strand by use of multiple square knots whereas the other docking suture is tied to the other end of the fibrin clot (Fig 2). An arthroscopic grasper is then passed down a 5.6-mm metal cannula (Stryker, Kalamazoo, MI) that has a smaller diameter than the diameter of the lateral cannula, and the clot is drawn into the metal cannula in a retrograde fashion. The metal cannula is inserted into the flexible lateral cannula until it is past the fluid dam in the lateral cannula (Video 1). The surgeon then pulls the other end of the clot sutures that are in the anterior and posterior portals, drawing the fibrin clot into the subacromial space (Fig 3) and docking it onto the superior aspect of the tendon-bone repair site (Fig 4). The medial suture ends are brought out through the

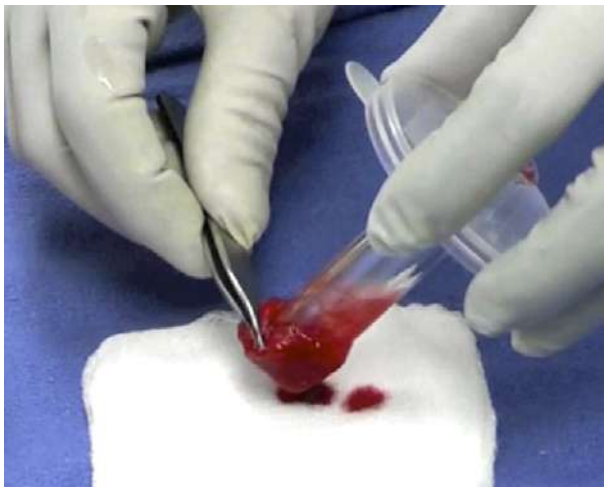

Figure 1. The endogenous fibrin clot ring forms on the sintered glass cylinder after 30 mL of the patient's blood is swirled in the cup for 10 minutes. Forming the fibrin clot in this fashion aligns fibrin and imparts a structural integrity readily allowing for suture fixation.

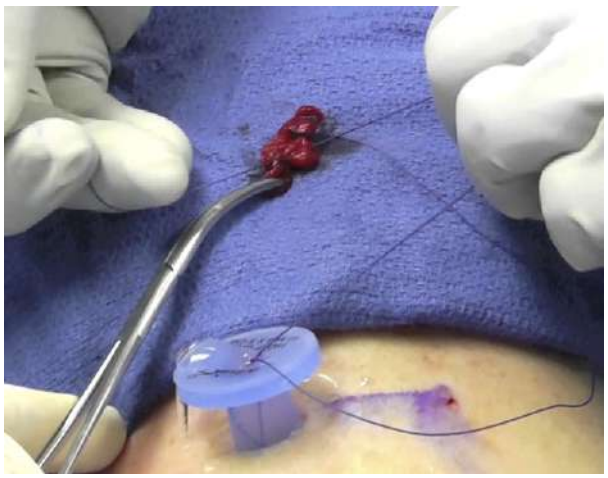

Figure 2. With the patient in the lateral position, the No. 0 Vicryl docking sutures are brought out through the flexible lateral cannula in this right shoulder. The endogenous fibrin clot is tied to the No. 0 Vicryl docking sutures with multiple square knots.

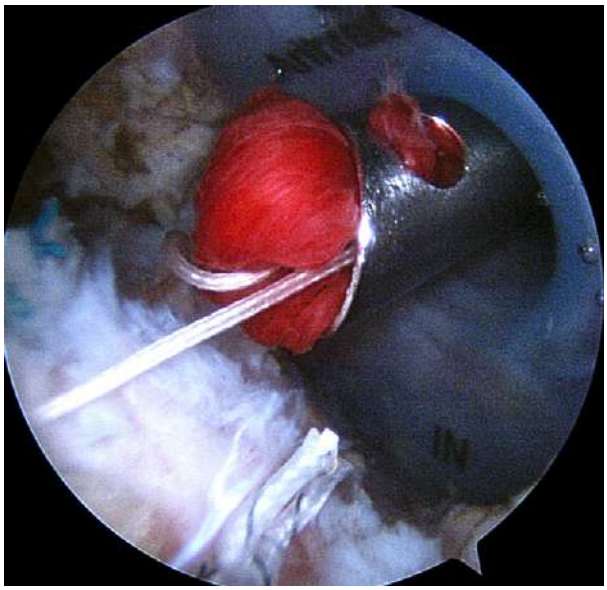

FIGURE 3. With the endogenous fibrin clot secured to the 2 No. 0 Vicryl docking sutures with multiple square knots, the endogenous fibrin clot is first pulled into a metal cannula with an arthroscopic grasper and then passed through the dam of the flexible lateral cannula and into the subacromial space. In this image of a right shoulder with the patient in the lateral position and viewed from the posterior portal, the endogenous clot secured to the No. 0 Vicryl sutures is emerging from the metal cannula that is used to pass the clot through the dam of the flexible lateral cannula.

lateral cannula and tied arthroscopically, thus securing the fibrin clot. This technique docks and secures the fibrin clot all along the superior aspect of the tendon-bone repair interface. The wounds are closed in standard fashion and a dry sterile dressing and sling applied. Postoperative rehabilitation follows normal rotator cuff protocols.

DISCUSSION

Rotator cuff repair is a common procedure that continues to have a high retear rate despite technical advances in performing the repair. With the hope of addressing this high failure rate, recent interest has focused on augmenting the biologic repair process with PRP. Despite in vitro studies showing that PRP does favorably affect many aspects of tendon healing, the results of in vivo studies have been mixed. There may be many reasons for this, potentially including differences in the preparation process of PRP and the fact that appropriate PRP dosing has not been established and techniques for applying PRP have not been optimized. Use of endogenous fibrin clots has also been shown to enhance the biologic repair process of tissues, and use of an endogenous fibrin clot prepared from either peripheral blood or bone marrow to augment rotator cuff repair may have advantages over the simple application of PRP. The fibrin clot is not only rich in platelets but also intrinsically serves as a source and reservoir of growth factors, provides a scaffold for cell migration and proliferation, and modulates cell function. In addition to these biologic advantages, a fibrin clot has structural integrity that enables it to be sutured into place at the site of the rotator cuff repair; moreover, making a fibrin clot in the operating room is quick and relatively inexpensive. Thus using an endogenous fibrin clot to augment rotator cuff repair not only has the advantages of being reproducible, quick, and inexpensive but also provides a method of securely fastening the biologic material at the repair site (Table 1). Furthermore, in vitro studies indicate that a fibrin clot may further enhance the healing response when compared with PRP alone. Another advantage of this technique is that the endogenous clot is positioned above the rotator cuff tendon–bone repair interface and not between the tendon and bone and thus will not act as a barrier for the tendon to heal directly to the bone. This

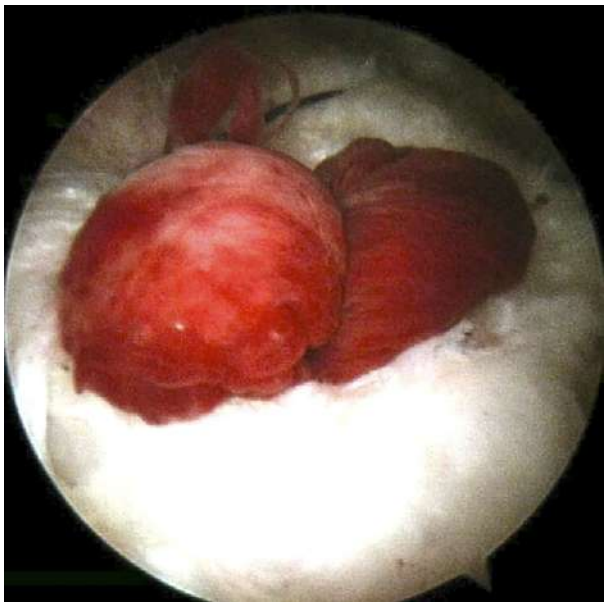

FIGURE 4. Once passed into the subacromial space, the endogenous fibrin clot is "docked" to the superior aspect of the rotator cuff repair at the tendon-bone interface by simultaneously pulling on the ends of the No. 0 Vicryl sutures exiting the anterior and posterior portals, respectively. With the endogenous fibrin clot docked, the ends of the sutures are brought out through the lateral cannula and tied arthroscopically medial to the clot-repair interface. This image of a right shoulder with the patient in the lateral position is viewed from the lateral portal and shows the endogenous fibrin clot docked on the superior aspect of the tendon-bone interface and the sutures tied medially.

Table 1. *Potential Biologic, Technical, and Cost Benefits of Endogenous Fibrin Clot*

Biologic	Technical	Cost
Rich in platelets	Quick and efficient	Inexpensive
Rich in fibrin	Not technically demanding	
Binding to blood-borne matrix proteins	Formulation of clot on operative field with no extra staff	
Structural integrity resulting from fibrin fibril covalent cross-linking	Ability to securely fix clot to repair site	
Possibility of using bone marrow to make clot	No disruption of tendon-bone repair interface	

technique, like PRP, has the limitation of not being able to quantify the number of platelets and specific growth factors that are being applied. This technical note describes an efficient technique to prepare an endogenous fibrin clot, prepared from either peripheral blood or humeral head bone marrow, and deliver and secure it to the superior aspect of the rotator cuff–bone repair interface.

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