Technical Note

Ultrasonography-Guided Muscle Hematoma Evacuation

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Abstract: Muscle injuries commonly occur in athletes, and in severe cases, they can result in hematoma formation, leading to pain and loss of function. A technique for minimally invasive ultrasound-guided evacuation of muscle hematoma is presented. A simple and quick outpatient procedure done under local anesthesia for faster muscle recovery provided immediate decompression of the muscle compartment, leading to early return to play.

Muscle injuries have been reported to occur commonly in athletes involved in contact sports, causing pain and limitation of movement and leading to time off from the sport. They can be in the form of muscle contusions, sprains, and strains, which may result in hematoma formation in severe cases. Hematoma formation within the muscle may be intramuscular, intermuscular, or mixed. Intermuscular hematomas appear striking due to visible bruising and swelling, but intramuscular hematomas are considered more serious because as the hematoma enlarges, it occupies space within an intact muscle fascia, creating increased pressure that can lead to decreased muscle contractility, extensibility, and function. Intramuscular hematomas have a greater potential to develop post-traumatic myositis ossificans and fibrosis, and thus it is recommended that intramuscular hematomas be drained.[1]

Current treatment for muscle injury is mainly conservative, consisting of rest, cold packs on the area, elevation, compression, pain medications, and rehabilitation.[2] Other promising treatment modalities such as diathermy, hyperthermia, massage therapy, laser therapy, ultrasound, and extracorporeal shock wave therapy have been used to promote muscle healing.[1] At present, studies on the surgical intervention of muscle contusion are limited and agreement on a gold standard for the management of muscle hematomas has not yet been reached. There is no consensus on the indication and timing of hematoma evacuation, and its benefits for muscle recovery and athletes' return to play are yet to be determined. Myositis ossificans is also one of the complications of muscle hematomas, and it is still not known whether evacuation of muscle hematoma will promote or prevent its formation.

The predicament outlined above led us to manage patients with muscle hematoma with evacuation through a minimally invasive technique. The purpose of this study is to convey a minimally invasive ultrasound-guided technique for muscle hematoma evacuation leading to immediate decompression of the muscle compartment and prevention of further loss of muscle function.

Surgical Technique

A surgical technique for ultrasound-guided evacuation of muscle hematoma is used on athletes who have sustained a muscle contusion. Preoperative ultrasonography is done to show hypoechoic areas that represent the hematoma within the involved muscle (Fig 1). These areas are obliterated significantly after the procedure (Fig 2). The procedure is done as an outpatient procedure.

The patient assumes the supine position with the affected limb elevated by a pillow in the case of quadriceps muscle hematoma. When hamstrings or calf

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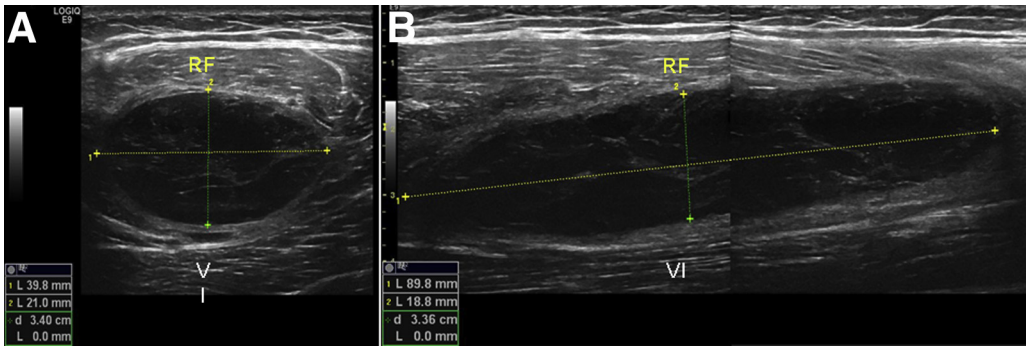

Fig 1. Preoperative ultrasound evaluation of the hematoma. The patient is placed in supine position and the ultrasound probe is placed on the anterolateral aspect of the left thigh. (A) The short-axis view on sonogram shows the hematoma between the rectus femoris (RF) and vastus intermedius (VI) with a diameter of 39.0 mm. (B) The long-axis view shows the hematoma with a diameter of 89.8 mm.

muscles are affected, patients should be in the prone position with the affected limb lifted to obtain enough working space for the control of an arthroscopic shaver. A 4.5 mm diameter arthroscopic shaver (Torpedo shaver; Arthrex, Naples, FL) 15-MHz linear probe (GE LOGIQ E9), and 11-MHz linear probe (Sonosite M-Turbo) are used. Diagnostic ultrasonography on the affected area is done to evaluate the extent of hematoma on the longitudinal and short-axis views (Fig 1 and Video 1). The surgeon should be in line with the patient's limb, probe, and ultrasound monitor (Fig 3A). The ultrasound probe is placed on a short axis (or transverse plane) of the affected limb rather than on a long axis (or sagittal plane) of the limb to align the shaver close to parallel with the long axis of the probe; visualization of the tip of the shaver can be better facilitated by this in-plane approach (Fig 3 B, C).

Infiltration of local anesthetic not only into skin and subcutaneous tissues but into the epimysium if possible is done after estimating the optimal depth of the insertion point of the needle under ultrasound guidance (Fig 4 A, B). A small incision is made using a stab knife with surgical blade 11. Dilation of the soft tissue is done using forceps (Fig 4C). A 4.5 mm diameter arthroscopic shaver is then introduced under ultrasound guidance to the center of the hematoma. The hematoma is removed using the shaver under ultrasound guidance so that the surrounding muscle tissues and neurovascular structures can be avoided (Fig 5 A, B). After removal of the hematoma at its center, the tip of the shaver is carried to the peripheral part of the hematoma and removal of the remaining hematoma is performed. A milking maneuver is added to aid in the complete evacuation of the hematoma (Fig 5C). Ultrasonography is used to ensure adequate removal of the hematoma. The hypoechoic areas are significantly reduced and almost completely removed as shown on short- and long-axis views (Fig 2).

No immobilization is required postoperatively, and the patients are allowed full range of motion and weight bearing as tolerated. Physical therapy is started thereafter.

Advantages

With ultrasound guidance, the complete removal of the hematoma was ensured without causing iatrogenic damage to the muscle and neurovascular structures. This technique is a quick, minimally invasive outpatient

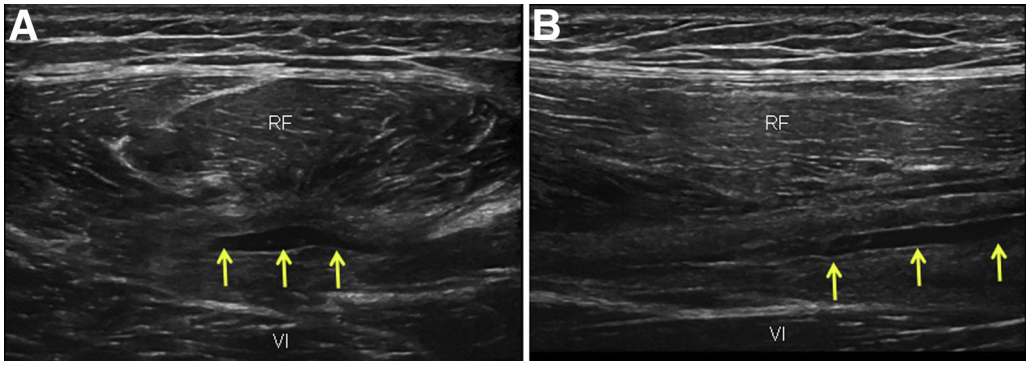

Fig 2. Postoperative ultrasound evaluation of the hematoma. (A) Short-axis view of residual hematoma (yellow arrows), rectus femoris (RF), and vastus intermedius (VI). Almost all of the hematoma was evacuated. (B) Long-axis view of residual hematoma (yellow arrows), RF, and VI. Almost all of the hematoma was evacuated.

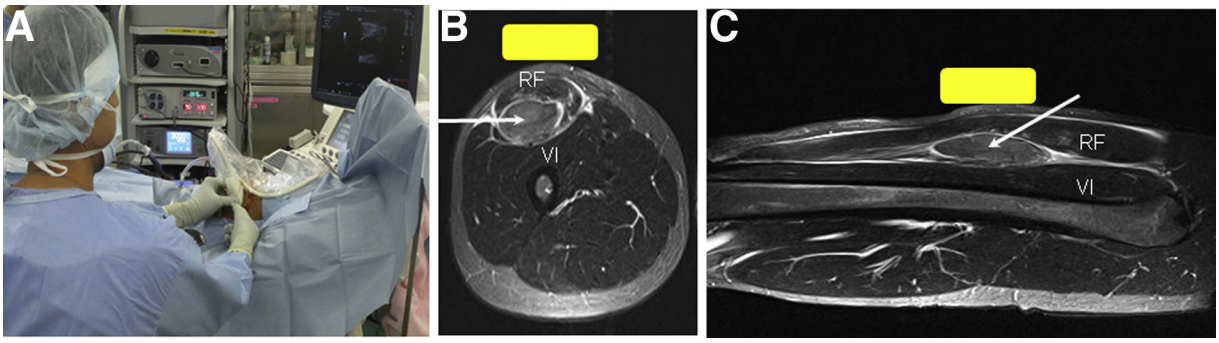

Fig 3. Operative setting of ultrasonography-guided muscle hematoma evacuation. (A) Surgeon, ultrasound (US) probe, affected limb (left thigh), and US monitor were in line with each other. (B) The US probe (yellow square) was placed on the axial plane of the hematoma and rectus femoris (RF) and vastus intermedius (VI). This in-plane approach to the hematoma is easier because the needle (white arrow) can be visualized parallel with the US probe. (C) If the US probe (yellow square) is put on the sagittal plane of hematoma, RF and VI, visualization of the needle is more difficult because the needle is not parallel to the US probe.

procedure using a 1-cm incision under local anesthesia providing immediate decompression of the muscle compartment for faster muscle recovery (Table 1).

Disadvantages

The technique demands skill in handling the ultrasound machine and the shaver to ensure a safe procedure. Moreover, in the presence of active bleeding, hemostasis is not possible with this technique.

Discussion

Muscle injuries are commonly treated conservatively; however, a concrete consensus and gold standard for the management of such injuries has still not been developed. In this study, muscle injury with hematoma formation was treated by evacuation, wherein visualization of the hematoma was done with a sonogram making use of a 1-cm incision as the working portal and a shaver to break down the consolidated hematoma. This procedure was a minimally invasive technique done for immediate decompression, immediate weight bearing, and rehabilitation.

Ultrasonography is a useful multifaceted tool that can aid numerous surgical procedures with more emphasis on minimally invasive surgery. Ultrasound-guided percutaneous release of the A1 pulley had a 93.75% success rate with fewer absences from work and better cosmetic results.[3] Minimally invasive, ultrasound-guided percutaneous carpal tunnel release surgery resulted in significant decrease in symptoms, complete section of transverse carpal ligament, and nerve decompression with no complications.[4]

Our surgical procedure was based on the principles of ultrasound-guided interventions, which commonly use 18 to 20 gauge needles.[5] However, for consolidated hematomas a small-bore needle will not suffice. Thus, we used a shaver instead to be able to adequately remove the hematoma. Similarly, a case report done by Rakovac et al.[6] used the cello technique on Haglund deformity of the calcaneus wherein ultrasound-guided

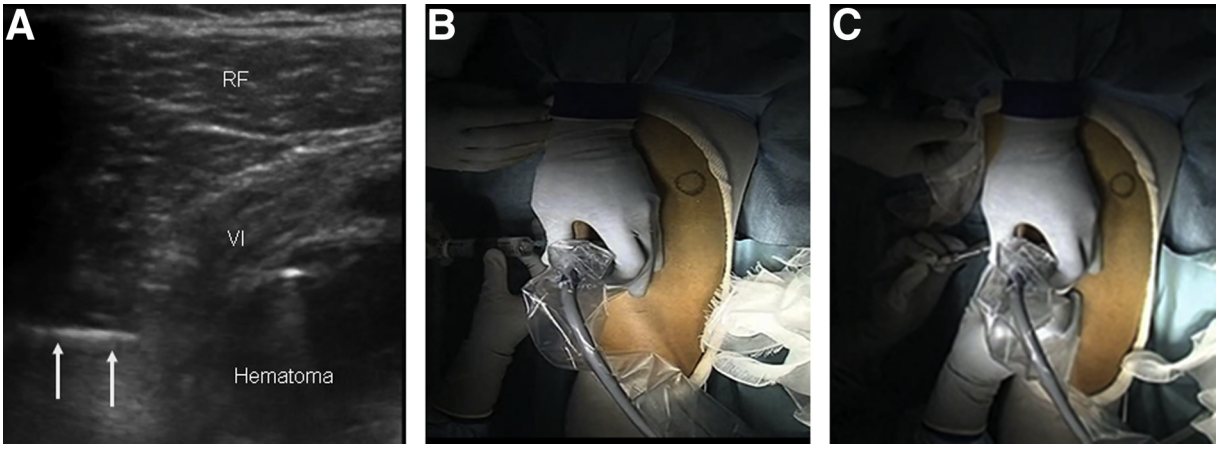

Fig 4. Preparation of ultrasonography-guided muscle hematoma evacuation. (A) Local anesthesia on the right thigh is performed. The needle is visualized as it goes through the muscle. Rectus femoris (RF) and vastus intermedius (VI) muscles are shown. The optimal depth of the needle (white arrows) is determined on ultrasonography. (B) Infiltration of 2% xylocaine is done. (C) An incision of 1 cm in length and dilation with a mosquito clamp are performed after infiltration of the anesthetic.

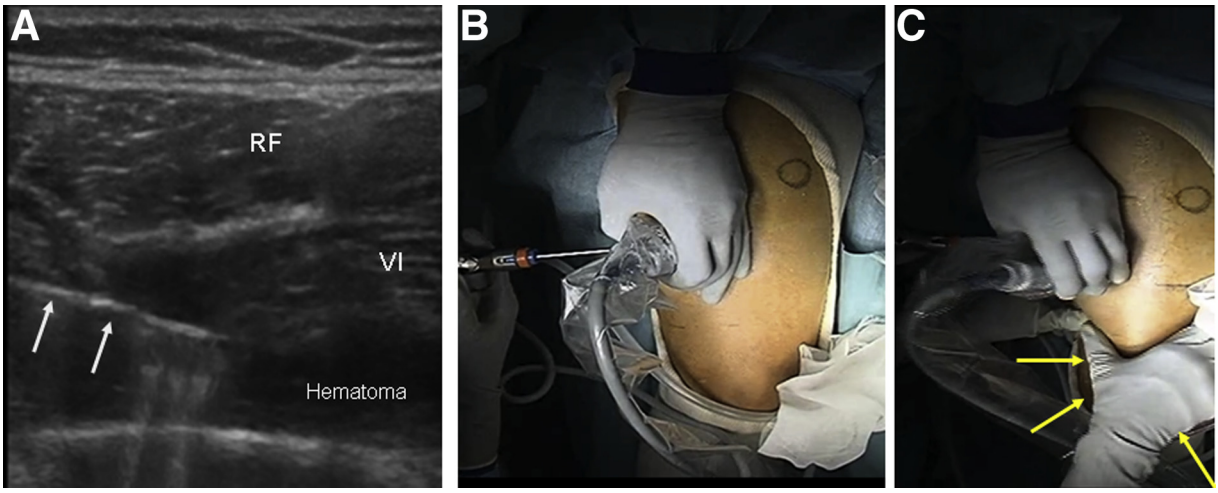

Fig 5. Ultrasonography-guided muscle hematoma evacuation. (A) A shaver (white arrows) is introduced to the right thigh under ultrasound guidance to the center of the hematoma. The surrounding muscle tissues and neurovascular structures are avoided. (RF, rectus femoris; VI, vastus intermedius.) (B) The shaver is kept parallel to the US probe. (C) After removal of the hematoma at its center, the tip of the shaver as well as the US probe are synchronously brought to the peripheral part of the hematoma, and removal of the remaining hematoma is performed. A milking maneuver (yellow arrows) of the hematoma by an assistant is added to aid in the complete evacuation of the hematoma.

resection of the deformity was done using an abrader for bony resection of the calcaneal deformity. The use of ultrasonography in hematoma evacuation was sufficient to avoid the surrounding muscle and neurovascular tissues and to adequately remove the consolidated hematoma, eliminating the need for an endoscope. In comparison, a case series done by Bell and Doumit[7] used liposuction techniques for hematoma evacuation following breast and abdomen surgery under local anesthesia using xylocaine with adrenaline; however, ultrasonography was not used in their cases. Perhaps this mechanism can be used in place of a shaver in our cases; however, ultrasonography was needed for us to examine the adequacy of the hematoma evacuation.

Despite the use of ultrasonography, the location of the hematoma in the muscle compartment was not determined in this study, that is, whether it was intramuscular, intermuscular, or mixed. This technique was not applied for patients who developed compartment syndrome due to hematoma formations or for patients with bleeding disorders, and the benefit of a minimally invasive hematoma evacuation alone in such cases was not determined. It is of utmost importance that the surgeon always visualizes the tip of the shaver, keeping it away from the surrounding muscle and neurovascular tissues. Bleeding occurs once the surrounding tissues are hit with the shaver. In the presence of active bleeding, the negative pressure from the shaver aggravates it. Ultrasonography cannot identify the bleeders; thus, hemostasis is not possible. In addition, the indication for this procedure is limited to subacute cases only (Table 2).

The technique presented was simple and quick; however, familiarity with ultrasonographical visualization of anatomic structures is required to ensure a safe

Table 1. Advantages(vs Open Removal of Hematoma) and Disadvantages of Ultrasound-Guided Hematoma Evacuation

Advantages	Disadvantages
Minimally invasive procedure using a 1-cm incision and a full-radius shaver.	Hemostasis is not possible in the presence of active bleeding.
Performed under local anesthesia.	Surgeon/operator should be skilled in handling the ultrasound machine and shaver.
Can avoid iatrogenic injury to the surrounding neurovasular and muscle tissues.	
Ensure complete removal of the hematoma.	

Table 2. Pearls and Pitfalls of Ultrasound-Guided Hematoma Evacuation

Pearls	Pitfalls
Visualization of the shaver in the in-line approach.	Failure to visualize the tip of the shaver can result in iatrogenic injury to the surrounding neurovascular and muscle tissues.
The shaft of the shaver should be parallel to the probe.	Indication is limited to subacute cases only (>1 week). Bleeding may aggravate in cases of acute injuries.
Check the remaining hematoma by scanning the affected area before ending the procedure.	

and adequate evacuation without damaging the surrounding tissues.

Muscle hematoma can be removed surgically through a minimally invasive procedure using ultrasonography under local anesthesia as a quick outpatient procedure. Ultrasound-guided muscle hematoma evacuation can provide a quick decompression of the muscular compartment and possibly provide better muscle recovery.

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