Use of an Oblique Obturator Radiograph in Aspiration at Anterior Iliac Crest

Nabil A. Ebraheim, MD; Jingwei Zhang, MD; Gregory E. Lause, MS

Abstract: The purpose of this study was to evaluate the use of an oblique obturator radiograph in bone marrow aspiration. The authors retrospectively reviewed 22 patients who underwent bone marrow aspiration guided by the real-time oblique obturator radiograph while in a supine position at their institution between November 2009 and August 2010. The mean duration of bone marrow aspiration was 35±9 seconds. According to the visual analog scale, the postoperative pain score at the site of aspiration was an average 1.6 of 10. No complications were observed. The oblique obturator radiograph can improve the accuracy of the aspiration.

N onunion of fractures and avascular necrosis of the femoral head remain challenging and clinically important problems in orthopedic surgery. The gold standard for bone grafting is autologous bone harvested from the iliac crest. However, significant donor site pain and morbidity have been reported by many authors, with rates as high as 30%.1,4 Recently, surgeons have sought new strategies to optimize bone repair, including the use of bone marrow stem cells. Bone marrow stem cells have the potential to aid in the development and regeneration of tissues, including bone.9 As a result, the use of autologous bone marrow aspirate for bone grafting has been advocated as a means to provide an osteogenic cell source.10

The most commonly used sites of bone marrow aspiration include the posterior and the anterior iliac crest. Hernigou et al11 found no substantial difference in the number of available progenitor cells between the anterior and posterior iliac crests, which makes either surgical technique clinically viable. The authors describe a method used to obtain bone marrow aspirate by 2 surgeons who worked simultaneously on an anterior iliac crest. In this technique, the trocar is pushed in by hand approximately 6 cm into the iliac crest and withdrawn 1 cm toward the surface through the same insertion site. This technique requires multiple perforations of the iliac crest and uses small (4 mL) volumes of aspirate to reduce peripheral blood.

Although the procedures of these aspirations are usually regarded as being of low risk, they should not be thought of as being risk free.5,12-15 Using the current approaches, it is possible to puncture the anterior cluneal and sacral nerves and vessels if the trocar does not remain in line with the edge of the pelvic ring. Furthermore, the procedure by Hernigou et al11 requires 2 physicians, which makes this procedure impractical at times. Current procedures for aspiration require physician experience and skill to ensure a safe and time-efficient procedure.
**MATERIALS AND METHODS**

Twenty-two patients who underwent local injection of bone marrow stem cells at our institution between November 2009 and October 2010 were retrospectively reviewed. Of these patients, 15 were men and 7 were women. The mean age of the patients was 62 years (range, 46-83 years). The reason for the local injection of bone marrow stem cells included nonunion of femoral shaft fracture in 5 patients, nonunion of tibial shaft fracture in 7 patients, nonunion of humeral shaft fracture in 4 patients, and avascular necrosis of the femoral head in 6 patients.

**SURGICAL TECHNIQUE**

After suitable anesthesia is achieved, the patient is placed in the supine position. Using sterile technique, the skin should be prepared with antiseptic and draped. The projection of the C-arm image should be adjusted to obtain the oblique obturator view (Figure 1). On the oblique obturator view, the spine of the iliac crest is visualized as a curved silhouette of the inner and outer wall of the anterior iliac crest. The path of the trocar needle is at the center the space between the 2 curved lines.

With the monitor of the C-arm image intensifier, the tip of the needle is inserted percutaneously at the anterior iliac crest and located at the midpoint between the inner and outer wall of the anterior iliac crest (Figure 2). Subsequently, the needle tip is advanced with the direction in accordance to the empty space between the inner and outer wall of the iliac crest (Figure 3). The depth of the needle advancing into the iliac crest should be approximately 4 to 5 cm (Figure 4). The volume of bone marrow used in our study was 60 mL.

Bone Marrow Aspirate (Biomet, Inc, Warsaw, Indiana) needles have 5 holes placed at the distal tip, allowing for better aspiration. One stylet with a trocar point is used for penetration of the cortical bone into the bone marrow cavity. One stylet with a blunt tip is used for easy movement of the needle within the bone marrow cavity. The 30-mL syringe can be connected to the bone marrow aspirate needle. Once the needle was determined to be at the given depth in the iliac crest, the bone marrow was aspirated. The needle was retracted backward approximately 5 mm when each 20 mL of bone marrow was aspirated. In this way, the largest possible space could be aspirated while reducing the percentage of peripheral blood in the aspirate.

After the aspiration of bone marrow from the anterior iliac crest, the stem cells were concentrated by a centrifugation system. The concentrated bone marrow stem cells were then locally injected into the specific site in all the patients. The site of percutaneous insertion was compressed with sponge gauze for 3 minutes to prevent any wound bleeding.

**RESULTS**

The average follow-up was 26.5 weeks (range, 12-52 weeks). All patients received 1 insertion of the needle at the anterior iliac crest. The mean duration of aspiration of 60 mL of bone marrow was 35 ± 9 seconds. According to the visual analog scale (VAS), the postoperative pain score at the site of aspiration was an average of 1.6 of 10. No reports of pain at the site of aspiration at the 1-week postoperative and final follow-up were observed. No hemorrhage, infection, hematoma, or penetration of the...
needle out of the iliac crest were observed. These results demonstrate equivalent or better outcomes compared with previous studies.

**DISCUSSION**

Bone marrow aspiration is an important tool for diagnostic and therapeutic options. Recently, with the advent of more studies focused on bone marrow stem cells, the aspiration of bone marrow is being performed more frequently. Bone marrow aspirations can be performed at the sternum, the posterior iliac crest, the anterior iliac crest, the medial surface of the tibia, the ribs, and the spinous processes of vertebrae.15

Although the complications of marrow aspiration are rare, they should not be thought of as risk-free. The most common problems encountered during the process of bone marrow aspiration were obstruction of the needle, malposition of the needle, penetration of the iliac crest, and the time required to obtain 60 mL of bone marrow. Therefore, the traditional methods for harvesting bone marrow from patients generally required several separate insertions of a large trocar needle into the donor’s iliac crest. However, the multiple sites of insertion may cause severe pain to the patient and increase the incidence of complications.

Tsai et al16 reported a retroperitoneal hemorrhage, which was more hazardous than hemorrhage into the buttock. Moreover, some of these rare adverse events are serious.5,13 Adverse events were reported in 0.08% to 0.12% of total procedures.13 In the report by Bain12 regarding aspiration and associated adverse events, the most common and serious complication was hemorrhage; 2 deaths were reported—1 following penetration of the sternum during a sternal aspiration and 1 from a hemorrhage following a trephine biopsy of the posterior iliac crest. Infection is the second most frequent adverse event associated with bone marrow aspiration. However, adverse events relating to broken needles are infrequently reported. Bain12 also reported fracture at the site of the biopsy in 1 patient with osteoporosis, which led to a 2-week hospitalization. As for the reasons for these complications, besides the factors related to the patients’ lesion (including the diagnosis of a myeloproliferative disorder, thrombocytopenia and therapy with heparin, warfarin or aspirin), several technical factors may have contributed to the occurrence of some of the observed complications. However, adverse events after bone marrow aspiration and trephine biopsy occur with operators of all levels of experience.17 To address these complications, we propose the use of the oblique obturator view during bone marrow aspiration.

In our study, all of the aspirations were performed by 1 senior orthopedic surgeon (N.A.E.) who had 25 years of clinical experience and had performed hundreds of cases of bone marrow aspiration at the anterior iliac crest without radiographic guidance.

The depth of the needle advancing into the iliac crest was approximately 4 to 5 cm. In this site, a generous cancellous stock was observed. During the successive process of aspiration, the needle was retracted backward approximately 5 mm when each 20 mL volume of bone marrow had been aspirated. In this way, the largest possible space could be aspirated in a minimal amount of time. In our study, 60 mL of bone marrow could be aspirated within 35±9 seconds. All of these results were favorable.

The major limitation of this technique is the equipment requirement for an intraoperative C-arm fluoroscope. In our study, the medullary cavity of the anterior iliac crest was clearly demonstrated under the monitor of the C-arm image intensifier with an oblique obturator view. As a result of having this clear visual, only 1 insertion of the needle was necessary for each patient. No infection or hemorrhage was observed. The postoperative pain at the iliac crest was an average VAS of 1.6 of 10. No pain was observed at the site of aspiration at 1 week postoperatively and at final follow-up.

If only the tip of the needle shown at the oblique obturator view was located between the inner and outer wall of the iliac crest, no risk of penetration existed. Application of this technique can prevent the malposition of the needle and, in turn, significantly decrease incidence of needle insertion. Furthermore, this technique could prevent the penetration of the needle into the inner and outer wall of the iliac crest, which could result in obstruction of the needle and hemorrhage.

**CONCLUSION**

The oblique obturator radiograph is useful and reliable in guiding the insertion of the needle for aspiration of bone marrow at the anterior iliac crest. This technique can improve the accuracy of aspiration, decrease the incidence of malposition of the needle, and facilitate the maneuver, resulting in a reduced procedural time and minimal complications.

**REFERENCES**


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