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Use of a Hybrid Operating Room to Improve Reduction of Syndesmotic Injuries in Ankle Fractures: A Case Report

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ABSTRACT

Ankle fractures are one of the most common orthopedic injuries requiring operative treatment, and approximately 1 in 4 ankle fractures will have an associated distal tibiofibular syndesmosis disruption. Syndesmotic reduction is crucial to restoring ankle function and preventing the development of arthritis. The hybrid operating room provides 3-dimensional intraoperative imaging capabilities that can enable the surgeon to ensure the syndesmosis is appropriately reduced, particularly by comparing it with the contralateral ankle. By confirming the syndesmosis reduction intraoperatively, the risk of a return to the operating room for revision surgery is decreased.

Ankle fractures are one of the most common operatively treated orthopedic injuries. It has been estimated that approximately 23% of ankle fractures will be associated with disruption of the distal tibiofibular syndesmosis (1). Reduction of the syndesmosis is crucial to restoring ankle joint anatomy and function preventing the development of ankle arthritis (2,3). Despite the importance of anatomic reduction, the incidence of malreduction after operative fixation has continued to be high. Most often, surgeons have used 2-dimensional (2D) intraoperative fluoroscopy to assist in the reduction of the syndesmosis after fracture fixation with the AO technique. However, the standard radiographic parameters used to verify syndesmotic reduction in the operating room are not sensitive and often result in undetected malreduction, which can lead to considerable disability (3–5). Studies have demonstrated malreduction rates as great as 52% for ankles treated with traditional fixation techniques and evaluated with postoperative computed tomography (CT) (6). Different syndesmotic reduction techniques, such as Needleman's glide-path technique and the center–center view, have been described to help overcome and enhance the shortcomings of 2D imaging (7,8). Although useful, these techniques lack long-term outcome data. Some investigators have suggested 3-dimensional (3D) CT scans in the immediate postoperative period to detect syndesmotic malreduction and a return to the operating room for revision reduction if present (9). Although this protocol would certainly increase the detection of malreduced syndesmotic injuries, patients would be exposed to more radiation and the increased morbidity of a second surgery with no assurance that the previous error would be corrected.

In recent years, surgical disciplines other than orthopedics have developed minimally invasive and advanced procedures through the use of advanced intraoperative 3D imaging in a hybrid operating room (OR) (10–13). The application of the hybrid OR to orthopedics has a minimal presence in published studies. The present report introduces the novel use of an existing intraoperative advanced imaging modality to avoid malreduction of the syndesmosis after fracture fixation. This technology centers on the use of a hybrid OR with a floor-based flat plate robotic C-arm with 3D scanning capability (Artis Zeego; Siemens Healthcare, Erlangen, Germany).

Preoperative Planning

As a standard approach to ankle fracture surgery, the patient's soft tissues and planned area of incisions must be examined for necrosis, infection, and swelling to ensure they are appropriate surgical candidates. The injury films should be evaluated preoperatively and uploaded in the operating room for preoperative templating and planning, in addition to evaluating for syndesmotic injury. The anteroposterior, lateral, and mortise views will allow for complete evaluation of the fracture fragments and classification as described by Lauge-Hansen. When appropriate, an external rotation stress view can aid in

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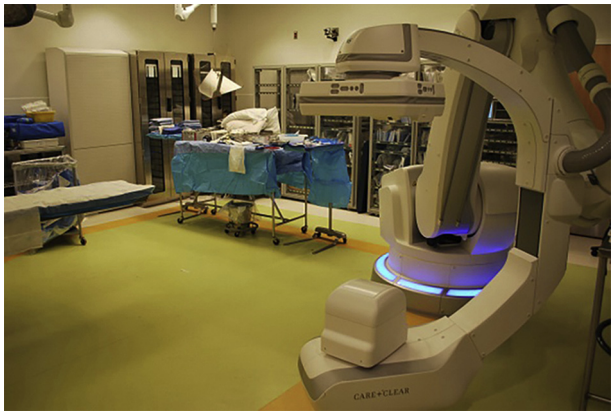

Fig. 1. Hybrid operating room containing Artis Zeego (Siemens Healthcare) robotic C-arm with 3-dimensional imaging capability.

determining the competency of the deltoid ligament. An external rotation stress view of a dorsiflexed ankle with widening of the medial clear space of >5 mm is indicative of deep deltoid disruption.

Patient Preparation

The equipment for the system is contained in a hybrid OR with a floor-based robotic C-arm (Artis Zeego; Siemens Healthcare) and an attached technical support room that incorporates a viewing window (Fig. 1).

The patient is transferred to the OR table in the supine position, and anesthesia is induced. A bump is placed under the ipsilateral hip to internally rotate the extremity such that the foot is in neutral rotation. A tourniquet is then applied. To capture each ankle with minimal obstruction, the operative ankle is elevated using a non-sterile foam block (Fig. 2). In addition to accurately comparing the syndesmosis of the operative ankle with that of the contralateral ankle after fixation, the dorsiflexion on the uninjured ankle should be noted before draping such that the operative ankle can be in a similar amount of dorsiflexion during the scan. The patient is then prepared and draped in standard sterile fashion.

Operative Technique

Standard AO principles and techniques are used to perform open reduction and internal fixation of the ankle fracture. The syndesmosis is then evaluated for instability using a stress external rotation test under fluoroscopic guidance. If positive, the surgeon can reduce

Fig. 2. Patient placed supine on the operating room table with a foam block under the operative extremity.

Fig. 3. Periarticular reduction clamp in place securing the distal tibiofibular joint before insertion of the syndesmotic screw.

and stabilize the syndesmosis with multiple techniques, including screw or suture button fixation. At our institution, the center–center technique is often used (7). This involves obtaining a center–center view by internally rotating the extremity to accurately place a large reduction clamp along the neutral anatomic axis of the distal tibiofibular joint and then inserting a syndesmotic screw in standard fashion, with the drill and screw remaining level with the horizon (Fig. 3). Three views of the ankle are then taken to evaluate the screw size and position before intraoperative 3D scanning. The lower half of the operating table is then wrapped with a sterile three-quarter sheet anteriorly and posteriorly and held with nonpenetrating clamps to maintain a sterile field during the spin of the C-arm (Fig. 4). Before conducting the 3D spin, the OR staff can enter the viewing room or step behind a lead glass shield for radiation protection. The 3D scan takes approximately 6 seconds to complete, after which the surgeon can assess the syndesmotic reduction by comparing the injured and uninjured ankles. This intraoperative 3D spin obviates the need for a postoperative CT scan and confirms an accurate reduction before leaving the OR. Once reduction has been confirmed, final radiographs are taken, and the wound is irrigated and closed in standard fashion.

Case Report

Patient 1

A 43-year-old female presented to the clinic 10 days after twisting her ankle on an icy driveway and experiencing immediate pain.

Fig. 4. Robotic C-arm in place for acquisition of 3-dimensional imaging. Sterile three-quarter drapes were placed over the operative extremity before positioning the C-arm.