

The Use of Dual C-arms During Fixation of Calcaneal Fractures: A Technique Tip

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Abstract: We describe a simple technique using dual C-arms (large and mini c-arm together) for open reduction internal fixation of calcaneal fractures in the lateral decubitus position which (1) decreases the difficulty of obtaining proper intraoperative imaging, (2) limits c-arm movement which decreases risk of contamination and operative time and (3) minimizes the drawbacks of each imaging fluoroscopic modality.

Keywords: dual C-arms, fluoroscopy, calcaneus fracture

This technique assumes that the patient undergoing calcaneal fixation is in the commonly used lateral decubitus positioning. For illustrative purposes of this technique, the patient is in the left lateral decubitus position (right-side up) on a flat radiolucent table and is prepped and draped in the usual fashion. The nonoperative leg (left leg) is maintained in a more extended position so as not to

obscure imaging of the injured side when the x-ray beam is shot through the table. The operative extremity is flexed 45-degrees at the hip and knee and placed on a high bolster. An outline of the extremity can be made with a surgical marker on the underlying surgical drape for more consistent positioning of both the extremity and the C-arm. The large C-arm and mini C-arm are draped prior to incision. (Figure 1)



FIGURE 1. Setup demonstrating positioning of dual c-arms



FIGURE 2. Obtaining a perfect lateral view of the foot using the large c-arm

To obtain a lateral foot image, the large C-arm should be placed on the left side, perpendicular to the operative table with the image intensifier under the OR table (Figure 2). Adjust the large C-arm by angling and arcing in various planes until a perfect lateral view of the calcaneus is obtained. After the large c-arm is angled appropriately it is locked and secured and moved out of the operative field. When lateral images are required during the procedure it can be wheeled into the predetermined area without the need to make any further adjustments. To obtain Broden views, the large C-arm should be centered on the fibula with slight external rotation of the limb and the appropriate amount of ankle dorsiflexion or plantarflexion as needed. To obtain a Harris heel view, the mini C-arm – which is turned horizontally – is placed on the contralateral side of the operative table is utilized. When a Harris heel view is required, the foot is dorsiflexed and the mini C-arm is advanced forward with the x-ray source placed near the popliteal fossa. The C-arm can then be rotated on its axis until a Harris heel view is obtained (Figure 3).



FIGURE 3. Utilizing the mini C-arm to obtain a Harris heel view

Discussion

The most commonly used approach for operative fixation of calcaneal fractures is the extensile lateral approach. Unfortunately, it has been associated with high wound complication rate that ranges from 1.8-27%^{1, 2, 3, 4, 5, 6, 7, 8, 9, 10}. In an attempt to improve patient outcomes and avoid surgical complications, minimally invasive procedures have evolved including the sinus tarsi and percutaneous approaches. However, these techniques afford limited direct visualization of the fracture and an increased use of indirect reduction techniques. These techniques often require an increased use of intra-operative fluoroscopy and are more dependent on the ability to obtain adequate intra-operative images to compensate for limited direct visualization of fracture reduction and fixation.

The use of either the regular large C-arm or the mini C-arm is mostly surgeon dependent and each imaging modality has its benefits and drawbacks. Large C-arms produce better image quality and a wider image field. However, they are difficult to move and require assistance from a radiology technician. Pally et al recently demonstrated great inconsistency in the terminology used between orthopedic surgeons and radiation technologists.¹¹ As a result, surgeons may become frustrated with time wasted due to miscommunication and increase in radiation dose exposure due to inappropriate images obtained. Harris heel views, in particular, are more difficult to obtain with the large C-arm due to the width of the arm, obstruction from the operating table and need to reposition which can be time-consuming.

Additionally, the large C-arm delivers a higher dose of radiation compared to the mini C-arm. A study by Dawe et al. revealed that the mini C-arm reduces radiation dose and costs when compared to standard fluoroscopy.¹² This has been shown in other studies which favor the use of mini c-arm over the larger counterpart when imaging the extremities due to less radiation exposure in spite of a larger number of images obtained with the mini C-arm in comparison to the large C-arm for each operation type.^{13, 14, 15} Our technique minimizes overall radiation exposure when using the

large C-arm in 2 ways. (1) Standardizing the location of the foot and securing the coordinates of the large C-arm results in less wasted images taken prior to obtaining the desired view. (2) Use of the mini c-arm to obtain Harris heel views decreases utilization of the large c-arm for this purpose.

Due to their size, mini C-arms are easier to maneuver during surgery. On the other hand, mini C-arms generally generate poorer image quality when compared to their larger counterpart. Perhaps the most concerning drawback is that mini C-arms carry a higher risk of contamination from the floor, the undersurface of the operating table or even the surgical gowns during repetitive manipulations to turn the C-arm horizontal or vertical to the ground. Peters et al. showed that the rate of contamination of the C-arm drape increases gradually with time. They recommended minimal contact with the C-arm to decrease the incidence of contamination.¹⁶ Bible et al. tried to determine the most sterile regions of the surgical gown and concluded that contamination rates were greater at levels 24 inches and less or 48 inches and more relative to the ground.¹⁷ With the mini C-arm turned vertically, for example when a lateral foot view is obtained, the mini C-arm falls below this safe zone and risk of contamination is greatly increased (Figure 4).



FIGURE 4. The mini C-arm turned vertically demonstrating the risk of contamination

We recommend maintaining the mini C-arm horizontal to the ground and using it exclusively for obtaining the Harris heel view so as to minimize the risk of contamination.

Conclusion

We describe an easy technique using dual c-arms for calcaneal open reduction internal fixation being performed in the lateral decubitus position which limits overall radiation exposure,

decreases the risk of contamination and decreases operative time and potential surgeon frustration due to ease of obtaining proper intraoperative imaging.

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