Preoperative Planning in Orthopedic Trauma: Benefits and Contemporary Uses

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Preoperative planning can improve surgical outcomes and prevent unanticipated problems. A thorough plan includes a drawing of the desired end result, a step-by-step surgical tactic, and details of operation logistics.

It has been said that no surgeon goes to the operating room planning to fail, but that many surgeons go to the operating room failing to plan. Preparation of a carefully thought out preoperative plan offers many advantages for both the surgeon and the patient. For the surgeon, cases go smoother and faster, with less stress during the operation. Furthermore, operating room personnel are more likely to view the surgeon as a competent and dependable surgeon with whom they enjoy working. Finally, improved outcomes and increased safety as a result of this preparation are of direct benefit to the patient.

The value of preoperative planning has long been recognized in orthopedic surgery, but it has become increasingly important as the technical complexity of procedures and equipment has expanded. With the advancement of AO principles, preoperative planning became an essential element of surgical preparation, and preoperative tracing of fractures, and use of acetate templates was popularized through AO instructional courses.

There are 3 main elements of a complete preoperative plan: (1) A drawing of the desired end result. (2) Development of a “surgical tactic,” or step-by-step process, to achieve the desired end result. (3) Operation logistics, such as the type of operating room table, patient position, any special anesthetic requirement, and required instruments and implants.

It is important to remember the adage, “Every fracture does not require the same type of plan, but every operation requires some sort of plan.” One of the most important aspects of preoperative planning is the advance stepwise thought process that is essentially a dress rehearsal of the operation. This “thinking” part of the process is more important than the quality of the final preoperative drawing.

A preoperative plan is helpful in communicating to the operating room team the surgeon’s plans and their necessary roles, as described above. In addition to the required instruments and implants, it is also helpful to identify which additional items might be needed. For example, if prior hardware needs to be removed it may be necessary to have broken screw removal instruments available if the surgeon encounters difficulty with the planned hardware removal. Identifying the necessary equipment is especially important for surgeons who operate at more than one facility, as some equipment may be readily available at one facility but need to be brought in specifically for the case at another facility. Communicating with the operating room staff regarding the necessary equipment is also important if the available equipment is being used simultaneously by another surgeon in a different room.

PREOPERATIVE DRAWING

The ability to hand-trace physical radiographic images disappeared with the conversion from film technology to digital radiographs. As printed radiographs disappeared, many worried that preoperative planning would become a lost art. However, several digitally based planning systems have been developed that allow manipulation of...
radiographic images and application of a wide variety of implant templates. More recently, planning software that incorporates 3-dimensional computed tomography (CT) reconstruction has been developed. The use of standard image analysis software (Adobe Photoshop; Adobe Systems Inc, San Jose, California) has also been described for digital analysis of deformity and subsequent surgical correction.

Another option is to trace an image of an intact bone from an anatomy textbook. This paper image can then be enlarged as needed to match the correct scale using a photocopier. While the image may not exactly match the individual bony anatomy, it can provide a reasonable approximation to proceed with creating a preoperative drawing.

By drawing out a preoperative plan, mistakes are made on paper, rather than in the operating room. Mast has been quoted as saying, “Better to throw your disasters into the waste paper basket than to consign your patients to the scrap heap.” In some procedures, such as corrective osteotomies of deformities, the drawing is critical to determine the desired outcome. However, in the majority of trauma cases, the main value of the preoperative planning process lies in carefully examining the radiographs and thinking through the sequential steps of the operation. This thinking process is far more important than the quality and scale of the actual drawing of the fracture reduction and fixation.

Several problems are faced when preparing a drawing of a fracture reconstruction. One problem is the displacement and angulation of the individual fracture fragments. The 2-dimensional imaging of the 3-dimensional configuration may not easily permit an accurate reconstruction of the intact bone (Figure 1). In addition, it is difficult to determine rotational deformity based on plain radiographs.

Either clinical examination or CT scan measurements are required to evaluate for rotational deformities. Finally, there are magnification issues to consider. A radiograph taken from the distance of 40 inches leads to approximately a 10% magnification, but depends on the distance of the bone from the cassette and may range from 6% to 36%.

To accommodate for the magnification error, most original acetate implant templates are enlarged by 10% to 15%. Various methods are available to more accurately calibrate radiographic measurements, but this may not be as important in templating trauma cases as in some other orthopedic indications.

Three main methods have been described for creating preoperative drawings. While different methods may be better suited for different situations, no single method is superior and in some instances a combination of methods may be required.

Using a Reverse Image of the Contralateral Uninjured Bone

If the contralateral limb is uninjured, a reverse image of the limb can be used as a template to reconstruct the injured limb. After tracing the outline of the reversed (mirror image) uninjured limb, the fracture lines are added by aligning the identifiable sections of the individual fracture fragments. The selected implant template is then used to add the planned fixation. Finally, a step-by-step “surgical tactic” is written out (Figure 2). Both anteroposterior and lateral drawings are typically performed; however, in this example we are limiting the images to only the anteroposterior view.

Cut-out or Jigsaw Method

In this method, each fracture fragment is individually traced. This approach has also been referred to as the jigsaw puzzle method, since each fracture fragment is cut out individually and reassembled like the pieces of a jigsaw puzzle. Alternatively, the tracing paper may be sequentially moved to appropriately align each fragment as they are traced (Figure 3).

Anatomic and Mechanical Axis Method

In this method, the individual fracture fragments are aligned to the known axis, such as the knee joint axis in the case of a supracondylar femur fracture. The anatomic axis of the patient’s normal side can be measured, or alternatively a standard lower limb axis can be used (Figure 4). While this method can be used for acute fractures, it is more commonly used for reconstructive osteotomies of the long bones.

SURGICAL TACTIC

The term “surgical tactic,” which describes a step-by-step guide to the operation, has been attributed to Maurice Müller. This is especially important in operations in which step A must precede step B. When writing out a step-by-step surgical tactic, it is important to remember that too much detail can be just as bad as too little. The surgical tactic needs to contain the key steps in the operation, but should not become lost in minutiae or sacrifice clarity for thoroughness.
The surgical tactic should include the planned patient position and surgical approach. You may also wish to note pertinent anatomy and specific structures at risk. Also included is the planned reduction technique, such as direct open reduction using a reduction forceps, or alternatively an indirect reduction using a universal distractor device. The next key element of the surgical tactic is the selection and positioning of the planned internal fixation implant. For plate fixation, the type and order of screw insertion should also be considered. The surgical tactic concludes with closure, any form of immobilization, and the subsequent planned rehabilitation regimen.

**OPERATION LOGISTICS**

Operation logistics can be covered as part of the surgical tactic, but because of the importance of communicating them with the operative team, it is useful to separate them from the details that are more integral to the surgical procedure. The planned operating room table, patient position, and any specific anesthetic needs should be communicated in advance to the operating room team. The need for intraoperative fluoroscopy or other radiographic imaging should be communicated. As the surgical tactic is developed, a list of necessary instruments and implants should be generated as well. In addition, it is often useful to add those instruments or implants that do not need to be open and on the sterile field but should be available in case they are needed.

Many surgeons have found it useful to develop an equipment checklist that they provide in advance to the operating room personnel (Figure 5). Preference cards do not work well in orthopedic trauma because of the wide variation between cases, making an equipment checklist an effective method to communicate planned equipment needs to the operating room personnel.

**CONCLUSION**

Preoperative planning offers many benefits for the surgeon and the patient. While not all orthopedic trauma cases require a detailed operative drawing, all procedures require a thought-out plan. Preoperative planning improves communication with the other members of the operative team. With thoughtful preparation, delays and complications can be reduced, and patient outcomes may improve.

Figure 2: Radiograph of left tibia and fibula fracture (A). Reverse image of contralateral uninjured tibia (B). Tracing of the tibia and fibula outline (C). Addition of fracture line. Note only the main fracture lines have been drawn for clarity. Additional fracture lines could be added using dashed lines for the posterior extension of the fracture lines (D). Addition of the planned plates and screws, along with the written surgical tactic (E). Postoperative radiograph of completed internal fixation (F).

Figure 3: Outline tracing of individual fracture fragments (A). Repositioning of fragments into a reduced position similar to putting together the pieces of a jigsaw puzzle. The planned plates and screws are then drawn in as shown in Figure 2E (B).
fusion can be easily avoided, leading to improved patient outcomes. Thinking through the sequential steps of an operation also allows a surgeon to identify possible unanticipated problems and to develop contingency plans for achieving a successful outcome.

REFERENCES


