Chasing Shadows

or

A Surgeon’s Misery with x-Rays

Orthopaedic surgeons must rely upon x-rays to visualize bones that are covered by soft tissues while they operate. X-rays are a type of invisible ionizing radiation and x-ray generated images (“x-rays”) are the shadows created by the bones. All shadows, whether from visible light or from X-rays, are subject to a variety of distortions. Still, x-rays are the best way for surgeons to visualize bones and implanted hardware.

When the operation is done, your surgeon needs to confirm that the fracture reduction, implanted hardware and screws are all correctly and safely placed. Therefore, orthopaedic surgeons “chase shadows” all day long. A surgeon’s job is to get these “perfect images” as post-operative proof that all is well.

The misery in obtaining these perfect representative images, or shadows, is due to many variables, such as variations in fracture type and location, patient related factors, such as weight, age, boney anatomy and medical conditions and the type of x-ray equipment and radiology personal available. As the surgeon chases these shadows, the patient, the surgeon, and the operating room personal all accumulate extra radiation exposure.

In a recent study, Rausch et al evaluated the use of tangential views and intra-operative 3D fluoroscopy for distal radius fractures as possibly being improved methods for detecting misplaced screws. They noted an additional 10.0 ± 3.8 minutes needed per case to get these possibly better “perfect images” with a 58.8 ± 25.4 seconds of additional radiation exposure time!

Importantly, even though 83% of orthopaedic surgeons are concerned about the negative health effects of x-ray exposure, 67% routinely use x-ray to check the position of the wire depth-gauge (with SMARTdrill® the wire depth-gauge is not needed).²

X-ray images change as the angle of the beam passing through the tissue is altered. Everybody has experienced how distorted shadows can look. In the morning with the sun (radiation source) on the horizon my shadow is tall and slim as the sun passes overhead my shadow changes and becomes short and stout. This happens with x-ray beams as well, see Figure 1, below.

In last months SMARTlab (Best Stay Out of That Joint!), we discussed how “surgeons have to constantly be aware of the potential for image distortion while quickly and accurately interpreting the paths and depths of their drill bits and screws.”³ A recent article on the most commonly fixed fracture in the world, the distal radius, showed that experienced surgeons had greater difficulty detecting dorsal cortical breeches
than less experienced surgeons.\textsuperscript{4} This underscores the problem with existing technology and trusting x-ray shadows. The longer you do it, the worse you get!

\textbf{Figure 1.} The photos above are of the same model tibia with a mid-shaft fracture. The overhead light source projects the shadow onto the surface below. The model tibia was rotated a multiple of 90 degrees between each photo. The shadows are analogous to x-ray images. The two images to the left show the bow in the fracture. The two images on the right falsely indicate the fracture has been straightened. "Oh the Misery of x-rays!"

Internal fixation can be a complex multi-step procedure, for example:

\textbf{Step 1.} Surgeon obtains exposure and manipulates fracture fragments attempting to achieve an anatomical, or at least acceptable, reduction.

\textbf{Step 2.} Surgeon achieves provisional stabilization of the fragments with pins.

\textbf{Step 3.} Surgeon finally places definitive fixation with screws and plates.

These operations require dozens of x-rays for each of these steps with countless shadow interpretations. This is the "surgeon's misery with x-rays." SMARTdrill\textsuperscript{®} technology replaces most of the x-rays with its graphical user output ("GUI") and can reduce the misery!

The SMARTdrill\textsuperscript{®} GUI gives the surgeon an instantaneous, continuous graph of drill bit torque, power, energy and position, see Figure 2. Finally, the surgeon will know where they are in the drilling process in real-time without using x-ray. If they want to stop the drill bit before going through the far cortex the surgeon has the choice to do so. If they select to breach the distal cortex, they can do so safely without a plunge. In addition, the exact depth of the hole and bone strength are determined and displayed on the GUI. The correct screw is easily selected the first time every time.
NO OTHER DRILL CAN GIVE THIS DATA OR THIS RESULT.

SMARTdrill® quantitates and measures data never before attainable in orthopaedic surgery. Why use old surgical drills then? Why use your home phone if you have a “Smart Phone?” SMARTdrill® is the future of surgical drilling. Patients and surgeons deserve better technology than the decades old drills used in operating rooms around the world today.

Old drills lack robotic technology to protect the patient against plunge injuries and lack electronic technology to give the surgeon actionable intelligence to ensure that the proper implant is used the first time. The SMARTdrill® and it’s GUI provide clear undistorted data on depth and bone strength to the surgeon in real-time and clear safety advantages to the patient.

