CHAPTER **27**

PRINCIPLES OF CLOSED REDUCTION OF FRACTURES

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INTRODUCTION

Since the publications of Sherman and Lane in the early part of the last century, accelerated by the work of the AO group, the emphasis in American surgery and elsewhere has been on the open reduction of fractures with internal fixation. While the western world has spent a hundred or so years rapidly developing technologies for surgical fixation, the body has spent thousands of years developing equally advanced means for healing its own injuries.

When asked about healing a soldier suffering from a gunshot wound/ankle fracture, barber-surgeon Ambrose Pare famously quipped, "I dressed the wound and God healed him".[1] Since the time of ancient Arabic tebibs (bone-setters), physicians also have been developing techniques for reduction and stabilization of broken and dislocated bones. The impetus for this article is the void in my own education on treating fractures by closed means. In school there are countless courses detailing the surgical management of injuries often footnoted by the phrase "or cast nonweightbearing 4 to 6 weeks." But it is not as simple as that. There are key tenets in the indication, reduction, and stabilization of fractures by closed methods.

BRIEF HISTORIC REVIEW

Chris Colton's chapter in Browner and Jupiter's text is perhaps the crispest and most florid treatment of the history of fracture management, much of this review comes from that source.[2] The Egyptians have been found to excel in multiple fields of medicine, not the least of those being fracture management. In fact, the earliest evidence of fracture treatment was found in the Hearst Egyptian expedition in 1903. They found two specimens of broken extremities wrapped in splints of wood and linen. The ancient architect Imhotep (3000 BC), credited with many of the great design feats of Memphis also described methods of splintage and bandaging. Believed to be the author of The Edwin Smith Papyrus, Imhotep details splinting fractured extremities (the humerus in particular) with linen, lint and honey.[3] Despite many detailed procedural descriptions he only generally discusses closed reduction of fractures.[3]

The spica splint used today in podiatry and sports medicine finds its roots in the writings of Galen (160 AD).[4] Although Hippocrates and other earlier practitioners describe various means of bandaging, the 13th century Arab surgeon Albucasis appears to be the first to detail the importance of controlling edema. In his book "The Surgery," he writes of a layered dressing of wool and pine applied to "allay the swelling and disperse the effusion."[2] He continues to say that the bandage should be changed to a more permanent and close-fitting dressing when the edema has been dispersed (combination of techniques still used today in both the acute traumatic and post-operative periods.) Albucasis also describes a sort of papier-mâché splint using eggs, dust, and flour. Some of the more elaborate and ornamental cast-devices were designed by Gersdorf in the 1500s. He illustrated wooden splints which tighten to the skin by cannulated toggles. Bandaging developed variously over the next several hundred years culminating with the contributions of Mathijesen and Pirogov's (1847) development of the modern plaster-of-Paris and today's Sir Robert Jones compressive dressing.[2,5]

Directing our focus to historic contributions to fracture-dislocations of the lower extremity, again, Hippocrates and others wrote about their experience with ankle injuries, but it was Pare (1634) who first wrote about the ankle in enough detail to describe multiple mechanisms of injury: "(the joint) may bee pluckt or drawne aside three manner of waies, that is, forwards, and to each side..." The significance to us here is that the understanding of specific mechanisms of fracture, allow specific techniques in reduction. Sir Percival Pott (1808), whose name is eponymous with a type

of bimalleolar fracture, held the reduction methods of his time in particular contempt, writing "...the most inexpert and least instructed practitioner, deems himself perfectly qualified to fulfill this part of the chirurgical art...They regard bone-setting...as no matter of science; as a thing which the most ignorant farrier may, with the utmost ease, become soon and perfectly master of."[6] In his day, it was the standard practice to attempt to overcome the power of the muscles with the leg in a straight course. This often involved a violent procedure using ligatures and machines. It was considered controversial and revolutionary when Pott began writing about reducing ankle fractures with the knee flexed and the limb in a relaxed position. Other contributors to the current understanding and treatment of ankle fractures include Hugh Owen Thomas, Lucas-Championniere, Lauge-Hansen, and Sir John Charnley.

The British orthopedic giant Hugh Owen Thomas and French surgeon Lucas-Championniere represent competitive views for the rehabilitation of fractures. Thomas epitomizes the school of prolonged, uninterrupted immobilization. In sharp contrast, Lucas-Championniere felt that "A certain quantity of movement, regulated movement, is the best condition for this process of repair."[2] His camp of mobilizers coined the phrase Le movement c'est la vie. The debate represented by these two continues today: the private practitioner balancing the AO group recommendation of early, active range of motion with trusting an individual patient to adhere to a specific regimen.

Figure 1. Prereduction and postreduction images demonstrating the use of the intact soft tissue hinge to manipulate the fracture fragments.

In the modern treatment of ankle fractures by closed methods, the greatest contributions almost certainly are derived from Lauge-Hansen and Charnley.[7] Lauge-Hansen described fracture patterns and hallmark signs which correlate reliably with the mechanism of injury. Charnley's 1950s text provides the basis for much of the remainder of this update. The significance of this history is to demonstrate that the contributions of Lauge-Hansen and Charnley are not isolated events; both of them were standing on the shoulders of giants and pulling from literally thousands of years of human experience with these injuries.

MECHANICS OF CONSERVATIVE TREATMENT

Describing the Lauge-Hansen classification is beyond the scope of this article. An intimate knowledge of the classification is mandatory before the principles of reduction can be fully meaningful.

The bone fragments in a fracture can be considered secondary to the soft tissue structures.[7] It is knowledge of the intact and ruptured soft components of a fracture that allow predictable closed reduction. The realignment of the soft tissues powers the realignment and prevents overcorrection (Figure 1). Each displaced ankle fracture has a convex and a concave tending surface.[7] The periosteum on the convex surface is ruptured during the injury, while that on the concave surface is predictably intact. This intact periosteum serves as a hinge for the reduction. Certain fracture patterns are inherently more stable and more amenable to prolonged immobilization without internal fixation. From most to least stable, long bone fracture patterns are categorized transverse, oblique, and comminuted. Charnley outlines four maneuvers in the closed reduction of displaced fractures, relying on this soft tissue hinge: increase the deformity; distal distraction; reverse the mechanism; immobilize with cast or splint.

The first step allows the separation and release of interposed fibrous tissues. Distal distraction brings the displaced and/or shortened fragments back to length and reversing the mechanism of injury brings both the osseous and soft tissues back into alignment. The realigned extremity is then immobilized in a compressive dressing.

INDICATIONS FOR NONOPERATIVE TREATMENT

It should first be noted that nearly every variety of fracture has, at some point, likely been treated non-operatively.[4] Ambrose Pare in 1861 was kicked from his horse while crossing the Seine, suffered an open fracture of the lower leg. Pare went against convention, avoiding amputation and described a course of regular wound care and prayer that allowed him to return to work in one month.[2] Sir Percival Pott reported a similar incident with similar success.[2] In another case that made history, Lord Joseph Lister found his first recorded success using a dilute carbolic acid in treating open wounds. On August 12, 1865, a 16 year-old boy was admitted to his hospital with an open tibia fracture - an injury often resulting in amputation at that time. Six weeks later the young boy, almost miraculously, walked out of the hospital.[1] This is not to say that all open fractures can be treated nonoperatively, but that a variety of injuries have been treated nonoperatively with great success.

The notion that less than anatomic reduction of a fracture leads to a greater risk of arthritis, malunion and later fusion is not supported by long-term studies.[4] Also surgical results will vary from procedure to procedure based on a surgeon's training and experiences. This leaves some openness to the indications for nonoperative treatment. Closed treatment of fractures allows good realignment and immobilization of the fragments; it is generally less costly and avoids the risks of infection, anesthesia and the technical errors that can occur through open techniques.[4] Disadvantages include difficulties with adequately aligning intra-articular fractures, also an epiphyseal injury can be difficult to realign due to the motion at the open growth plate and the thickness of the periosteum can be less pliable and more difficult to manipulate. Again, despite the enjoyable stories at the beginning of this section, open fractures generally do well with aggressive operative irrigation.

As one chapter on closed treatment concludes, "the truly skilled physician who treats fractures must appreciate the biologic cultivation of healing as well as the carpentry of fracture fixation."[4] While avoidance of operative treatment may at first seem an old and dated approach, in light of the current cultivation of minimally invasive, arthroscopic and percutaneous treatments- particularly in the traumatic situation - it may actually reflect a more progressive thought process.

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