

Section I

Introduction

Chapter

1

Radiologic Guide to Orthopedic Devices and Miscellaneous Foreign Bodies

An Introduction

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There are a large number of medical devices visible on everyday radiographs and on cross-sectional imaging – computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound exams (US) – as well as Nuclear Medicine studies. Many devices (electrocardiographic leads, pulse oximeters, Foley catheters, and IV lines) are used to monitor a patient's condition. Other devices (fracture fixation plates and screws, Kirschner wires, and joint arthroplasties) have therapeutic uses (Figure 1.1).

This book and the website www.medapparatus.com are designed to help physicians and other healthcare workers identify and understand the indications and uses for common orthopedic apparatus visualized on everyday imaging studies. The book also identifies and discusses many of the potential complications associated with orthopedic instrumentation.

It is not important to know the specific name for a given device, as the names and the variations for medical apparatus are endless. What is important is to recognize the presence of a medical device and understand its generic function. It is important to be familiar with a device's normal appearance and be able to identify when it is abnormally positioned, abnormally functioning, or has a life-threatening complication. For more information about a specific illustrated device, please see any associated references listed for the device.

Orthopedics is the surgical specialty devoted to the diagnosis and treatment of diseases and injuries affecting the musculoskeletal system (Orthopedic Surgery/Introduction). The range of conditions addressed by modern orthopedics involves trauma, degenerative diseases, congenital diseases, metabolic diseases, sports injuries, and tumors related to the musculoskeletal system – bones, joints, muscles, ligaments, tendons, and connective tissue supporting structures. Modern orthopedics overlaps with many other surgical and non-surgical specialties, particularly in regard to the treatment of spinal disorders, tumors of the extremities and trunk, and traumatic injuries to the hand.

The French physician and writer Nicholas Andry (1658–1742) coined the word “orthopaedics” from Greek words meaning straight “orthos” and “child” (paideion). In 1741 he published *Orthopaedia: or the art of Correcting and Preventing Deformities in Children* (Orthopedics University of Colorado; Nicholas Andry). Until the early part of the twentieth century, orthopedics was part of general surgery, with much of orthopedic treatment devoted toward correcting bony deformities

caused by rickets, tuberculosis, and congenital scoliosis. Treatment of fractures was limited until the introduction of x-rays in the early twentieth century. Internal fixation of fractures did not get widely accepted until the mid-twentieth century through the work of Robert Denis (1880–1962). The first practical use of “rods” and “nails” to treat long bone fractures was by Gerhard Kuntscher (1900–1972) in 1940 while he served in the German army. The Kirschner wire (K-wire) was developed by Martin Kirschner (1879–1942), a German surgeon, who introduced the use of wire skeletal traction in 1909.

There are two common spelling for “orthopedics”: **orthopaedics** and **orthopedics**. Both are correct. The shortened form, orthopedics, is favored in the United States, while the more classic form, orthopaedics, is favored in Britain. Many universities and higher education departments in the United States favor the classic spelling as does the American Academy of Orthopaedic Surgeons (AAOS). *This website and its associated book have no classical pretensions and will use the common United States spelling for orthopedics.*

The devices presented and discussed are categorized by body site (Neck and Spine; Dental Devices) or orthopedic use (Fracture Fixation; Joint Arthroplasty). They are also displayed online as part of a **gallery of medical devices** which consists of simple radiographs and line drawings that illustrate a multitude of common orthopedic devices found in daily practice. The gallery is designed as a quick reference for those wishing to identify an unfamiliar medical device found on a radiologic study. Sometimes, a specific trademark name is shown for a particular device, but most of the devices illustrated are given generic names which apply to the device shown as well as to similar devices. This gallery can be found at http://medapparatus.com/Gallery/Gallery_Introduction.html.

With regard to the head, neck, and spine, there are few orthopedic devices associated with the skull other than tongs for cervical spine traction (Figure 1.2). However, considerable orthopedic apparatus can be found in the cervical, thoracic, and lumbar spine for treatment of fractures, degenerative spinal conditions, spinal tumors, and spinal infections (Figure 1.3). This apparatus ranges from spinal braces to spinal fixation hardware and spinal cord stimulators.

The largest array of orthopedic apparatus involves fracture fixation (Figure 1.4, Figure 1.5). This ranges from external stabilization with wraps, splints, and casts to internal traction and

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Figure 1.1 Intramedullary tibial nail and fibular Rush rod for stabilization of left distal tibial and fibular fractures (from Taljanovic *et al.*, 2005).



Figure 1.3 Cervical spine fusion cage and anterior cervical fixation plate.



Figure 1.2 Child with severe intracranial and cervical spine injuries with bilateral cranial stabilization tongs, an endotracheal tube, an orogastric tube, and a feeding tube entering via the nose. From Hunter *et al.*, 2004.

fixation with wires, pins, plates, screws, rods, and nails. Bone grafts and bone substitute material is extensively used for fracture treatment.

Modern bioengineering coupled with advanced surgical techniques has enabled the orthopedic surgeon to offer a large selection of prosthetic joints (joint arthroplasty) for painful, poorly functioning native joints that have end-stage inflammatory or degenerative arthritis (Figure 1.6). The most successful joint arthroplasties are for the hips and the knees, but successful arthroplasty is also being performed for the shoulder and the small joints in the hand. There is the expectation that more successful joint prostheses will soon be available for the elbow, wrist, and ankle. Limb salvage prostheses successfully replace joints destroyed by tumor or removed due to extensive surgical resection for a life-threatening neoplasm (Figure 1.7).

Medical devices used for orthopedic applications as well as numerous other applications (heart valves, pacemakers, central indwelling catheters, subcutaneous ports, hernia repair mesh, etc.) rely on an armamentarium of modern biomaterials compatible with human tissue chemically,

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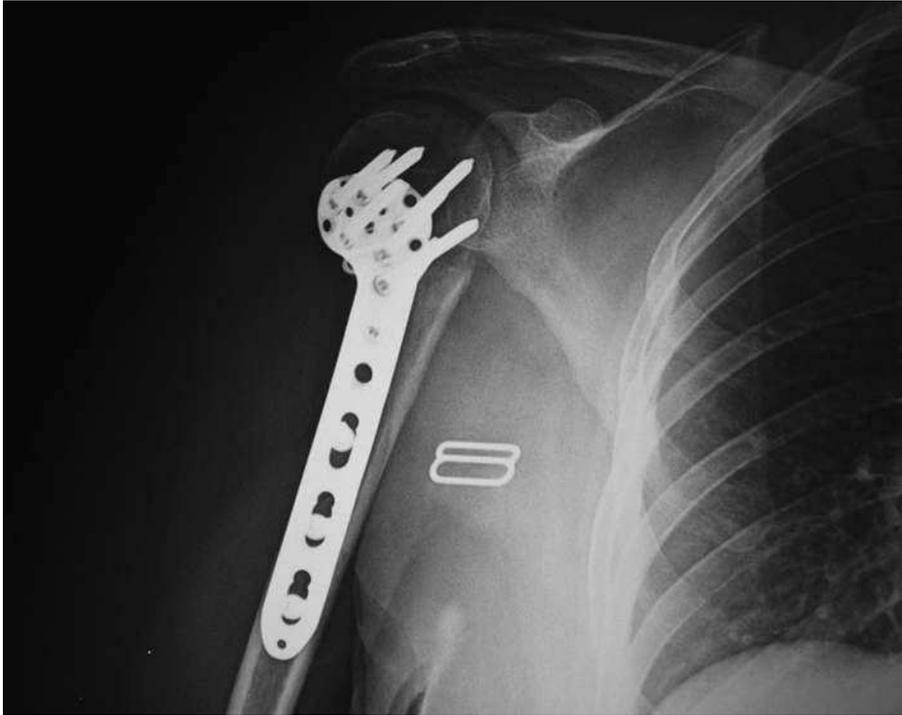


Figure 1.4 Humerus periarticular locking plate.



Figure 1.5 Short hip nail with helical (spiral) blade in femoral neck. From Taljanovic *et al.*, 2005.



Figure 1.6 Unipolar hip arthroplasty (endoprosthesis) with a cemented femoral component. From Taljanovic *et al.*, 2005.

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Figure 1.7 Lower limb salvage prosthesis (limb-salvage total knee arthroplasty). From Taljanovic *et al.*, 2005.

mechanically, and pharmacologically. Any material brought into contact with living tissue and used for treating medical and dental diseases is a biomaterial. Biomaterials should have adequate strength, be chemically inert, stable, and not elicit allergic, carcinogenic, immunologic, or toxic reactions. A detailed study of biomaterials is beyond the scope of the present book and associated website. However, a brief overview of biomaterials is presented to enable the reader to better appreciate the design and functionality of common orthopedic devices.

Dental apparatus is not ordinarily considered part of the collection of orthopedic devices. However, radiologists frequently encounter the teeth, mandible, and maxilla when interpreting head and neck images for trauma or infection or when evaluating orthopedic apparatus placed for cervical spine fixation and stabilization (Figure 1.8). Dental apparatus is not unimportant and is generally poorly understood and evaluated by most radiologists and other physicians. For this reason, a brief discussion of the mandible, tooth anatomy, and dental apparatus is provided as part of this book and associated website (Figure 1.9).

The book and associated website also display and discuss a large number of **foreign bodies** that may be found in patients, either ingested, inserted, or obtained as part of an external injury. Foreign bodies are uncommon, but they are important and interesting (Figure 1.10). Foreign bodies may go unrecognized or mistaken for a normal structure or a normally functioning medical device. They can sometimes simulate orthopedic apparatus, and inadvertent foreign bodies (surgical sponge, broken fixation pin, retained suture needle) can result from an unrecognized surgical mishap (Figure 1.11). Sometimes, what starts out as a useful device may cause

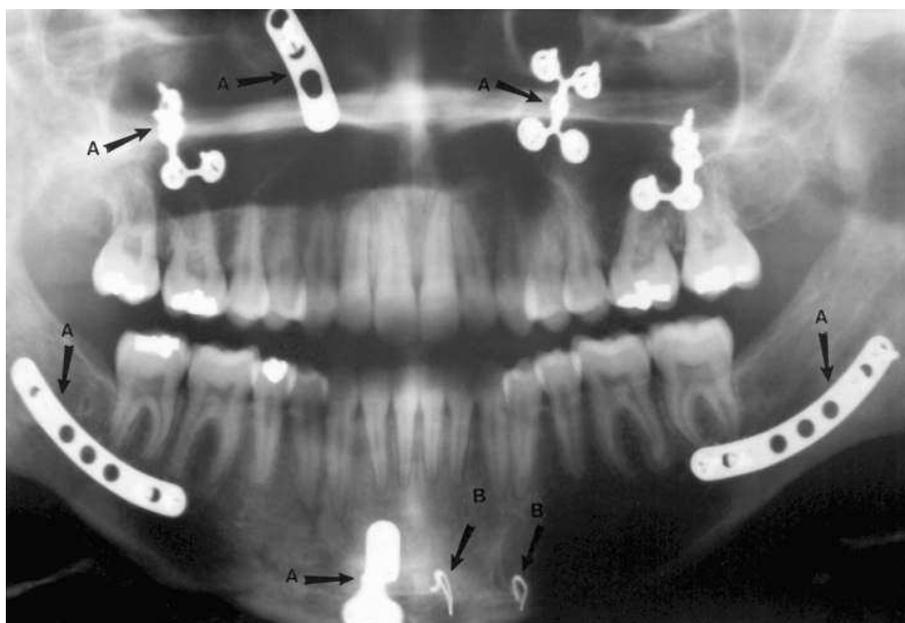


Figure 1.8 Panoramic view of the mandible shows dental plates with screws (A) and bone ligature wires (B). There are multiple dental alloy restorations (amalgam fillings). From Hunter & Bragg, 1994.

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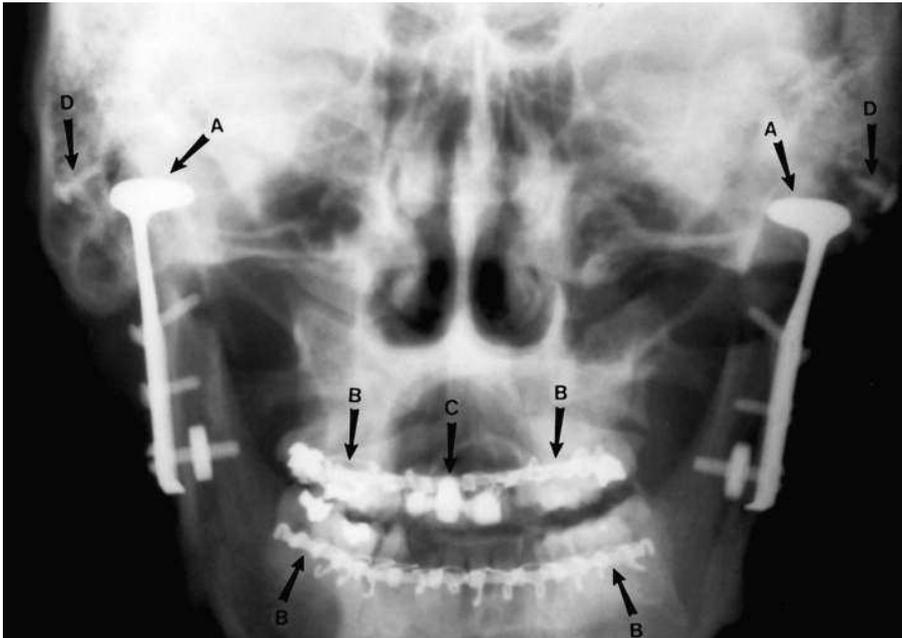


Figure 1.9 Temporomandibular prosthetic condyle implant (A); orthodontic arch bars (B); porcelain veneer dental crowns (caps) (C); fixation screws (bone screws) (D). From Hunter & Bragg, 1994.



Figure 1.10 Multiple lap sponges in a trauma patient who died at surgery.



Figure 1.11 79-year-old woman undergoing chest CT study with contrast extravasation from attempted contrast injection in her left antecubital fossa.

problems later (e.g., a surgical sponge left in the abdomen after surgery or a dislocated joint prosthesis).

A **glossary** is available with many terms and abbreviations used in connection with orthopedic devices as well as medical apparatus in general. Terms and abbreviations like ORIF, POOP, CABG, TENS unit, K-wire, and IM nail may be unfamiliar,

depending on one's training, locale, or practice situation. Many terms associated with medical devices are often used inappropriately in the radiologic literature. Sometimes they are misspelled, and frequently they are not properly defined or referenced. In addition, abbreviations have different meanings in different contexts. CT means "computed tomography" to a

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radiologist, but it can signify “cardiothoracic [surgery]” to a surgeon. Every attempt has been made to adequately spell and define important terms as they arise in the device discussions in addition to their being included in the glossary.

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