

## Extremity Fractures in Children: When Is It an Emergency?

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Not all pediatric fractures require emergent orthopedic attention. The information needed to assess and provide the appropriate interventions to children and their families following an extremity fracture is discussed in this article. A case study is used to describe a fracture that requires emergent intervention. The role of the pediatric orthopaedic nurse practitioner in the emergency department, inpatient, and outpatient setting is also illustrated.  
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**W**HEN A CHILD breaks a bone (sustains a fracture), the family, the school nurse, the coach, even nonpediatric emergency departments, often consider this a medical emergency situation. Many pediatric extremity injuries are actually a low-priority situation. Overcrowded emergency departments and long waiting times necessitate alternative approaches for managing children with extremity fractures. This article describes pediatric skeletal extremity injuries, lists fractures and associated complications that require immediate evaluation, identifies teaching needs of families, and describes a unique program developed by a busy pediatric ambulatory orthopedic service at a Level I pediatric trauma center.

### INCIDENCE OF FRACTURES IN CHILDREN

Fractures in children are a common reason for emergency department visits and hospitalizations.

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However, the majority of fractures can be safely managed on an outpatient basis. It is estimated that boys have a 42% chance of sustaining at least one fracture between the ages of 0 and 16 years and girls have a 27% chance. The chance of a fracture severe enough to require hospitalization during the first 16 years of life is 6.8%. In girls, fracture incidence peaks at age 12 years and in boys peaks at age 15 years (Beaty & Kasser, 2001). Fractures in the upper extremity are more common than fractures in the lower extremity, although admission with surgical treatment is more common for injuries to the lower extremities than the upper extremity (Kay & Matthys, 2001). The radius is the most commonly fractured upper extremity bone followed by the bones in the hand (metacarpals, carpals, and phalanges). In the lower extremities, the tibia is fractured more often than other bones (Worlock & Stower, 1988). Fractures occur because of three main causes: accidental trauma, nonaccidental trauma (child abuse), and pathological conditions. Accidental trauma composes the largest group.

### UNIQUENESS OF FRACTURES IN CHILDREN

Because fractures in children are very common, it is important for nurses to understand the unique characteristics of the immature and developing

**Table 1. Unique Characteristics of Fractures in Children****Anatomic**

*Presence of growth plate/physis:* The physis (growth plate) is the cartilage between the epiphysis, the most distal aspect of the long bones, and metaphysis, the growing portion of the long bones (Figure 1). Each long bone has at least two growth plates, one at each end. The growth plate will determine the future length and shape of the bones. The growth plate in a child is the weakest part of the bone and is frequently the site of injury during trauma. Fractures through the growth plate are most commonly described using the Salter–Harris classification system (Salter, 1999). With this classification system, there is a progressive increase in physal damage from Types I to VI fractures.

*Nursing care implications:* Any growth plate injury should be referred for further evaluation and possible intervention. Delay in treatment, depending on the severity of the injury, can cause part or all of the bone to stop growing, resulting in shortening and/or angular deformity of the limb. The Salter–Harris classification can assist prognostic information regarding the risk for permanent growth plate injury.

*Thicker and more elastic periosteum:* The periosteum is the vascular sheath around bone that is responsible for the thickness of the bone. It helps to partially stabilize the bone when a fracture occurs. This allows many fractures to be treated with closed reduction and casting rather than surgery.

*Nursing care implications:* Fractures in children are more stable than those in adults because of the thick periosteum. Therefore, fractures in children are often less displaced and do not require surgery as often as fractures in adults. For a stable fracture, splinting is usually adequate, but casting may be needed to decrease the child's activity level and provide comfort.

**Biomechanical**

*Increased number of vascular canals and decreased mineral content:* This increases the bones' flexibility, allowing bones to buckle or bow rather than to break completely.

*Nursing care implications:* The greater porosity of the bones causes greater flexibility in the bones of children leading to a bowing deformity, which is a unique fracture pattern seen primarily in children. If this fracture is untreated or undiagnosed, this could affect long-term motion in the affected extremity.

*Bone is weaker than ligaments and tendons:* Ligamentous injury, or a sprain, is uncommon in the skeletally immature pediatric population. It is more common to sustain a growth plate/physis fracture.

*Nursing care implications:* Fractures in children are more common than sprains and should be suspected if the child complains of pain at the growth plate even with a negative x-ray. Often, splinting or casting is necessary to decrease the child's activity level and provide comfort. Growth plates have not yet hardened into solid bone, therefore do not show up on x-ray.

**Physiological**

*Rapid healing:* Because of increased blood flow and cellular activity, nonunions or fractures that do not heal are rare in pediatrics.

*Nursing care implications:* The younger the child, the more rapid the healing process. The closer the fracture is to the growth plate, the more rapid the healing process.

*Remodeling:* In this process, bone is broken down and new bone is formed. Remodeling allows bones to straighten themselves out over time.

*Nursing care implications:* Because children have a greater potential for remodeling (straightening out of the bones) than adults, perfect alignment of a fracture is not necessary for adequate healing and function.

Data from England and Sundberg (1996), Lipp (1998), Mabrey and Fitch (1989), Musgrave and Mendelson (2002), and Ogden (1990).

skeletal system and how fractures in children differ from those of adults. Children's bones are anatomically, biomechanically, and physiologically different from adults. An understanding of these differences will allow nurses to better identify and triage fractures of an urgent nature. Table 1 describes these unique differences of fractures and their nursing care implications. Figure 1 shows the normal anatomy of the wrist.

### COMMON EXTREMITY FRACTURES IN PEDIATRICS

Table 2 describes the types of fractures seen in children (see Figures 2-5 for the anterior-posterior view of the fractures). Depending on history, physical assessment, and radiological findings, many of them do not require emergency orthopedic intervention.

### FRACTURES REQUIRING IMMEDIATE ATTENTION

Several orthopedic injuries require emergent treatment and surgical intervention. Compartment syndrome with and without fracture, open fractures, fractures associated with vascular or nerve injuries, and irreducible joint dislocations are surgical emergencies. Delay in treatment can result in morbidity such as loss of limb function and infections such as osteomyelitis. The child should be referred immediately to a medical center that can provide pediatric orthopedic expertise. All of these surgical emergencies can be detected with a thorough history, physical assessment, and radiological findings (O'Carroll, 2000).

### PHYSICAL ASSESSMENT

Table 3 provides an overview of nonemergent and emergent physical assessment findings. "Red



Figure 1. Anterior–posterior view of the wrist: normal anatomy.

flags” indicate emergency situations. Table 4 summarizes key nursing interventions that are required for situations that are considered emergent in nature.

### EDUCATIONAL NEEDS OF THE CHILD AND FAMILY

Each family should receive instruction for assessing the neurovascular status of the distal extremity while in a splint or cast. They should also receive teaching on care of the splint or cast and care of the skin under and around the cast edges. If the child will be discharged with crutches or a walker, thorough instruction should be given on use and maintenance of the equipment, as well as weight-bearing status of the extremity. Table 5 lists some key points to address during teaching.

Table 2. Types of Fractures Seen in Children

<i>Plastic or bowing deformity:</i> Significant bending without breaking may cause angular deformity of the bone (Figure 2).
<i>Buckle fracture:</i> Compression injury with minimal cortical disruption. The cortex of the bone is the protective outer shell around the bone. These fractures are usually caused by axial loading in which the force is exerted parallel to the primary axis. Example: A child runs into a wall with his arm straight out—all the force goes down the bone (Figure 3).
<i>Greenstick fracture:</i> Incomplete fracture of the bone (Figure 4).
<i>Complete fracture:</i> Bones become divided into two pieces: They often remain attached by the periosteum (Figure 5).

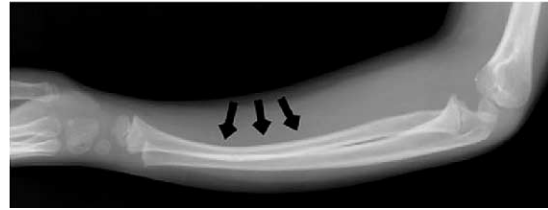


Figure 2. Lateral view of a plastic or bowing deformity of the forearm.

### CASE STUDY

An example of a fracture that requires emergent evaluation and intervention is illustrated in the following case.

A 5-year-old male presents to the emergency department with his mother; his chief complaint is left elbow pain. While playing on the jungle gym earlier that day, he fell and landed on his outstretched left arm. He reported immediate pain to his left elbow and was unable to move it. He had visible swelling and deformity around the elbow.

On examination, his vital signs were normal for age except for sinus tachycardia of 120 bpm. Swelling, bruising, and deformity were visualized slightly above the left elbow with no evidence of broken skin at the site of injury (Figure 6). Radial and brachial pulses were palpable. He had full sensation to light touch and intact motor function of his wrist, hand, and shoulder. He was tearful when his elbow was touched and refused attempts at flexion and extension. There were no other signs of external trauma.

Figure 7 reveals a normal anterior-posterior x-ray of the elbow for purposes of comparison.



Figure 3. Anterior–posterior view of a buckle fracture.



Figure 4. Anterior–posterior view of a greenstick fracture.

Anterior–posterior x-rays of the elbow revealed a Type III left supracondylar humeral fracture (Figure 8).

Following emergency evaluation, he was taken to the operating room. He underwent a closed reduction with percutaneous pinning of his fracture (Figure 9). He was placed into a long arm cast, which was bivalved to accommodate anticipated swelling. The child spent the night in the hospital for pain management, arm elevation, and circulation, sensation, and motion assessment. The following day, an orthopedic nurse practitioner visited the child and his parents on the inpatient unit to reinforce the home care instructions, and provided



Figure 5. Anterior–posterior view of a complete fracture.

Table 3. Physical Assessment

Parameter	Lower Extremity	Upper Extremity
<i>Inspect</i>		
<i>Skin</i>	Discoloration Swelling Deformity <i>Red flag</i> Open wound	Discoloration Swelling Deformity <i>Red flag</i> Open wound
<i>Observe</i>		
<i>joint range of motion</i>	<i>Hip</i> Decreased ability to flex, extend, abduct, adduct, or externally and internally rotate <i>Knee</i> Decreased ability to flex, extend, abduct, adduct, or internal and external rotation <i>Ankle</i> Decreased ability to dorsiflex, plantarflex, invert, or evert <i>Phalanges</i> Decreased ability to flex, extend, hyperflex, or hyperextend <i>Red flag</i> Incapable of any movement	<i>Shoulder</i> Decreased ability to flex, extend, abduct, adduct, or externally and internally rotate <i>Elbow</i> Decreased ability to flex, extend, supinate, or pronate  <i>Wrist</i> Decreased ability to flex, extend, ulnar deviate, or radial deviate <i>Phalanges</i> Decreased ability to flex, extend, hyperflex, or hyperextend <i>Red flag</i> Incapable of any movement
<i>Palpate</i>		
<i>Pulses</i>	<i>Integrity of pulses</i> Presence and strength distal to the injury (femoral, popliteal, pedal) <i>Red flag</i> Diminished or absent pulse Cool, cold, blue hue distal to injury	<i>Integrity of pulses</i> Presence and strength distal to the injury (brachial, median, radial) <i>Red flag</i> Diminished or absent pulse Cool, cold, blue hue distal to injury
<i>Describe</i>		
<i>Sensation</i>	<i>Integrity of nerves</i> Sensation to touch present <i>Red flag</i> Numbness, tingling, and intermittent or complete paresthesia Localized point tenderness; constant or intermittent rate pain by approved pain scale <i>Red flag</i> Persistent pain, not relieved by analgesics	<i>Integrity of nerves</i> Sensation to touch present <i>Red flag</i> Numbness, tingling, and intermittent or complete paresthesia Localized point tenderness; constant or intermittent rate pain by approved pain scale <i>Red flag</i> Persistent pain, not relieved by analgesics
<i>Pain</i>		

Data from Moloney-Harmon and Czerwinski (2003).

them with a discharge instruction tool specific for supracondylar fracture. All questions were answered and a follow-up appointment was scheduled with the orthopedic surgeon. The nurse practitioner

**Table 4. Nursing Care Interventions for Findings of an Emergent Nature**

Issue/ Complication	Intervention
Bleeding	Control bleeding by applying pressure with a sterile dressing. Avoid hypovolemic shock by administering intravenous fluids and oxygen.
Open fracture	Stabilize an impaled object; do not remove it. The wound should be irrigated with saline and covered with a sterile dressing to prevent infection. Tetanus prophylaxis should be administered if not up to date. Intravenous antibiotic therapy is indicated for open fractures. First-generation cephalosporins are usually used.
Deformity	Immobilize above and below the injury site in the most comfortable position with a splint. Do not attempt to straighten the limb or manipulate protruding bone.
Swelling	Apply and intermittently reapply cool packs to the injured area for up to 48 hours if needed. Elevate the extremity above the level of the heart.
Pain/anxiety	Initiate oral or intravenous analgesia as soon as possible.
Status change	Frequently assess, document, and report the five Ps (pain, pallor, pulses, paresthesia, and paralysis).
Procedure education	Preoperative or procedural sedation teaching for the child and family. Clearly explain all procedures to the child and family.
Discharge education	Verbal and written family teaching for management at home.

Data from Moloney-Harmon and Czerwinski (2003).

also gave the family contact information in the event of concerns or questions after discharge.

### ROLE OF ORTHOPEDIC NURSE PRACTITIONER ACROSS THE CONTINUUM OF CARE

The role of the nurse practitioner within the department of orthopedic surgery at Children's Hospital Boston began in 1997 and continues to evolve to meet the complex needs of the patients. Currently, there are five full-time nurse practitioners collaborating with 16 orthopedic surgeons. The nurse practitioners primarily work in the ambulatory setting. They complete all histories, physical assessments, and teaching on preoperative patients; they diagnose and treat children with common orthopedic disorders; they assist the orthopedic surgeons with the care of patients, such as patients with scoliosis, birth defects, and traumatic injuries. They are also responsible for telephone triage, which includes assisting with scheduling of patients based

on urgency, answering parents' questions about the care of their child, and acting as a resource for the nonnursing appointment schedulers. Outside the ambulatory care setting, the nurse practitioners cross over to inpatient units and the emergency department to assist with education of both patients and the nurses. They work with interprofessional staff members on patient care plans and discharge/follow-up plans, as well as contribute to staff education.

Since 1996, the nurse practitioners have also helped to track and monitor patient care-related problems, such as poor communication and missed appointments. One problem that was identified was the lack of appropriate teaching and follow-up for children who were evaluated by the orthopedic

**Table 5. Education**

Teaching Point	Suggested Intervention
Swelling	Elevate the limb above the level of the heart. Apply cool packs. Have the child wiggle the fingers and toes hourly.
Itchy skin	Use a hair dryer on a cool, low setting to blow air into the cast. Use distraction. Never put anything into the cast to scratch, the skin may break and result in complications.
Skin care	Check the skin around the cast daily for open or irritated areas. Never use lotions or powders because they will soften and irritate the skin. Protect the cast from getting wet. When showering and bathing, cover the cast with a heavy plastic bag and waterproof tape. Use a hairdryer on cool to help dry a cast that is damp.
Pain management	Provide oral analgesia as directed. Decrease activity and elevate the extremity. Provide distraction.
Equipment maintenance	Check walkers and crutches daily for loose screws and fasten tightly. Check the grips and tips for worn out areas and replace if necessary. Survey the area in which the child will be using the equipment for safety hazards.
When to call the doctor	Persistent numbness and tingling. Severe pain when moving fingers or toes. Extreme soreness or discoloration of fingers or toes. Coolness of the extremity in cast. Decreased ability to move fingers or toes. A bad smell or drainage from under the cast. Severe itching. Red, broken, or swollen skin around or under the cast. Cracked, split, or softened cast. Fever for more than a day.



Figure 6. Painful elbow after fall.

surgeons in the emergency department, so the nurse practitioners were charged with improving outcomes for orthopedic patients seen in the emergency department. The role of the orthopedic nurse practitioner expanded to include follow-up on patients who had been evaluated, treated, and discharged to home from the emergency department or admitted for surgery or observation.

After a meeting with emergency department physicians, nurses, and support staff, an orthopedic patient logbook was developed to identify all orthopedic patients seen in the emergency department. The logbook includes patient demographics, diagnosis, treatment, and proposed follow-up plans. Patients are entered into the logbook by the orthopedic surgeon who sees the patient. The orthopedic nurse practitioners oriented the rotating orthopedic surgeons to the use of the logbook, and

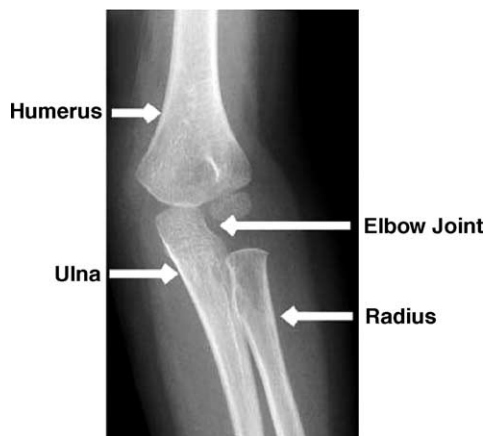


Figure 7. Anterior-posterior view of the elbow: normal anatomy.



Figure 8. Anterior-posterior view of a Type III supracondylar fracture of the humerus.

have frequent discussions with the surgeons to review patient teaching and follow-up plans.

Each morning, a nurse practitioner reviews the logbook and calls all the patients who have been discharged to home. The purpose of these calls is to assure that families have a clear understanding of what occurred in the emergency department, to answer any further questions, and to schedule appropriate follow-up appointments. Many of the children with simple fractures or sprains are scheduled in the nurse practitioner clinic with physician coverage if necessary. Families have been



Figure 9. Anterior-posterior view of a supracondylar fracture of the humerus after a closed reduction and percutaneous pinning.

very receptive to the telephone follow-up and nurse practitioner care. For admitted patients, the nurse practitioner visits the child in the hospital and assists with care plan development and discharge planning and teaching. The nurse practitioner also participates in daily inpatient rounds, which include nursing, child life, social work, physical therapy, and the discharge planning coordinator.

The emergency department follow-up has been very successful. Parents have expressed gratitude for the follow-up service; the number of incoming calls from parents asking questions about care of their child has decreased; and the number of inappropriately scheduled appointments has decreased. This role extension has freed up appointment space for other children, and it has assured safe follow-up for emergency department patients.

Not every hospital has the resources to implement this type of nurse practitioner-sponsored program. This information was included to illustrate the efficiency and effectiveness of using advanced practice nurses to improve care outcomes for this pediatric patient population. The primary purpose, however, was to illustrate some important underlying concepts of this article. When children have fractures, they are brought to emergency departments. Whether the fractures are simple or complex, whether they require

surgical intervention or not, fractures produce a great deal of anxiety and concern. Our experience as nurse practitioners caring for this population has shown that problems occur when there is lack of sufficient education and follow-up to allay concern and to decrease anxiety. Nurses are in an ideal situation to use their knowledge of fractures, physical assessment skills, and basic intervention skills to effectively educate and inform parents (and patients) about the injury. It is inevitable that children with fractures will require nursing intervention. What nurses say and do can make a significant difference.

## CONCLUSION

Musculoskeletal injury is a leading cause of emergency department use and disability among children (Buckley et al., 1994). It is important for nurses to obtain a thorough history focusing on the mechanism of injury, to understand the unique characteristics of the immature, developing skeletal system, and to recognize common fractures. Early identification of clinical signs of emergent injuries can expedite definitive treatment. Prompt nursing interventions, accompanied by thoughtful explanations and appropriate education can help alleviate unnecessary fear and concern.

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