Orthopaedic Conditions in the Newborn

Abstract

The occasional consultation on a neonate can be unfamiliar territory for many orthopaedic surgeons. Just as children are not little adults, newborns are not just little children; rather, they have a unique physiology that affects the presentation of their orthopaedic concerns. Careful physical examination with appropriate understanding of neonatal development is essential to making the proper diagnosis. A flail extremity in the newborn is most commonly attributed to fracture or brachial plexus palsy; however, infection must also be considered and ruled out to prevent long-term morbidity. Metatarsus adductus is the most common foot abnormality, but clubfoot, calcaneovalgus deformity, and congenital vertical talus may also be encountered. Joint contractures that spontaneously improve are normal in the newborn, but it is important to identify and institute proper treatment for early developmental dysplasia of the hip, congenital knee dislocation, and torticollis. Clavicular pseudarthrosis and periosteal reactions may be discovered on radiographic examination. A basic understanding of the relevant conditions will help the orthopaedist with the initial diagnosis and management of orthopaedic issues in the newborn.

Consultation on a newborn can elicit anxiety for many orthopaedic surgeons. Even for the dedicated pediatric orthopaedist, neonates constitute a small fraction of an overall practice. Newborns have a distinctive physiology and pathology, and many consulting orthopaedic surgeons are relatively unfamiliar with the diagnostic criteria and management of orthopaedic diseases and disorders in the newborn. Fortunately, there are relatively few orthopaedic problems in this age group. However, it is imperative to make a proper and timely diagnosis to minimize long-term morbidity as a result of delayed or improper treatment. Infants from birth to 3 months of age are most likely to be encountered in a neonatal intensive care unit (NICU) or newborn nursery.

Examination of the Newborn

Evaluation of a newborn can be challenging because the surgeon may be unfamiliar with musculoskeletal conditions deemed “normal” in children of this age. Proper patient evaluation begins with a careful history, including gestational age and prenatal and birth history. For example, difficult vaginal delivery of a large infant can be a risk factor for fracture or brachial plexus injury, and breech position can be associated with developmental dysplasia of the hip (DDH).
Physical examination should be performed with the patient in the supine position and away from direct light. The skin should be evaluated for overall integrity. Depigmented nevi and café-au-lait spots can be associated with tuberous sclerosis, fibrous dysplasia, and neurofibromatosis. Neck range of motion (ROM) should be carefully assessed because limited motion can be an indicator of Klippel-Feil syndrome or congenital muscular torticollis (especially when the sternocleidomastoid muscle is tight). The clavicles should be palpated to detect fracture or congenital pseudarthrosis. Assessment of the shoulders, elbows, hips, knees, and ankles should include ROM testing; stiffness in multiple joints may be caused by arthropgyrosis.

Newborns should be evaluated for DDH. With the patient supine, the examiner should grasp the infant’s thigh with the thumb over the lesser trochanter medially and the ring or middle finger around the greater trochanter laterally. The Ortolani test is performed by gently abducting the hip while exerting an upward force on the greater trochanter. A palpable “clunk” represents the reduction of a dislocatable (but reducible) hip. The Barlow test is performed with the patient in the same position and the hip in neutral or slight abduction; a gentle downward force is applied to the hip joint. If the femoral head moves out of the acetabulum, the hip is considered dislocatable. In addition, the hips should be checked for asymmetric abduction or unequal leg lengths (Galeazzi test). The Galeazzi test is performed on a flat surface with the hips and the knees flexed. Unequal knee heights suggest the presence of a dislocated hip or a congenitally short femur.

The feet should be methodically examined, with the examiner taking note of the position of both the hindfoot and the forefoot. Normally, the longitudinal arch is absent in infants, but a high arch could be an indicator of neurologic problems. The examiner should observe for spontaneous movement of all extremities. Newborns should then be turned onto their side or belly to examine the back and gluteal cleft, looking carefully for hairy patches, dimples, and midline defects.

Many primitive reflexes are present in neonates and are indicators of normal development. These reflexes are present at birth and disappear as a part of normal maturation. The absence of these reflexes often indicates a delay in normal neurologic development, and their persistence beyond the expected time of disappearance also suggests neurologic dysfunction. The grasp reflex can be elicited by placing a finger or an object in the infant’s palm or foot, stimulating a grip response because of reflexive flexion of the digits. The hand grasp reflex is strongest at birth and normally disappears between 2 and 4 months of age; the plantar response disappears between 9 and 12 months of age. Asymmetry or persistence beyond 4 months for the hand and 1 year for the foot may be an indicator of cerebral palsy. Unilateral absence of the reflex may indicate flaccid paralysis secondary to complete brachial plexus palsy.

The Moro reflex is elicited by sudden extension of an infant’s neck. This reflex can be tested for by holding the infant supine above the examining table and suddenly lowering the hand supporting the child’s head. The first phase of the reflex consists of sudden abduction and extension of all four limbs, extension of the spine, and extension and fanning of the fingers. This is followed by adduction and flexion of all four limbs, with the arms clapping over the body. The Moro reflex is present at birth and normally disappears between ages 3 and 6 months. The reflex may be subdued in infants with severe hypertonicity, marked hypotonicity, or flaccid paralysis. If the reflex persists beyond age 6 months, developmental delay from a condition such as cerebral palsy should be suspected. The Moro reflex will be absent when nerve injuries exist but present in other conditions causing decreased upper extremity movement, such as fracture or infection.

The walking or stepping reflex is demonstrated by supporting the trunk of the infant in an upright position. The plantar surfaces are touched down on the examining table, and the child is tipped forward. This normally results in a reflexive alternating flexion and extension of the lower limbs, simulating walking. This reflex is present at birth and disappears by 1 to 2 months. Its absence may be the result of flaccid paralysis, and its persistence beyond normal age may signal neurologic impairment.

Major Diseases and Disorders

The Flail Extremity

One of the most common reasons for orthopaedic consultation in the NICU is failure of an infant to move a limb, usually an arm. Although it may be obvious to include fracture or brachial plexus palsy in the differential diagnosis, infection is one of the most concerning diagnoses that must be ruled out. Lack of movement can be seen with any of these diagnoses. The affected limb should first be palpated to check for crepitus or other signs of obvious fracture. If the diagnosis is still uncertain, a way to distinguish brachial plexus palsy from the pseudoparalysis of an infection or fracture is to gently shake the limb. If the infant experiences pain, infection or fracture is likely.
not completely rule out concomitant nerve injury. One study cited a 10% incidence of brachial plexus injury with clavicle fractures, highlighting the need for neurologic evaluation in the setting of a fracture.\(^5\)

**Infection**

The diagnosis of infection in neonates is often difficult and requires a high index of suspicion. Infants have underdeveloped immune systems that affect clinical and laboratory findings. Infected joints are usually, but not always, red, swollen, and hot. Fever can be an unreliable sign of infection. At least 15% to 25% of newborns with sepsis present with hypothermia rather than a fever because of thermoregulatory dysfunction.\(^3\) In the first week of life, normal white blood cell counts range from 9,000 to 30,000 cells/mL. Leukopenia (<5,000 cells/mL), rather than leukocytosis, is often suggestive of infection. Erythrocyte sedimentation rate is also an unreliable indicator in this age group. A normal C-reactive protein value, however, is extremely useful for ruling out infection, with a negative predictive value of 95%.\(^6\) The positive predictive value of an elevated C-reactive protein level is 60%, making an elevated value suggestive but certainly not diagnostic of infection.\(^6\) At the time of orthopaedic evaluation, the index of suspicion for infection should be even higher in neonates attached to multiple intravenous lines and central catheters, which can serve as iatrogenic sources of infection.

Historically, *Staphylococcus aureus* has been the most common offending pathogen involved in neonatal infections, followed by group B streptococci.\(^7,9\) A recent study, however, has cited a possible change in the epidemiology toward gram-negative infections.\(^10\) Blood cultures are positive in between 21% and 47% of cases, and the incidence of culture-negative septic arthritis may be as high as 43%.\(^10\) Multiple-site involvement is seen in as many as one half of neonates.

Before the appearance of the secondary ossification center, the epiphysis receives blood directly from metaphyseal blood vessels. Thus, septic arthritis is a common sequela of adjacent osteomyelitis. One study indicated that in 76% of neonates with osteomyelitis, infection led to epiphyseal insult or septic arthritis.\(^11\)

Because of the lax nature of surrounding muscles, septic arthritis in neonates may lead to joint subluxation or dislocation visible on plain radiographs\(^12\) (Figure 1). Metaphyseal rarefaction and periosteal reaction are other radiographic findings that have been described.\(^9\) If the diagnosis is uncertain, ultrasonographic examination should be performed to look for intra-articular pus or subperiosteal abscess (Figure 2). Suspected joints should be aspirated, and infections should be surgically drained as soon as is practical. When a septic hip is found, an ultrasound examination of the contralateral hip should be performed because there may be bilateral involvement.

Considerable morbidity may be associated with neonatal infections. Septic arthritis in particular can rapidly destroy joint cartilage and can cause physeal destruction, secondary limb-length discrepancy, postinfectious arthritis, osteonecrosis of the epiphysis, and even epiphyseal separation.\(^12,13\) Early diagnosis and treatment of neonatal infections is critical to avoid such severe complications.

**Brachial Plexus Palsy**

Another cause for lack of movement in an upper limb is a brachial plexus palsy. The incidence of this disorder has been estimated to be between 0.13 and 3.6 per 1,000 live births.\(^14,16\) Risk factors include maternal diabetes, high birth weight, prolonged labor, forceps delivery, and shoulder dystocia. Brachial plexus palsies are associated with clavicle and humerus fractures, as well as torticollis.\(^14,16\)

Diagnosis is based on clinical ex-
amination. The infant should be evaluated both supine and prone for spontaneous movements; muscle groups should be palpated for tone and voluntary contractions. The most common type of brachial plexus palsy with upper trunk (ie, C5 and C6) involvement is known as Erb palsy. This palsy exhibits the characteristic “waiter’s tip” appearance of the arm and hand caused by shoulder internal rotation, elbow extension, forearm pronation, and wrist flexion (Figure 3). With total plexus involvement, the neonate’s limb is often completely flaccid and may be associated with Horner syndrome (ie, ptosis, miosis, enophthalmos) of the ipsilateral eye when the sympathetic chain is affected. In these severe cases, the surgeon should consider obtaining a chest radiograph to check for ipsilateral diaphragmatic paralysis resulting from phrenic nerve dysfunction. Radiographs are useful for ruling out non-physeal fractures. The Moro test or the “shake test” can be used to distinguish a brachial plexus palsy from an infection or a fracture.

Occupational or physical therapy should be considered for all patients with brachial plexus palsies, but ROM exercises should be deferred for 10 to 14 days after birth to allow for pain to subside. Because as few as 1 of 10 infants with plexus palsies at birth will require surgical intervention, the goal of initial management is to maintain passive ROM while motor function is recovering. Because the decision to explore the plexus is based entirely on recovery of muscle function, a neonate with brachial plexus injuries should be promptly referred to a specialist who can follow the child with careful, sequential neurologic examinations. Historically, surgery has been recommended when there is no recovery in biceps function by ages 3 to 6 months. However, a recent study has suggested that some infants with no biceps recovery by 3 months will eventually achieve adequate biceps and shoulder function without surgery. Although the timing of surgical intervention is controversial, early referral is important because surgical exploration after 18 months is of little benefit.

Fracture

Fracture is the third major cause of a nonmoving limb. Birth-related fractures are not uncommon; risk factors include breech position, macrosomia, and vaginal delivery. The incidence of clavicular fractures has been reported to be 1.1% of all live births. The number of femoral fractures is smaller: one series found 0.13 instances per 1,000 live births. For infants whose fractures are noted after hospital discharge, child abuse must be considered as a potential cause.

Diagnosis is not always straightforward because large physes and incomplete ossification of the epiphyses can make fracture visualization difficult. In the upper limb, a major pitfall in neonates is an unrecognized proximal humerus physis fracture or, less commonly, a fracture of the distal humerus. On physical examination, there is usually local fullness and tenderness as well as pain with motion of the limb. Clavicular fractures can often be diagnosed by palpating a spongy mass over the fracture site. Radiographs generally confirm the diagnosis of nonphyseal fractures. Callus is often already visible at a fracture site by the time the fracture is diagnosed. When radiographs are normal, ultrasonographic imaging is extremely useful for demonstrating occult fractures, particularly those about the proximal humerus. Ultrasonography also can reveal joint effusion or subperiosteal fluid accumulation characteristic of infection. In a patient with multiple fractures, an underlying condition such as osteogenesis imperfecta or neonatal rickets should be considered.

Fractures in the neonate generally heal rapidly, and outcomes are often be-
Limb-length discrepancy or angular deformity following proper fracture treatment is rare. Most neonatal fractures require immobilization for only 7 to 10 days. The Pavlik harness is a well-accepted treatment modality for femoral fractures in the neonate. Advantages of a Pavlik harness compared with conventional spica casts include ease of application without the need for general anesthesia, reliable fracture reduction, and improved diapering and perineal care. Certain surgeons cite higher pain scores with the use of Pavlik harnesses and therefore prefer single-leg Gore-Tex (W. L. Gore, Flagstaff, AZ) soft cast splints, which are washable and provide better compressive forces at the fracture site. For upper extremity fractures, standard slings and shoulder immobilizers are much too large to fit most newborns. One option is to use a cotton stockinette, although this may migrate around the neck (Figure 5). A safe and simple alternative is to pin the sleeve of the infant’s shirt to the torso of the shirt.

**Metatarsus Adductus**

Metatarsus adductus is a common foot deformity seen after birth, occurring in as many as 1 in 100 live births, and is thought to relate to intrauterine positioning. Metatarsus adductus consists of an adducted forefoot, a curved lateral border, and a neutral heel, creating the characteristic “bean shape” sole of the foot. Flexible deformities may be treated with observation or stretching; 90% to 95% will resolve spontaneously regardless of treatment. For rigid deformities, serial manipulation and casting should be done before age 6 months. Surgery is rarely required and is indicated only for a child older than age 3 years with a rigid deformity that has not responded to serial casting.

**Clubfoot**

Talipes equinovarus (ie, clubfoot deformity) occurs in approximately 1 to 2 in 1,000 births. This deformity is characterized as cavus, forefoot adductus, hindfoot varus, and equinus (ie, CAVE). Clubfoot has a wide spectrum of presentations, from a mild, postural form to a severe, rigid deformity. The latter is usually associated with arthrogryposis, myelomeningocele, Larsen syndrome, or other underlying disorder.

Most neonatal clubfoot deformities can be treated nonsurgically. The Ponseti method of serial manipulation and casting has gained widespread support and has revolutionized the treatment of talipes equinovarus. Several studies have shown excellent mid- and long-term results.
results with decreased stiffness as a result of using the Ponseti method of serial casting and Achilles tenotomy compared with feet that have been treated surgically.\(^{29,30}\) Although some centers initiate casting in the newborn nursery or NICU within a few days of delivery, treatment is not emergent. Dobbs et al\(^{31}\) demonstrated that neither the age at which treatment was initiated nor the severity of the initial deformity was found to have a significant effect on recurrence. As a result, many pediatric orthopaedists prefer to initiate serial casting in a controlled, outpatient setting after the infants have been discharged from the hospital. Others prefer early casting in the hospital to take advantage of neonatal ligamentous laxity and to reassure family members that the child’s deformity is being attended to.

**Calcaneovalgus Foot**

Although some believe that a mild form of calcaneovalgus foot deformity occurs in 30% to 40% of newborns, the estimated incidence of this deformity is 0.4 to 1.0 in 1,000 live births.\(^{32}\) In the calcaneovalgus foot, the hindfoot externally rotates and dorsiflexes. In some cases, this causes the dorsum of the foot to be in contact with the anterior tibia. It is important to distinguish the calcaneovalgus foot from posteromedial bowing of the tibia; in the former, the apex of the deformity is in the ankle joint, whereas in the latter, the apex is in the distal tibia\(^{4}\) (Figure 6). Gentle stretching of the foot into plantar flexion and inversion can be helpful; however, most deformities will resolve spontaneously by age 3 to 6 months regardless of treatment. In patients with posteromedial bowing of the tibia, parents should be counseled that a limb-length discrepancy (usually 3 to 4 cm) is likely to result.

**Congenital Vertical Talus**

Congenital vertical talus (CVT) is a rare foot deformity that can be confused with the calcaneovalgus foot. CVT is characterized by a hindfoot that is in equinus. The forefoot is dorsiflexed, resulting in a midfoot dislocation through the talonavicular joint (Figure 7). Unlike the calcaneovalgus foot, which is flexible, CVT is a rigid deformity with a convex plantar surface that forms a rocker-bottom deformity. Plantar flexion lateral radiographs are useful for distinguishing an oblique vertical talus from a CVT (Figure 8). A genetic consultation may be considered because up to 60% of cases of CVT may be associated with arthrogryposis or myelomeningocele.\(^{33}\)

During the neonatal period, serial manipulation and casting are useful to stretch the anterior skin as well as the capsular and musculotendinous soft tissues. Definitive surgical correction (ie, open release) is usually performed between ages 6 and 12 months, and results are better when surgery is performed before age 2 years.\(^{34}\) Recently, Dobbs et al\(^{31}\) described a new technique consisting of serial manipulation and cast immobilization followed by percutaneous talonavicular pin fixation and Achilles tenotomy. Early results have demonstrated excellent outcomes in terms of clinical appearance, deformity correction, and foot function.

**Dislocations and Contractures**

In the newborn, mild flexion contractures of the knee, hip, and elbow are normal and usually resolve with time.\(^{4}\) For example, one study found that the mean knee flexion contrac-
ture was 21° at birth, diminishing to 11° at age 3 months and to 3° at age 6 months. Absence of these “normal” contractures may be an indicator of an underlying disorder (eg, congenital knee dislocation).

**Early Developmental Dysplasia of the Hip**

The incidence of frank hip dislocation is 1 in 1,000 births, while the incidence of subluxation or dysplasia is 10 in 1,000. Major risk factors include breech position, congenital muscular torticollis, and family history of DDH. Lesser risk factors include being a first-born child and female sex. Newborns should be evaluated for asymmetric knee heights (ie, Galeazzi sign) in addition to undergoing the Barlow and Ortolani tests. The surgeon should be aware that bilateral hip dislocation may be present without asymmetry of leg length or hip abduction. One test that can help identify a bilateral dislocation is the Klisic test, in which the physician places the middle finger over the greater trochanter with the index finger on the anterior superior iliac spine. An imaginary line between these two fingers should point to the umbilicus. In the patient with a hip dislocation, the greater trochanter moves proximally, causing this line to point somewhere between the umbilicus and the pubis. An infant with a unilateral hip dislocation will eventually demonstrate limited hip abduction but may appear to be normal immediately after birth. Severe limitations in ROM with an irreducible hip abduction may indicate a teratologic dislocation resulting from a syndrome or neuromuscular cause.

Ultrasoundography is the diagnostic modality of choice for DDH before the appearance of the femoral head ossific nucleus (4 to 6 months). However, during the early newborn period (0 to 4 weeks), physical examination is preferred because there is a high incidence of false-positive sonograms in this age group. Ultrasoundographic imaging can identify mild subluxation and acetabular dysplasia in addition to documenting reducibility and stability of a hip undergoing treatment. Plain radiographs for this age group may document grossly dislocated teratologic hips, but they cannot be used definitively to declare a hip as being located or normal.

Orthopaedic consultation to evaluate an early hip click or a positive ultrasound image in the first few weeks of life does not automatically mandate immediate treatment. Most neonates with acetabular dysplasia or subluxatable hips may be observed until ages 3 to 4 weeks because a significant proportion of hips will resolve spontaneously. However, newborns with frank dislocations (Ortolani positive) or dislocatable hips (Barlow positive) should be treated at the time of diagnosis. The Pavlik harness is the mainstay of treatment for most cases of DDH in the newborn period (excluding teratologic hip dislocations). Straps should be adjusted so that the child is in approximately 100° of hip flexion and 60° of abduction. Excessive abduction can increase the risk of osteonecrosis. A follow-up ultrasonographic examination should be performed after 2 or 3 weeks of treatment to confirm reduction of the hip. Harness treatment should be discontinued at 4 weeks if the hip is not reduced by that time. Continued use of the harness beyond this period in a persistently dislocated hip can cause “Pavlik harness disease,” or a wearing away of the posterior aspect of the acetabulum, which may make the ultimate reduction less stable. In one study, investigators reported that the use of an abduction brace for those hips that failed Pavlik harness treatment may lead to stable hip reduction, thereby avoiding the need for closed reduction under general anesthesia.

**Congenital Knee Dislocation**

Congenital knee dislocation is a rare condition, with a reported incidence of 0.017 per 1,000, or about 1% as common as DDH. The etiology remains unclear, but the condition is most likely related to contracture of
the quadriceps femoris muscle with variable deformity of the anterior cruciate ligament. Associated conditions include clubfoot, arthrogryposis, myelodysplasia, and Larsen syndrome. Ipsilateral congenital hip dislocation is present in 70% to 100% of cases.41

The physical signs of congenital knee dislocation are apparent at birth. The knee is hyperextended, often to such a degree that the child’s foot can touch the face (Figure 9). In true dislocations, the knee cannot be flexed, and the femoral condyles can often be palpated in the popliteal fossa. Radiographs demonstrate the position of the tibia relative to the femur and allow classification as grade I (severe genu recurvatum), grade II (subluxation), or grade III (complete dislocation)41 (Figure 10). In cases that are still unclear, ultrasonography can be helpful for delineating the immature anatomy, classifying the condition, and monitoring treatment.42,43

Nonsurgical treatment should be started promptly after diagnosis. Manipulation techniques involve manual traction until the tibia is felt to engage with the femoral condyles, followed by flexion of the knee. Serial casting in progressive flexion should then be performed. In children with concomitant DDH, the congenital knee dislocation should be treated first. As knee flexion improves, the patient can be placed in a Pavlik harness, allowing treatment of both the knee and the hip.44 Surgery is indicated for children who do not respond to nonsurgical treatment and is best performed at the age of approximately 6 months. The procedure typically consists of open reduction with quadriceps lengthening.

Congenital Muscular Torticollis

Congenital muscular torticollis, a painless deformity caused by contracture of the sternocleidomastoid muscle, is the most common form of torticollis in newborns. The etiology remains controversial but most likely arises from intrauterine or perinatal compartment syndrome, which causes fibrosis of the sternocleidomastoid muscle.45 Risk factors include breech position and difficult delivery; associated conditions include DDH and metatarsus adductus.

The clinical appearance is characteristic, with the infant’s head tilted toward the involved muscle and the chin rotated toward the contralateral shoulder. An olive-shaped mass can sometimes be felt in the body of the sternocleidomastoid muscle in the first 3 months. This mass often disappears during early infancy but is replaced by a tight fibrous band over the length of the muscle as it fibroses.

Initial treatment consists of a massage and stretching program, which is successful in most cases when started in the first 6 months of life.46 For infants who do not respond to physical therapy, plain radiographs should be taken to rule out Klippel-Feil syndrome or other cervical spine anomaly. Children who present at an older age and those with torticollis refractory to therapy may require a release of the sternocleidomastoid muscle, usually around age 5 years.
Unusual Radiographic Findings

Congenital Pseudarthrosis of the Clavicle

Congenital pseudarthrosis of the clavicle is a rare condition in which the medial and lateral ossification centers of the clavicle fail to unite. The radiographic appearance is often confused with that of a clavicle fracture; however, congenital pseudarthrosis is not painful (Figure 11). A bump may be palpable at the pseudarthrosis site. The diagnosis is confirmed by the absence of callus on subsequent radiographs. The condition almost always occurs on the right side, unless dextrocardia is present. The natural history is benign, but surgical treatment of the congenital pseudarthrosis may be required if there is discomfort or concern about the cosmetic appearance of the bump.

Figure 11
Anteroposterior radiograph demonstrating pseudarthrosis of the right clavicle in an 8-day-old boy. (Reproduced with permission from Skaggs DL, Flynn JM [eds]: Staying Out of Trouble in Pediatric Orthopaedics. Philadelphia, PA: Lippincott Williams & Wilkins, 2006.)

Figure 12
Anteroposterior radiograph demonstrating physiologic neonatal periosteal reaction in a tibia. Note that the thickness is <2 mm. (Reproduced with permission from Kwon DS, Spevak MR, Fletcher K, Kleinman PK: Physiologic subperiosteal new bone formation: Prevalence, distribution, and thickness in neonates and infants. AJR Am J Roentgenol 2002;179:985-988.)

Periosteal New Bone

Periosteal reactions occur in a variety of scenarios in the newborn and can be both physiologic and pathologic. Physiologic periosteal reactions can be seen in 35% of infants ages 1 to 4 months. These are usually discovered incidentally on radiographs taken for other reasons. Physiologic periosteal reactions are thin, even, and symmetric, occurring along the femur, tibia, and humerus. Periosteal new bone that occurs in children younger than age 1 month or older than age 4 months may be pathologic. Periosteal thickness ≥2 mm is considered abnormal and should prompt further work-up (Figure 12). The differential diagnosis for pathologic periosteal reactions in the neonate includes Caffey disease, congenital syphilis, infection, malignancy, child abuse, hypervitaminosis A, history of prostaglandin infusion or extracorporeal membrane oxygenation, and scurvy (Figure 13).
Summary

Careful history and physical examination are required in the orthopaedic evaluation of a neonate. A flail extremity is usually caused by infection, fracture, or a brachial plexus palsy. Metatarsus adductus is the most common foot deformity, but clubfoot, calcaneovalgus deformities, and CVT may be seen. Flexion contractures early in the newborn period are common and are not pathologic. However, congenital dislocation of the hips or the knees may occur. Congenital pseudarthrosis of the clavicle and periosteal reactions are a few of the unusual radiographic findings in this age group. Armed with a basic understanding of the common orthopaedic issues in the newborn, the consulting orthopaedist should be comfortable making an initial diagnosis and managing most conditions.

References

Evidence-based Medicine: There are no level I references. References 3, 5, 20, 23, 26, and 35 are level II studies. References 2 and 24 are level III case-control studies, and references 7, 9, 10, 13-15, 18, 21, 22, 25, 29, 31, 32, 34, and 37-48 are level IV case series. Reference 30 is expert opinion.

Citation numbers printed in bold type indicate references published within the past 5 years.

34. Stricker SJ, Rosen E: Early one-stage


