

Proximal Valgus Femur Osteotomy for Coxa Vara

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Abstract: Coxa vara is a deformity of the proximal femur in which the femoral neck-shaft angle is decreased. This can be the result of an acquired deformity, metabolic disorder, congenital syndrome, or idiopathic (developmental). In this paper, we discuss the unique radiographic characteristics of developmental coxa vara, as well as radiographic measurements that can be used to determine severity. When surgical intervention is required, a proximal femoral valgus osteotomy is indicated. Most pediatric orthopaedic surgeons are facile with the varus proximal femur osteotomy but may not be as familiar with a valgus producing osteotomy. In this paper, we describe our preoperative planning algorithm, our surgical technique, and postoperative protocol.

Key Concepts:

- A complete metabolic and genetic workup should be done when evidence of coxa vara is seen on x-ray.
- A patient with a Hilgenreiner's epiphyseal angle (HEA) of less than 45 degrees will likely not need surgical intervention, while those patients with an HEA of 45-60 degrees should be carefully watched for progression, and patients with an HEA of 60 degrees or more need surgery.
- The typical rotational deformity of developmental coxa vara is retroversion, so internally rotate the femur to help correct this during surgery.
- The goal HEA correction is 38 degrees or less to prevent recurrence.

Introduction

Coxa vara is an abnormal proximal femoral condition characterized by a decreased femoral neck-shaft angle, a shortened femoral neck, relative overgrowth of the greater trochanter, and a shortened limb. This condition can be acquired as seen after slipped capital femoral epiphysis, femoral neck fracture, secondary to avascular necrosis of the femoral head (Perthes, post-traumatic), or due to metabolic bone disorders (rickets, osteogenesis imperfecta, or fibrous dysplasia). Coxa vara can be seen in association with a range of skeletal dysplasias such as cleidocranial dysostosis and metaphyseal dysostosis or as part of the broad condition of proximal femoral

deficiency. The term developmental coxa vara is typically reserved for the idiopathic condition of coxa vara associated with a primary defect in the endochondral ossification of the medial aspect of the femoral neck.¹ Due to the physiologic forces seen across the femoral neck, this inferomedial femoral neck defect leads to progressive deformity with the physis becoming more vertical as the child grows.

In the setting of an otherwise normal child, developmental coxa vara is associated with a pathognomonic finding of an inferomedial femoral neck

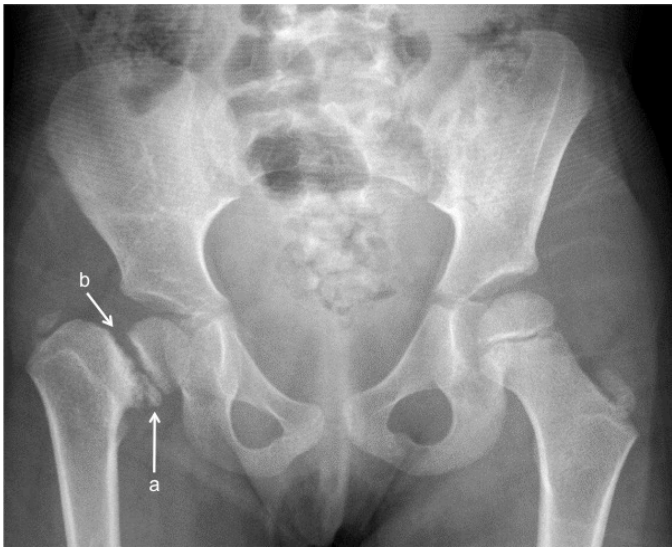


Figure 1. AP radiograph of a 5-year-old female with congenital coxa vara a) triangular metaphyseal fragment present at the inferior neck, b) vertical physis

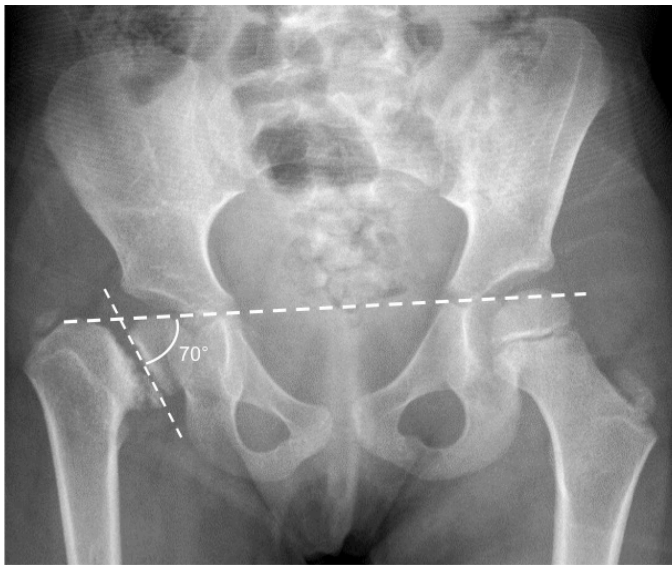


Figure 2. Hilgenreiner's epiphyseal angle (HEA) is the angle formed between Hilgenreiner's line and the physis, <25 degrees is normal. The HEA measured for this 5-year-old girl with congenital coxa vara is approximately 70 degrees.

cartilaginous defect. The condition is bilateral in approximately one third to one half of the cases. The child with unilateral coxa vara typically presents after walking age when caregivers notice a painless limp, easy

fatigability, or aching pain around the gluteal muscles. On exam, the patient demonstrates a classic Trendelenburg gait with a slight limb length inequality and often an external foot progression due to associated relative femoral retroversion. If both hips are involved, the patient will have a waddling gait, bilateral external foot progression, limited hip abduction (often described as an inability to sit in the crisscross position), and difficulty keeping up with peers. When indicated, the goals of surgery are to improve the mechanical alignment of the hip by increasing the neck shaft angle, improve hip range of motion, normalize gait, and in unilateral conditions, to equalize the limb length discrepancy.¹ Below we will describe indications for surgery, preoperative planning, our operative technique, our postoperative protocol, some tips, and potential complications that may arise while treating coxa vara.

Description of the Method

Work-up and Diagnosis

Due to the frequent association of coxa vara with other conditions, it is essential a complete workup accompanies this diagnosis. Referral to genetics, as well as a thorough metabolic evaluation, is important. Abnormally low vitamin D levels can indicate rickets, and abnormal chemistries can point towards renal osteodystrophy, both of which can present around the same age and should be treated medically before any surgical intervention.² The diagnosis of coxa vara is typically apparent radiographically. The classic findings seen on the AP pelvis x-ray are a decreased femoral neck-shaft angle, a vertically oriented physis, and a triangular metaphyseal fragment inferior in the neck. (Figure 1).^{1,2}

Decision-making

Treatment is based on both the severity of the initial deformity and if the deformity progresses over time. The severity of the deformity is measured by the Hilgenreiner's epiphyseal angle (HEA) (Figure 2).

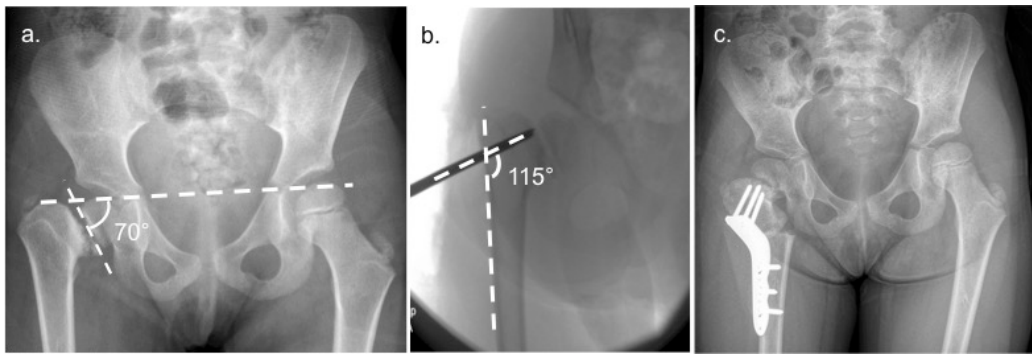


Figure 3. (A) Shows the HEA, (B) Shows the calculated pin to shaft angle, (C) Shows final correction (HEA measured at approximately 35 degrees).

The HEA is the angle formed by Hilgenreiner's line and a line drawn through the proximal femoral physis. An HEA less than 45 degrees is typically stable or resolving, 45-60 degrees is indeterminate, and greater than 60 degrees will usually be progressive. Surgical intervention is indicated for progressive deformity seen with growth or an initial HEA of >60 degrees. If the HEA is between 45 and 60 degrees, and the patient has a symptomatic gait disturbance with or without discomfort, surgery could also be considered.³ Timing of surgical intervention is debated. As addressed earlier, one can avoid the acetabular dysplasia that occurs with untreated coxa vara but too early and the risk for recurrence is higher. Contraindications of surgery include inadequate bone size to support necessary internal fixation and uncorrected underlying metabolic bone disorders.

Treatment and Preoperative Planning

The goal of surgical treatment is to normalize the proximal femoral alignment, via a valgus producing proximal femoral osteotomy. This osteotomy improves the mechanical forces across the physis and stimulates ossification through the femoral neck defect and can prevent recurrent deformity. AP and frog lateral x-rays of the pelvis are important to measure the neck shaft angle and HEA. For more complex deformities, a CT scan can be of use, but this is typically not needed.

The surgeon should plan to correct the HEA to less than 38 degrees in order to limit the risk of recurrence.⁴ To preoperatively plan for this, one should find the HEA and subtract 38 degrees. This is minimum the amount of valgus correction required. The surgeon then chooses the angle of the pediatric proximal femoral locking plate (typically

150 degrees) and subtracts the correction angle from the plate angle to find the angle at which to place the initial guidewire relative to the femoral shaft. An example is below (Figure 3).

HEA=70°
 Goal HEA= 35°
 $70-35=35^\circ$ correction
 150° locking plate
 $150-35= 115^\circ$ to the shaft

Operative Technique

OR set-up: The patient is positioned supine on a radiolucent table. The operative leg or legs should be fully draped to just above the iliac crest to allow for easy control of the entire leg. If only approaching one hip, a small bump under the affected side will allow for an easier time draping and better access during the approach. Typically, a folded sheet placed under the ipsilateral hemipelvis is sufficient to ensure that the lateral proximal femur is free and approachable. If bilateral osteotomies are planned, drape both legs in and place a small bump under the sacrum to elevate both hips off the table.

Fluoroscopy should be positioned on the contralateral side from the surgical hip. If the patient requires bilateral osteotomies, the C-arm can be moved after the completion of the first side. It is important to check the

imaging before the surgical prep is applied to ensure the ability to obtain a good AP and frog leg lateral.

The author's preferred implant is a pediatric proximal femoral locking plate, with a 150 degree proximal valgus fixed angle. Ensure the implant supply has the size and length plate needed. Other implants, such as a proximal locking plate with less valgus angle or blade plate, can be used with simple adjustments to the surgical planning, as indicated above.

Operative Technique: The greater trochanter is marked out by palpation of the femoral shaft. An incision is made from the tip of the greater trochanter in line with the femoral shaft. In general, the approach to the femur is 1-2 cm more proximal for valgus osteotomies as opposed to varus osteotomies with blade plate fixation. The length of the incision is typically about 1.5 times the length of the plate, distal to the vastus ridge. Superficial dissection is carried out using electrocautery and sharp self-retaining retractors to the iliotibial band (ITB). Once the iliotibial band is identified, some of the adherent fat should be cleared away. The incision through the ITB is made in line with the skin incision. Take care to palpate the femoral shaft prior to ITB incision to ensure this incision is not too anterior or too posterior. Being too anterior or too posterior will make the soft tissue retraction and visualization more difficult.

Identify the vastus ridge and clear the bursa off greater trochanter (GT) proximally. Incise the vastus lateralis insertion off the vastus ridge in an inverted L pattern, just distal to the lateral physis of the GT. Elevate the corner created by the L-incision, which can be tagged for later repair. Carry the posterior limb of this incision distally along the vastus lateralis fascia. The fascia of the vastus lateralis muscle is incised using the electrocautery just anterior to the lateral intermuscular septum. The vastus lateralis is retracted anteriorly using a rake retractor. The posterior aspect of the vastus lateralis is gently teased off the lateral intramuscular septum, taking

care to avoid dissecting through the muscle. Be aware of perforating vessels traveling through the intermuscular septum from anterior to posterior and cauterize as they are encountered.

Once the vastus is free from the fascia, the femoral periosteum is incised along the lateral aspect of the femur. Bluntly elevate the periosteum circumferentially in order to place Hohmann retractors anteriorly and posteriorly proximally. Next, the guidewire is placed laterally, just distal to the vastus ridge and centered in the femoral neck. Position should be checked on fluoroscopy. A sterile triangle, or goniometer, can be used to ensure that the wire is inserted at the templated angle. The wire can then be advanced to the physis but not across the physis. The plate is then placed along this wire, and an AP fluoroscopic image is obtained to determine the osteotomy site. This site is then marked on the femur using a marking pen, saw, or electrocautery.

After centering the plate on the femur, two proximal screw guidewires are inserted using the locking towers on the plate but the screws are not placed at this time. The plate is removed, and the anterior aspect of the femur is scored with a handheld oscillating saw inline with the femoral shaft as a rotational guide. Alternatively, a guidewire can be placed parallel to the ground distally in the femur, and the relationship between this pin and the pin in the neck noted.

Protect the soft tissues with Holman retractors, placed anterior and posterior to the femur and ensuring these meet medially. A transverse osteotomy is then made using a pencil saw. To relieve some tension on the soft tissues a 5 mm bony resection is often done to slightly shorten the femur.

The plate is then placed back over the proximal guidewires, and the two locking screws are placed, securing the plate to the proximal femoral segment. Prior to placing the plate on the proximal fragment, the lateral distal femoral cortex is decorticated distal to the plate as

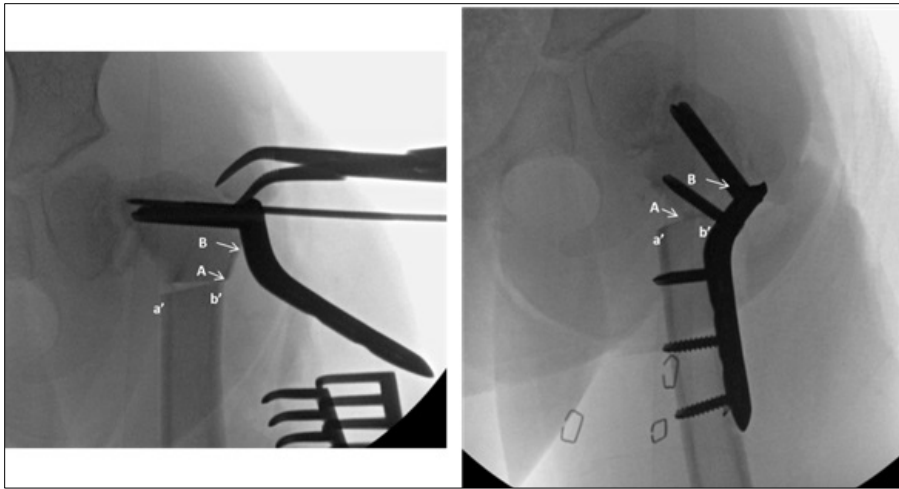


Figure 4. The cortex between A and B in the image on the left should be decorticated and reduced as seen in the figure on the right.

this segment will be in contact with the distal cortical osteotomy (Figure 4).

The plate is then gently reduced to the femur using a Verbrugge or Lowman bone clamp. Care should be taken to slowly proceed with this reduction, allowing time for soft tissue creep. The abductor musculature, which was previously short due to the deformity, will be felt lengthening, intramuscularly, during this plate-shaft reduction.

Rotation should be checked using the previously placed femoral marks. There is typically some femoral retroversion, so slight internal rotation of the distal segment will correct this. The clamp is then tightened fully. AP and lateral fluoroscopic images should be obtained to confirm placement of the plate and adequacy of the correction. Distal screws are then placed in compression fashion. After final x-rays, irrigation and layered closure are performed. The vastus lateralis can be repaired back to the proximal cuff of tissue left at the vastus ridge, and the ITB is repaired in a running layer.

Postoperative immobilization is dependent on both patient and fixation related factors. If the child is small and the fixation robust, no immobilization is needed, and

partial weight-bearing, gentle range of motion can be initiated immediately. If the patient is bigger or fixation of the osteotomy is a concern, immobilization in an abduction pillow or spica cast can be used to allow healing of the osteotomy before range of motion, and weight-bearing is initiated.

Tips

Assessment of the size of the child and imaging is important in deciding timing of operative procedure and approach. It is

vital to ensure the fixation device used in the procedure (proximal femoral plate vs. blade plate) will fit in the femoral neck and allow adequate fixation to reduce the deformity. Some small children with small femoral necks will not accommodate both screws in the proximal femoral locking plate.

Due to the longstanding proximal femoral deformity in some cases of coxa vara, preoperative assessment of the excursion of the hip abductors and adductors is suggested. In order to assess the tightness of the hip abductors, a preop AP pelvis radiograph with the affected hip in maximal adduction can be obtained simulating the projected valgus positioning of the proximal femur. Excessively tight abductors may limit the passive adduction of the hip in this radiograph, indicating the possible need for abductor lengthening during correction. Similarly, adductor tightness can also be unmasked after proximal femoral valgus correction. Intraop post-correction hip abduction should be assessed, and adductor lengthening should be undertaken if excessively tight.

Due to the robust healing potential of children, a wedge osteotomy is not typically needed. A transverse osteotomy is adequate, with compression across the osteotomy site. Decortivating the lateral cortex on the proximal fragment is important for bony healing.

The correction obtained (target a residual HEA < 38 degrees) is dependent on the insertion angle of the proximal guidewire. This angle should be checked with a goniometer after insertion to ensure the correction will be adequate. It is also important to remember that the proximal femur is typically in some degree of retroversion, and this must be accounted for when positioning the proximal fixation. If it is not, this fixation may be directed out of the femoral neck.

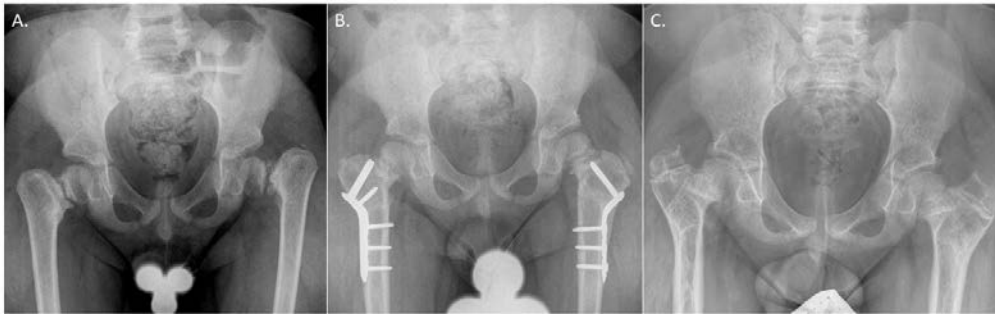


Figure 5. A) A 7-year-old boy with bilateral coxa vara. B) One-year s/p bilateral proximal femoral valgus osteotomy. C) A patient at 12 years of age after removal of proximal femoral implants. Notice correction of proximal femoral alignment but overgrowth of bilateral greater trochanters.

Postoperative Care

Immobilization, if needed, is typically used for 4-6 weeks until some initial healing is seen at the osteotomy site. Physical therapy is started after the period of immobilization. Full weight-bearing begins once there is sufficient healing on x-ray (usually about 6 weeks). Hardware removal can be done after about 1 year if needed (Figure 5).

Complications

Recurrence is the most common complication, so patients must be followed regularly. If there is recurrence, revision valgus osteotomy can be considered if the patient is symptomatic. Growth of the proximal femoral physis should be followed through maturity. Ipsilateral proximal femoral early growth arrest has been noted after osteotomy, and if this is seen, consideration is given to greater trochanter arrest or contralateral

epiphysiodesis to ensure equal limb length at maturity. In addition, overgrowth of the greater trochanter can occur, leading to recurrent abductor muscle weakness (Figure 5). Greater trochanter epiphysiodesis may be needed if overgrowth is noted.

Summary

Coxa vara is an uncommon deformity for which a proximal femur valgus osteotomy is often indicated. The

proper work-up of any underlying metabolic or genetic issues is crucial before proceeding with an operative intervention.

Preoperative planning can help reduce the risk of recurrence by planning for an adequate final HEA. While the approach to the proximal femur is the same as most other proximal femur osteotomies, there are some nuances in guidewire placement, femoral rotation, and plate

reduction that are worth bearing in mind. The most common complication of the valgus osteotomy is recurrence.

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