My Approach to Femoroacetabular Impingement

17

J.W. Thomas Byrd

Introduction

Impingement is not a new concept. As early as 1913, Vulpius and Stöffel described a bony resection procedure for the deformity created by a slipped capital femoral epiphysis [1]. In 1936, Smith-Petersen described an operation with excision of the acetabular rim sometimes combined with a wedge resection of the femoral head/neck junction for cases of protrusio, slipped epiphysis, and coxa plana [2]. Although primitive, the technique bears a striking similarity to the recent descriptions of open surgical dislocation for pincer and cam impingement. This combined approach received no further mention in the literature, but osteoplasty for the femoral deformity associated with chronic slipped capital femoral epiphysis was popularized by Heyman and Herndon and has similarly been described for the misshapen femoral head of coxa plana as a sequela of Perthes disease [3, 4].

However, it was Professor Ganz and colleagues who formulated the concept of femoroacetabular impingement (FAI). This was first described as an iatrogenic process associated with overcorrection of periacetabular osteotomy (PAO) performed for dysplasia [5]. Subsequently, they described FAI occurring in the native hip as a precursor to the development of osteoarthritis [6]. They subgrouped this into pincer, cam, and combined types and described an open surgical approach for correction [7]. Successful reports have been published with a goal of delaying the progression of osteoarthritis, but this has not been a technique advocated for the resumption of an active lifestyle [8].

It is our perspective that FAI is not a cause of hip pain. It is simply a morphologic variant that predisposes the joint to intra-articular pathology that then becomes symptomatic. Pincer impingement, caused by an overhanging of the anterolateral rim of the acetabulum, results primarily in breakdown of the acetabular labrum and secondarily, over time, a variable amount of associated articular damage to the acetabulum (Fig. 17.1). Cam impingement, created by the prominent portion of a nonspherical femoral head engaging against the articular surface of the acetabulum, results in selective delamination and failure of the articular surface of the acetabulum with relative preservation of the labrum (Fig. 17.2). These observations are important in the

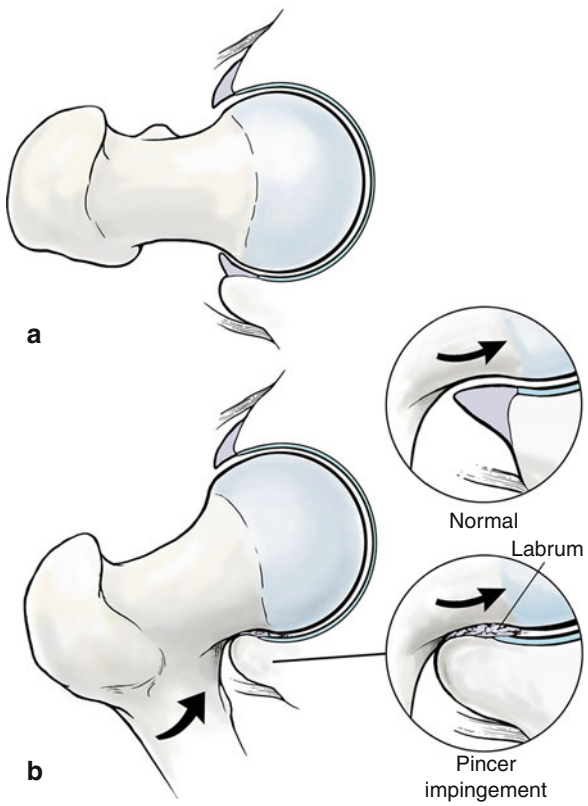

Fig. 17.1 (**a**) Bony over-coverage of the anterior labrum sets the stage for pincer impingement. (**b**) With hip flexion, the anterior labrum gets crushed by the pincer lesion against the neck of the femur. Secondary articular failure occurs over time. In the normal circumstance, there is adequate clearance for the labrum during hip flexion. (All rights are retained by Dr. Byrd)

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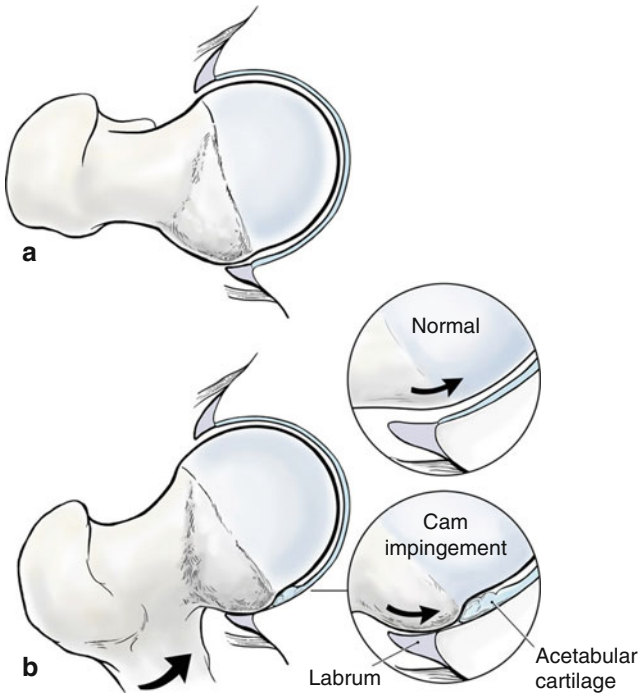

Fig. 17.2 (**a**) The cam lesion is characterized by the bony prominence centered on the anterolateral femoral head/neck junction. (**b**) Cam impingement occurs with hip flexion as the nonspherical portion of the femoral head (cam lesion) glides under the labrum engaging the edge of the articular cartilage and results in progressive delamination. Initially, the labrum is relatively preserved, but secondary failure occurs over time. (All rights are retained by Dr. Byrd)

proposed arthroscopic management of FAI. Hips may possess the morphologic features of FAI without developing the cartilage failure associated with pathological impingement. Thus, the arthroscopic findings are a determinant in the course of management for patients who possess radiographic features of FAI. Impingement is not the sole cause of intra-articular pathology and hip joint symptoms in active adults.

Patient Evaluation

The onset of symptoms associated with FAI is variable, but the damage results from the cumulative effect of cyclical abnormal wear associated with the altered joint morphology. Examination will usually demonstrate diminished internal rotation caused by the altered bony architecture of the joint. However, many patients may have reduced internal rotation and still not suffer from pathological impingement. Also, while uncommon, pathological impingement is occasionally observed in individuals with normal or even increased internal rotation. Forced flexion, adduction and internal rotation, is called the impingement test in reference to eliciting symptoms associated with impingement (Fig. 17.3).

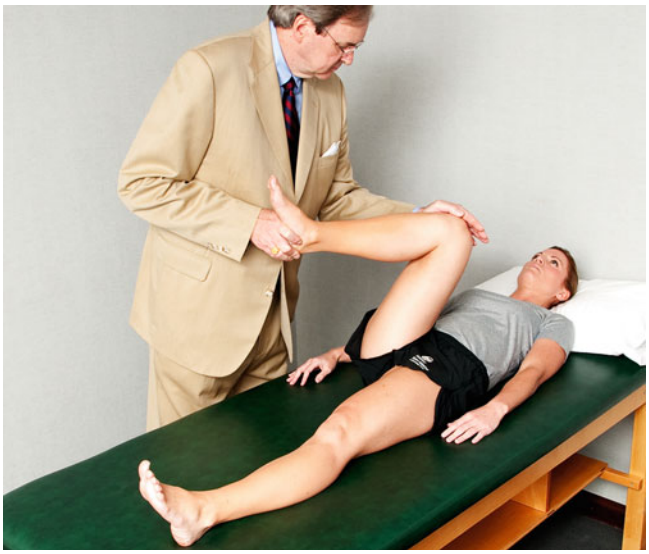

Fig. 17.3 The impingement test is performed by provoking pain with flexion, adduction, and internal rotation of the symptomatic hip. (All rights are retained by Dr. Byrd)

However, virtually any irritable hip, regardless of the etiology, will be uncomfortable with this maneuver. Thus, while it is quite sensitive, it is not necessarily specific for impingement. Athletic pubalgia may mimic or coexist with FAI and necessitates careful evaluation of the lower abdominal and adductor region (Fig. 17.4). Tenderness with resisted sit-ups, hip flexion, or adduction should raise an index of suspicion for athletic pubalgia. Pain with passive flexion and internal rotation is more indicative of an intra-articular source.

Imaging

Radiographs should include a well-centered AP pelvis view and a lateral view of the affected hip (Fig. 17.5) [9, 10]. Overcoverage of the anterior acetabulum, characteristic of pincer impingement, is evaluated by the presence of a cross-over sign (Fig. 17.6). This can be due to acetabular retroversion, indicated by the posterior wall sign (Fig. 17.7). The lateral center edge (CE) angle of Wiberg was described to quantify dysplasia which is variously defined as less than 20–25° among different reports. No true measure for impingement has been defined, but it is generally associated with higher CE angles. Dysplasia can sometimes coexist with acetabular retroversion, and trimming the acetabular rim would be contraindicated (Fig. 17.8). For some cases, a false profile view can be helpful to further assess acetabular over- or undercoverage. The sphericity of the femoral head is assessed on both the AP and the lateral views (Fig. 17.9). We tend to rely on a frog lateral view as a routine screening radiograph. It is easy to obtain in a reproducible fashion.

Fig. 17.4 (**a**) Careful palpation aids in assessing for the presence of soft tissue pelvic pathology. (**b**) Hip flexor soreness is elicited by palpation during resisted contraction. (**c**) Tenderness is elicited at the origin of the adductors by palpation during resisted contraction. (**d**) The insertion of the rectus abdominis is palpated for tenderness during resisted contraction. Counterpressure is applied to the contralateral shoulder causing selective recruitment and contraction of the involved side. (All rights are retained by Dr. Byrd)

One study showed that the 40° Dunn view most predictably demonstrates the cam lesion [11]. However, because of the variable shape and location of the lesion, no radiograph is consistently reliable. Magnetic resonance imaging (MRI) and gadolinium arthrography with MRI (MRA) can both be helpful at detecting the intra-articular damage accompanying FAI. These studies are best at defining labral pathology but are less reliable in assessing the associated articular damage [12]. In the presence of a cam lesion, anticipate that the articular damage will be more extensive than the labral pathology. Also, subchondral edema in the anterior acetabulum is usually a harbinger of subjacent articular failure. With MRAs, the injection of long-acting anesthetic along with the contrast is important to substantiate whether the hip disease is the source of the patient's symptoms. This distinction may not always be clear on clinical examination alone. Computed tomography (CT) is much better at showing bone architecture and structure. Three-dimensional reconstructions provide the clearest image of the impingement morphology. These images are especially helpful in the arthroscopic management, providing a clear interpretation of the exact shape of the abnormal bone that must be exposed and then resected.

Arthroscopic Procedure

(See Video 17.1: http://goo.gl/n2RMq) Arthroscopic management of FAI begins with arthroscopy of the central compartment. This is where the intra-articular damage, indicative of pathological impingement, is identified. The patient is positioned supine with traction applied, and three standard portals provide optimal access for surveying and accessing intra-articular pathology (Fig. 17.10a, b) [13, 14]. Portal placement is usually routine. However, severe impingement cases with a tight capsule and altered bony architecture can introduce significant challenges. It is important that the surgeon be prepared for these challenges in order to perform the

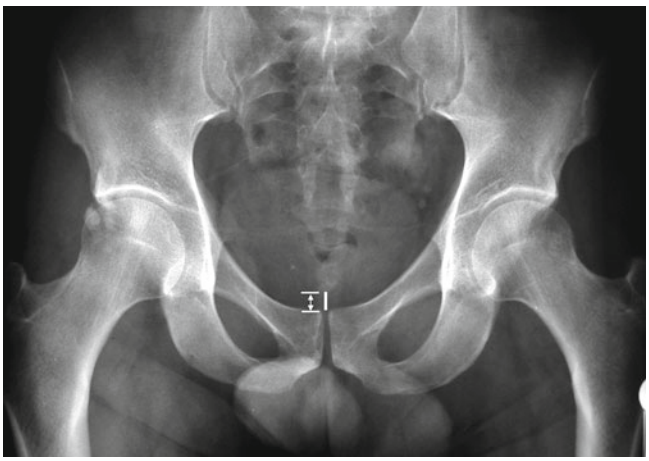

Fig. 17.5 A properly centered AP radiograph must be controlled for rotation and tilt. Proper rotation is confirmed by alignment of the coccyx over the symphysis pubic (*vertical line*). Proper tilt is controlled by maintaining the distance between the tip of the coccyx and the superior border of the symphysis pubis at 1–2 cm. (All rights are retained by Dr. Byrd)

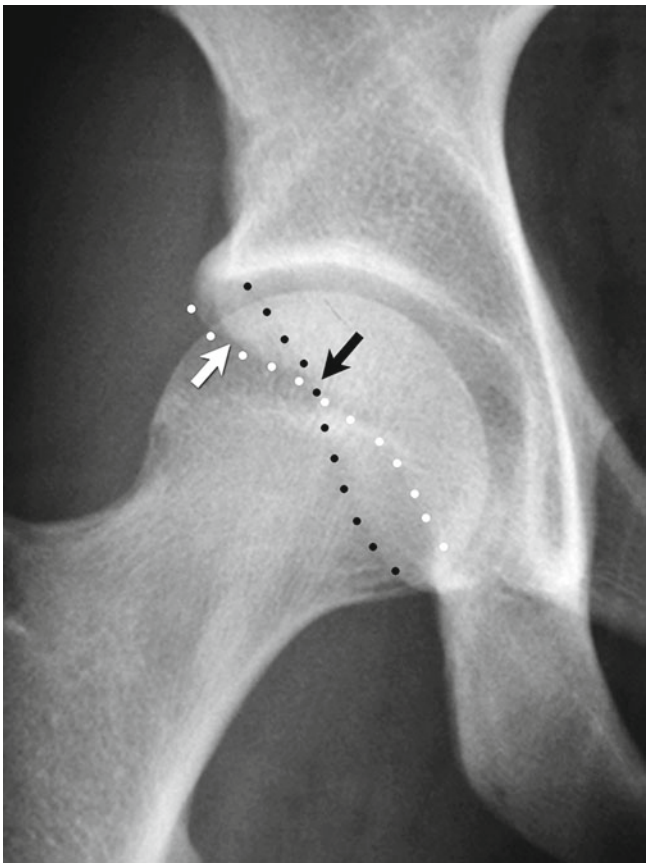

Fig. 17.6 AP view of the right hip. The anterior (*white dots*) and posterior (*black dots*) rim of the acetabulum are marked. The superior portion of the anterior rim lies lateral to the posterior rim (*white arrow*) indicating overcoverage of the acetabulum. Anteriorly, it assumes a more normal medial position, creating the crossover sign (*black arrow*) as a positive indicator of pincer impingement. (All rights are retained by Dr. Byrd)

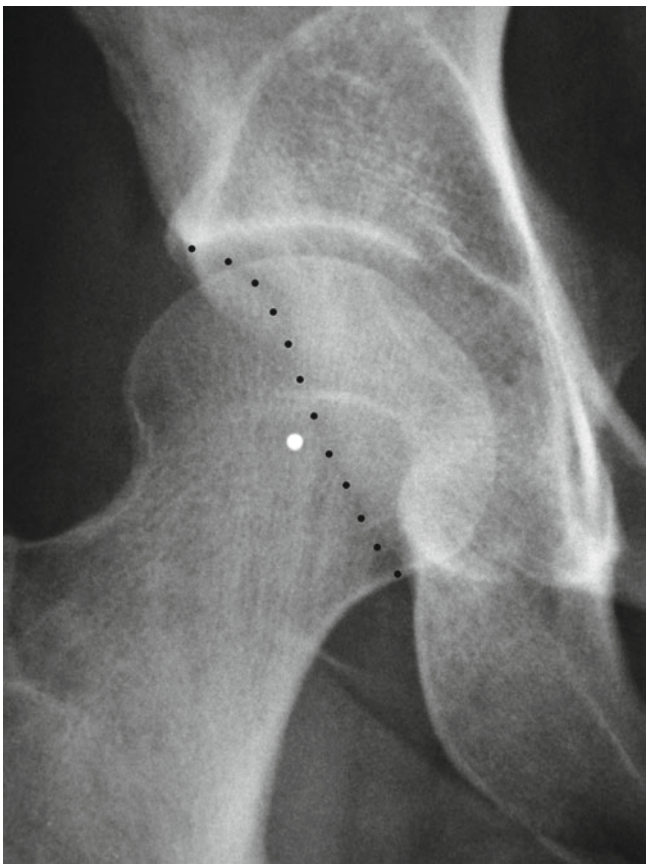

Fig. 17.7 AP view of the right hip. Acetabular retroversion as a cause of pincer impingement is indicated by a shallow posterior wall in which the posterior rim of the acetabulum (*black dots*) lies medial to the center of rotation of the femoral head (*white dot*). (All rights are retained by Dr. Byrd)

procedure as atraumatically as possible. Unique challenges of the stiff and arthrofibrosed hip are discussed in Chap. 27.

There are three arthroscopic parameters of pincer impingement. First is the presence of anterior labral pathology that must be present in order to have pathological pincer impingement. Second, positioning of the anterior portal may be difficult despite adequate distraction, and this is due to the bony prominence of the anterolateral acetabulum. Third is the presence of bone overhanging the labrum where normally there would just be a capsular reflection when pincer impingement is not present. The amount of bone to be removed is determined in conjunction with the radiographic and arthroscopic findings. In determining whether to excise bone, the radiographs should be carefully assessed for evidence of dysplasia. Retroversion in a dysplastic hip can give a false sense of pincer impingement. Recontouring the acetabulum in this setting can result in iatrogenic instability.

If the labrum appears normal, we would be hesitant to violate healthy tissue to correct a pincer lesion because of the theory that it could be a problem (Video 17.2: http://goo.gl/dxws7). A normal labrum will never look the same

Fig. 17.8 AP radiograph of the left hip of a 24-year-old female demonstrates acetabular retroversion (crossover sign) in conjunction with dysplasia (CE angle 19°). Misinterpreting this as an impingement problem and trimming the acetabulum would place the patient at high risk of instability. (All rights are retained by Dr. Byrd)

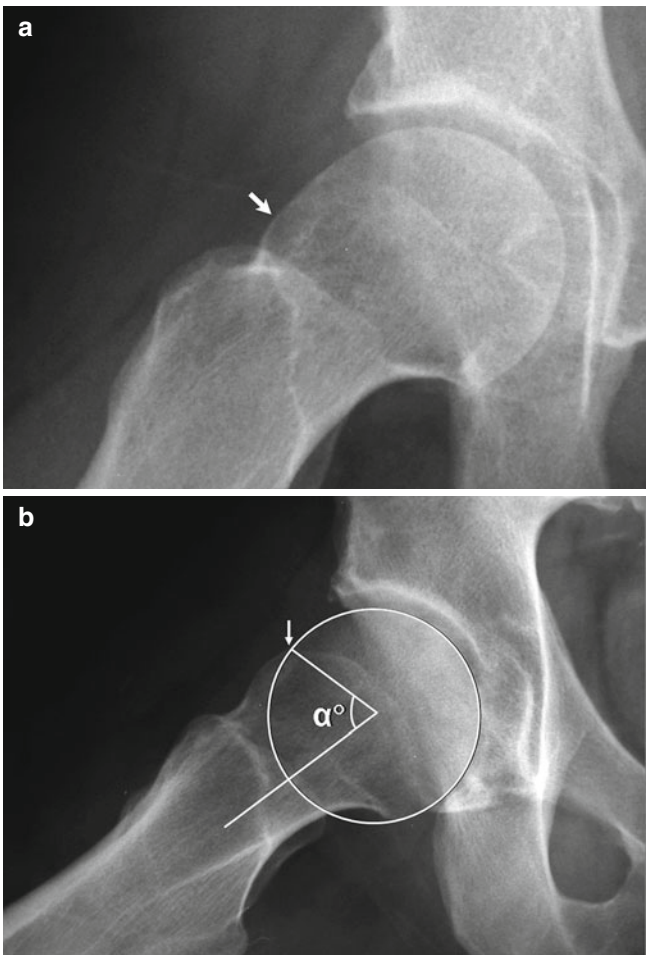

Fig. 17.9 A frog lateral view of the right hip. (**a**) The cam lesion (*arrow*) is evident as the convex abnormality at the head/neck junction where there should normally be a concave slope of the femoral neck. (**b**) The alpha angle is used to quantitate the severity of the cam lesion. A *circle* is placed over the femoral head. The alpha angle is formed by a line along the axis of the femoral neck (1) and a line (2) from the center of the femoral head to the point where the head diverges outside of the *circle* (*arrow*). (All rights are retained by Dr. Byrd)

when it is restored. Assessing a damaged labrum is usually straightforward. However, assessing impending labral failure can be more subjective. This is especially important in younger patients. If the labrum is starting to appear crushed and draped across a bony prominence of the acetabular rim, then it is preferable not to wait until it is severely damaged to make the choice of correcting the accompanying pincer impingement (Video 17.3: http://goo.gl/EQtIA). Deciding how abnormal is abnormal enough to make this decision can sometimes be challenging.

If labral degeneration is extensive, as is often seen in middle age, then it may be managed with simple debridement (Video 17.4: http://goo.gl/r9dxf). The labral damage may not be salvaged, but recontouring the acetabulum opens the joint and may substantially improve mobility and symptoms. After completely inspecting the joint, attention is turned to the labral lesion. Selective debridement of the damaged portion will reveal the overhanging lip of bone instead of the normal capsular reflection from the labrum (Fig. 17.11a–e). Once the damaged tissue has been removed, exposing the pincer lesion, the bone is then recontoured with a spherical burr. Generous capsulotomies around the portals facilitate maneuverability and access. The pincer lesion is addressed switching the arthroscope and instrumentation between the anterior and anterolateral portals. Resection is typically carried to the articular edge of the acetabulum. The amount of bone to be removed is dictated by the severity of the pincer lesion. Proximally, the bone is resected flush with the anterior column of the acetabulum. The anteromedial and lateral extent of the bony resection is dictated by the margin of healthy labrum. The bone is recontoured to create a smooth transition with the healthy portion of the labrum, which is preserved. A variable amount of associated secondary articular damage may be present which is addressed with a chondroplasty or microfracture for grade IV lesions.

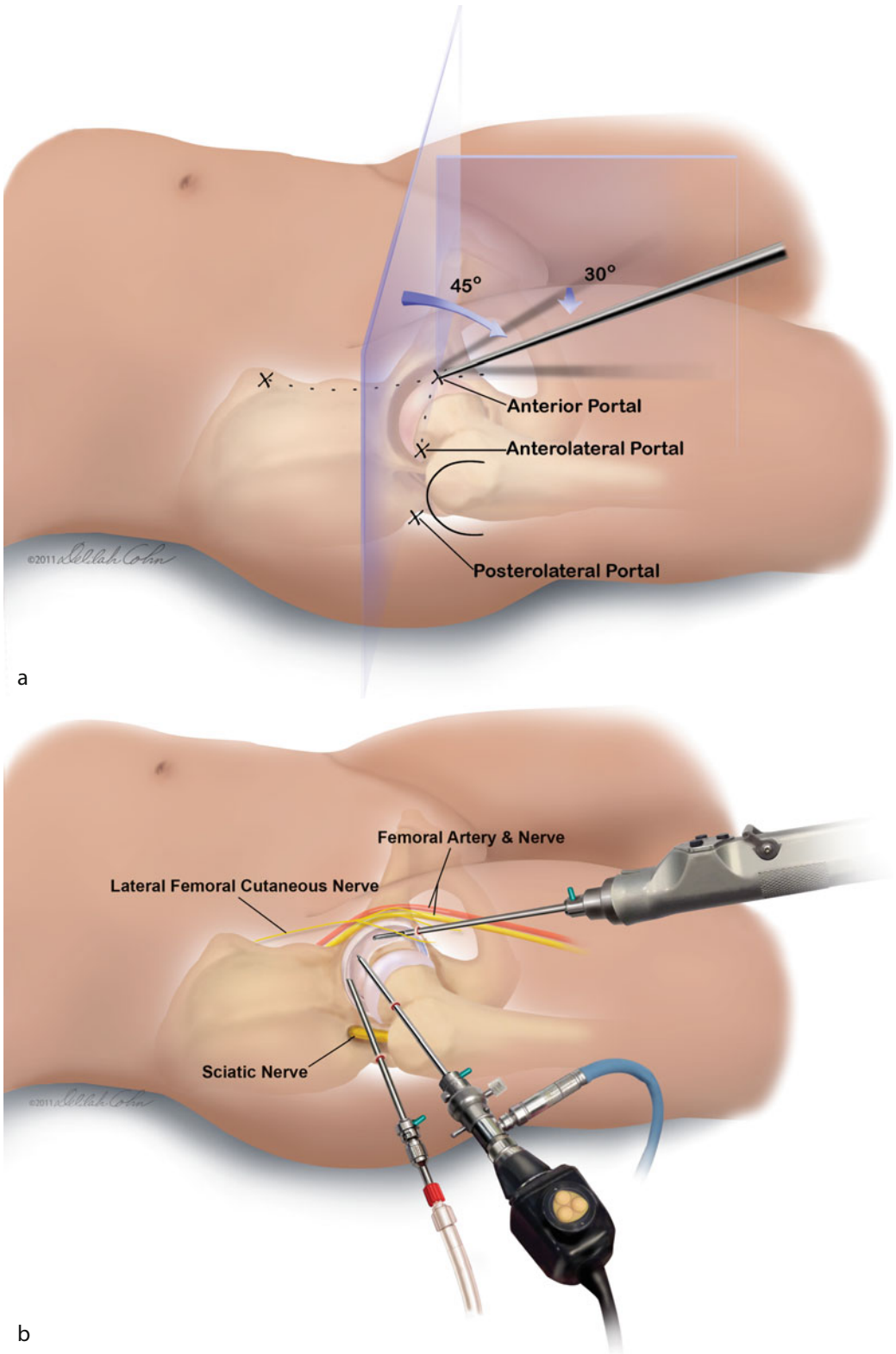

Fig. 17.10 (**a**) The site of the anterior portal coincides with the intersection of a sagittal line drawn distally from the anterior superior iliac spine and a transverse line across the superior margin of the greater trochanter. The direction of this portal courses approximately 45° cephalad and 30° toward the midline. The anterolateral and posterolateral portals are positioned directly over the superior aspect of the trochanter at its anterior and posterior borders. (**b**) The relationship of the major neurovascular structures to the three standard portals is illustrated. The femoral artery and nerve lie well medial to the anterior portal. The sciatic nerve lies posterior to the posterolateral portal. The lateral femoral cutaneous nerve lies close to the anterior portal. Injury to this structure is avoided by using proper portal placement. The anterolateral portal is established first because it lies most centrally in the safe zone for arthroscopy. (All rights are retained by Dr. Byrd)

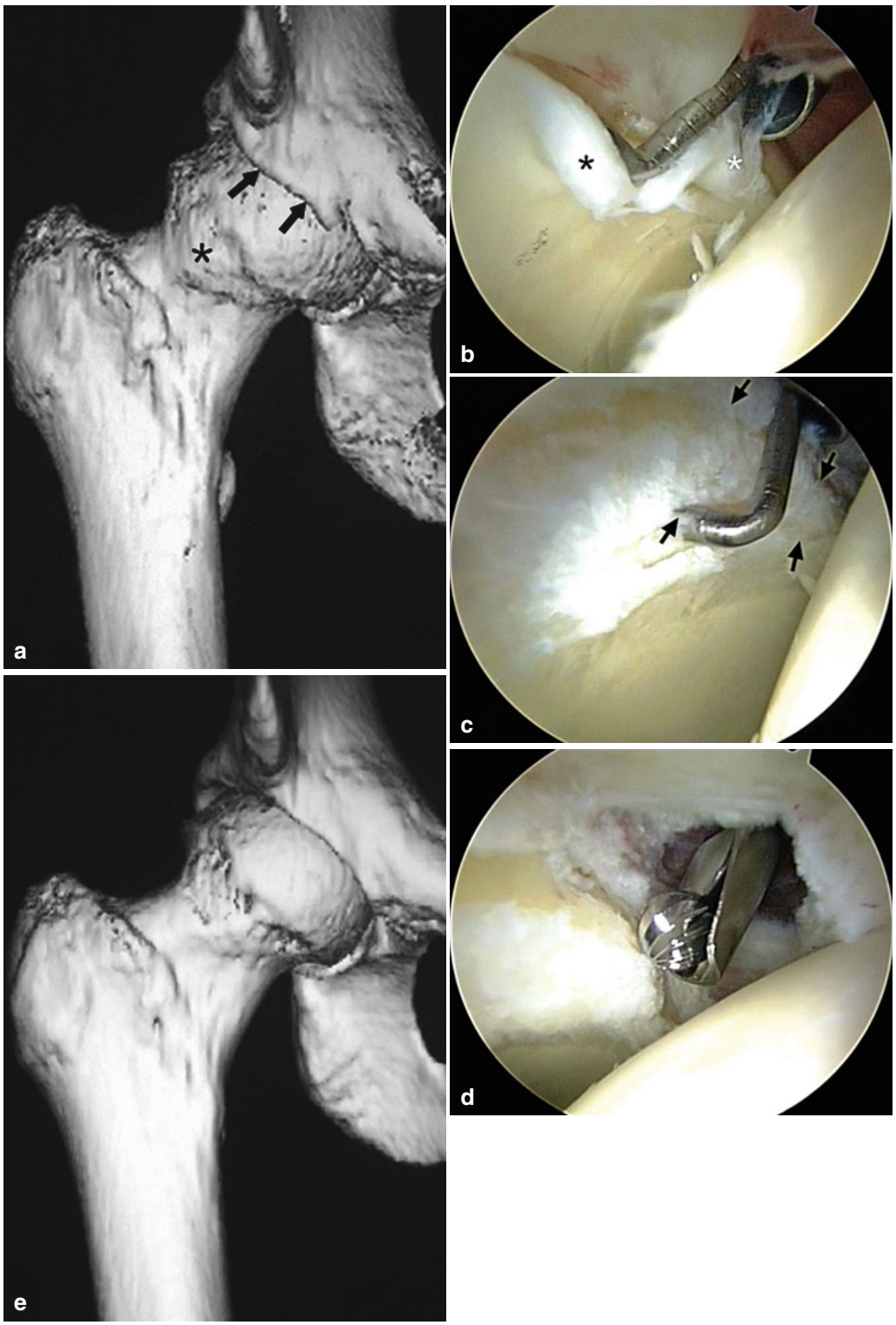

Fig. 17.11 A 38-year-old female with progressive pain and loss of motion of the right hip. (**a**) A 3D CT scan illustrates pincer impingement (*arrows*) as well as a kissing lesion characterized by osteophyte formation on the femoral head (*asterisk*). (**b**) Viewing anteriorly from the anterolateral portal, there is maceration of the anterior labrum (*white asterisk*) and some associated articular delamination (*black asterisk*). (**c**) Debridement of the degenerate labrum exposes the pincer lesion (*arrows*). (**d**) The pincer lesion is recontoured with a burr. (**e**) A postoperative 3D CT scan demonstrates the extent of bony recontouring of the acetabulum and the femoral head. (All rights are retained by Dr. Byrd)

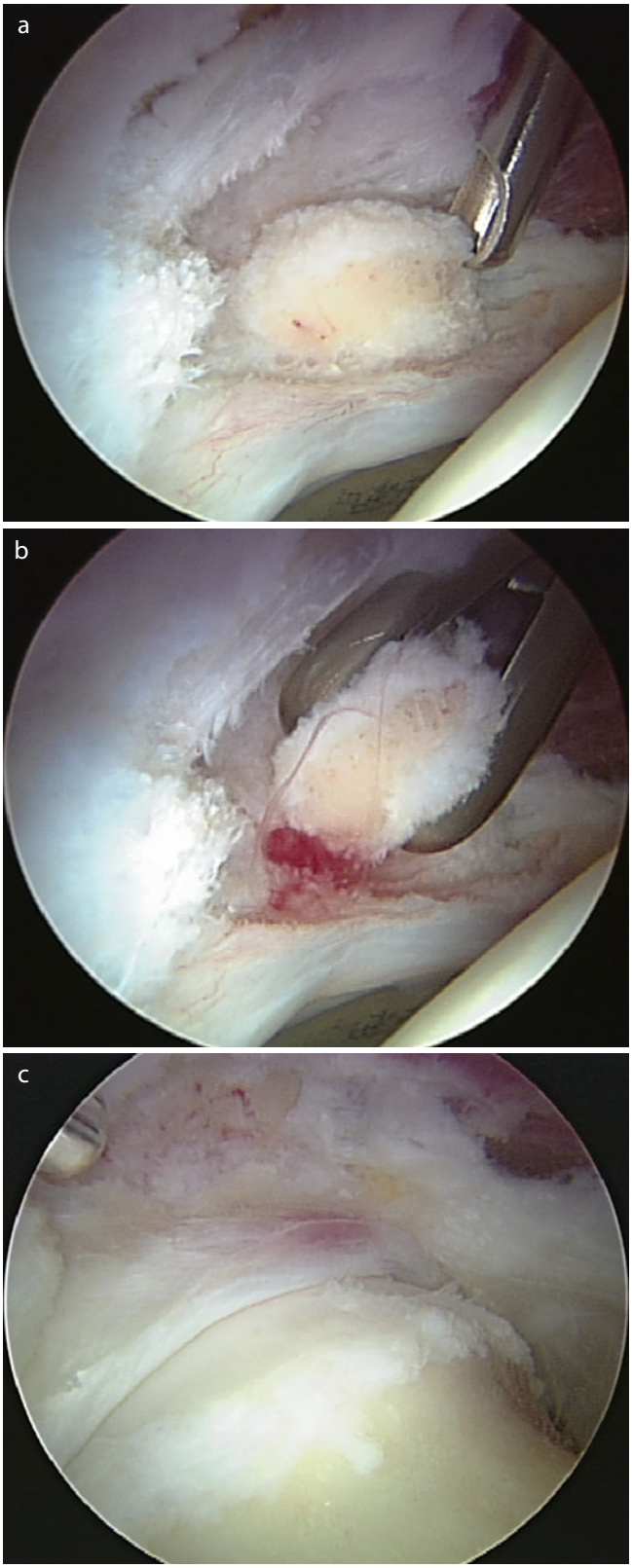

Fig. 17.12 A pincer lesion created by an os acetabulum along the anterolateral rim of a right hip. (**a**) The fragment is exposed. (**b**) The fragment is being removed. (**c**) The integrity of the labrum has been preserved. (All rights are retained by Dr. Byrd)

In the presence of good quality labral tissue and especially in younger patients, preservation of the labrum is preferred. In a few cases, the bony lesion can be exposed on the capsular side of the labrum and recontoured without compromising the labrum's structural integrity (Fig. 17.12) (Video 17.5: http://goo.gl/2bUcp). More often, when the labrum is failing due to pincer impingement, it is mobilized to resect the pincer lesion and then refixed (Fig. 17.13). The portion of the labrum to be mobilized must be exposed at its bony attachment on the capsular side. The labrum is sharply dissected from the overlying bone to reveal the pincer lesion. The acetabulum is then recontoured with a high-speed burr, taking care to preserve the mobilized labrum. With this technique, adequate mobilization of the labrum is necessary to visualize the bony margins of the pincer lesion for recontouring. Inadequate exposure results in simply a small scalloped defect in the acetabular rim with incomplete correction. The depth of resection is typically 3–5 mm but is determined by the dimensions of the pincer lesion. Resection of the bony rim requires good arthroscopic visualization. Do not rely solely on fluoroscopy because it will cause you to underestimate the amount of bone being removed anterior to the 12 o'clock position. After reshaping the rim, the labrum is then refixed with suture anchors. The anchors are placed in the rim of the acetabulum on the capsular side of the labrum. The anchor placement is consistent from one case to the next. The anchors are spaced approximately 8–10 mm and as close to the rim as possible while assuring that they do not perforate the surface of the acetabulum. For this purpose, we use a percutaneous delivery system that allows the skin entry site of the drill sleeve to be placed as distally as necessary to make sure that the anchor diverges from the acetabular surface. This is placed distally, halfway between the anterior and anterolateral portals (Fig. 17.14). The modified anterior portal, that is sometimes popular, may not always be distal enough to assure the correct amount of diversion [15]. However, there is also a curved drill guide system that can give a better angle for this portal (Fig. 17.15). Either way, it is imperative that the articular surface is visualized while drilling. Any evidence of rippling of the cartilage indicates that the drill is too close, and it must be repositioned (Video 17.6: http://goo.gl/4LKKp). The most common error is not allowing enough divergence, which forces the drill hole to be placed further away from the rim of the acetabulum in order to avoid perforation. Then, when the labrum is tied down, it is not properly reapproximated to the rim, and its function has not been restored. With the distal percutaneous site halfway between the anterior and anterolateral portals, or with the use of the modified anterior portal, anchors can be placed along the anterior acetabulum up to the 12 o'clock position. Note that fluoroscopy is not very helpful because the direction of entry is more in

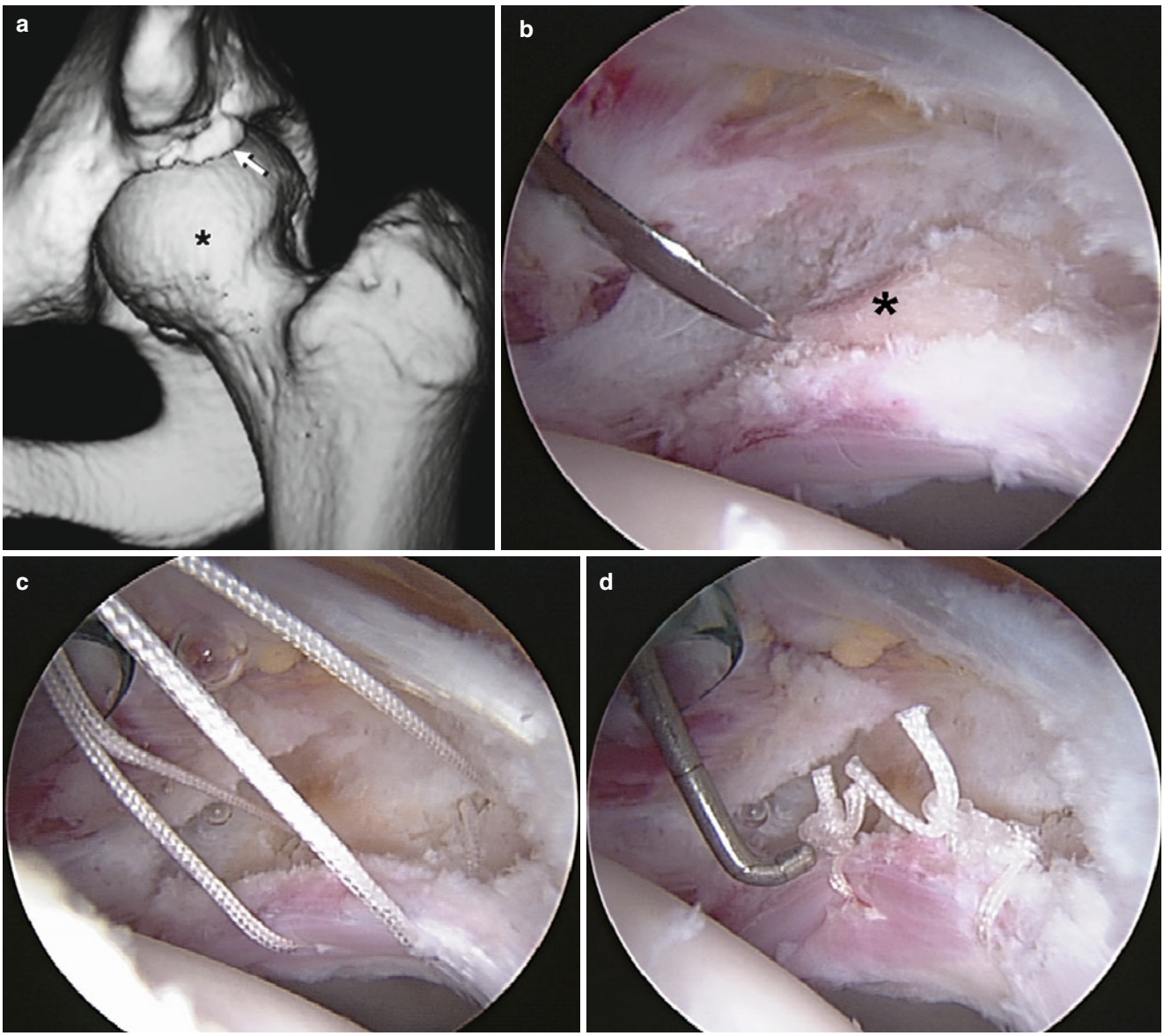

Fig. 17.13 A 15-year-old female gymnast with pain and reduced internal rotation of the left hip. (**a**) A 3D CT scan defines a pincer lesion with accompanying os acetabulum (*arrow*) and cam lesion (*asterisk*). (**b**) Viewing from the anterolateral portal, the pincer lesion and os acetabulum (*asterisk*) are exposed with the labrum being sharply released with an arthroscopic knife. (**c**) The acetabular fragment has been removed and the rim trimmed with anchors placed to repair the labrum. (**d**) The labrum has been refixed. (All rights are retained by Dr. Byrd)

the plane of the x-ray beam (Fig. 17.16). Far lateral anchors are best placed from the anterolateral portal, and for these, fluoroscopy can be helpful in seeing that the drill is diverging from the subchondral surface (Fig. 17.17).

While anchor placement is consistent, the pattern and method of suture passage is variable depending on the damage and morphology of the labrum. If the chondrolabral junction is intact, then a simple suture passage is used through the midsubstance of the labrum and tied against the capsular side. This reconstitutes the labrum against the rim well. The suture can be passed through the labrum with a tissue-penetrating device, or if the labrum is small, then a suture shuttle technique allows the smallest possible hole in the labral tissue (Fig. 17.18). If the labrum is robust, then a simple suture technique may distort its configuration, or if the articular edge of the labrum has been separated from the adjacent articular surface, then a different type suture must be used to reconstitute the chondrolabral junction. For this, a modified single limb mattress suture is used (Fig. 17.19) (Video 17.7: http://goo.gl/GS58c). One limb of the suture is passed into the joint at the chondrolabral junction, using a tissue-penetrating device. It is then grasped through the midportion of the labrum and pulled out for tying against the capsular edge.

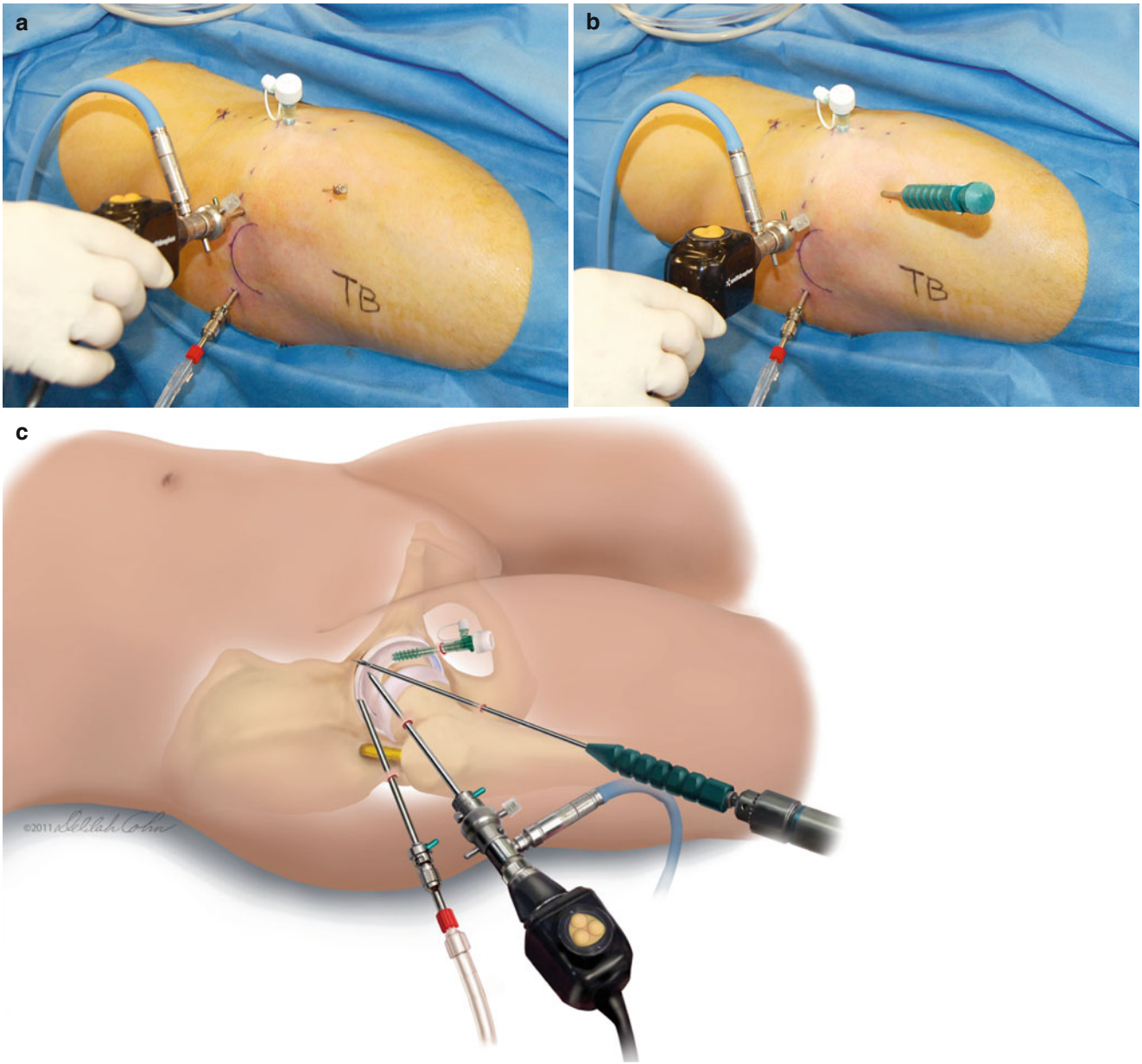

Fig. 17.14 An anchor delivery system can be placed percutaneously and thus not depend on portals. Placed midway between the anterior and anterolateral portals, it is positioned as distally as necessary to assure that the anchors will diverge from the face of the acetabulum. (**a**) Prepositioning is performed with a spinal needle. (**b**) The anchor delivery system has been percutaneously placed. (**c**) Schematic illustrates the drill sleeve placed against the acetabular rim. (All rights are retained by Dr. Byrd)

This anatomically restores the labrum to the rim of the acetabulum and avoids distortion. If the quality of the labral tissue is poor, then simply looping the suture around the labrum may be necessary in order to assure that sufficient tissue has been reapproximated.

Management of cam impingement also begins with arthroscopy of the central compartment to assess for the pathology associated with cam lesion [16]. The characteristic feature of pathological cam impingement is articular failure of the anterolateral acetabulum. The femoral head remains well preserved until late in the disease course. Early stages of the disease are characterized by closed grade I chondral blistering, which sometimes must be distinguished from normal articular softening (Video 17.8: http://goo.gl/s10Ws). Our experience has been that most already have grade III or grade IV acetabular changes by the time of surgical intervention. The articular surface is seen to separate or peel away from its attachment to the labrum (Fig. 17.20), and this is caused by the shear effect of the cam lesion (Video 17.9: http://goo.gl/Jo7hV). The labrum may be relatively

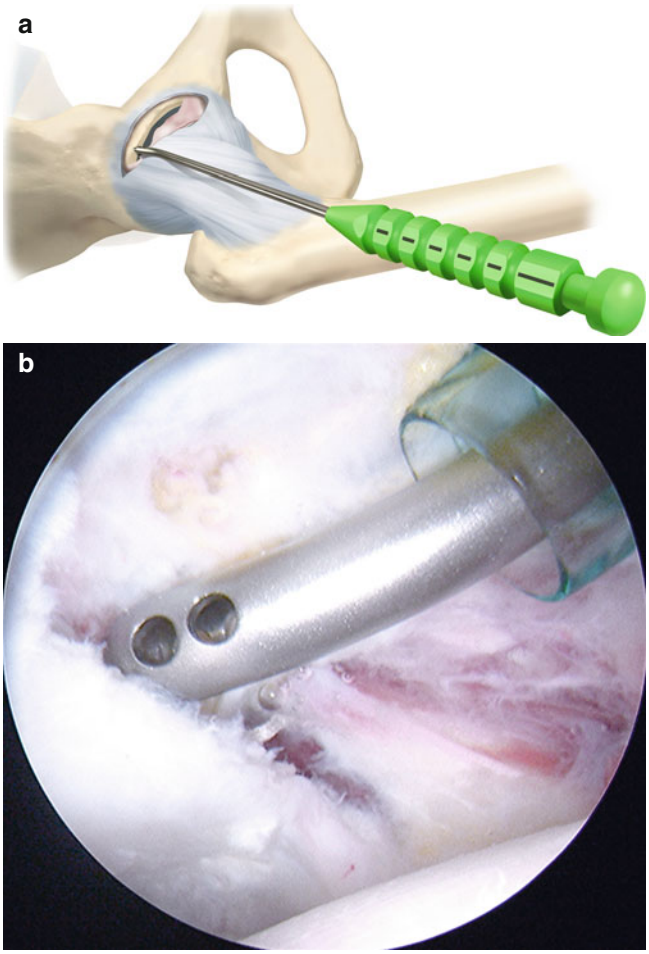

Fig. 17.15 (**a**) A curved anchor delivery system provides more latitude for assuring divergence when the anchor is placed through a conventional portal. (**b**) The curved system is placed against the acetabular rim from the modified anterior portal in this right hip with appropriate divergence for the acetabular surface. (All rights are retained by Dr. Byrd)

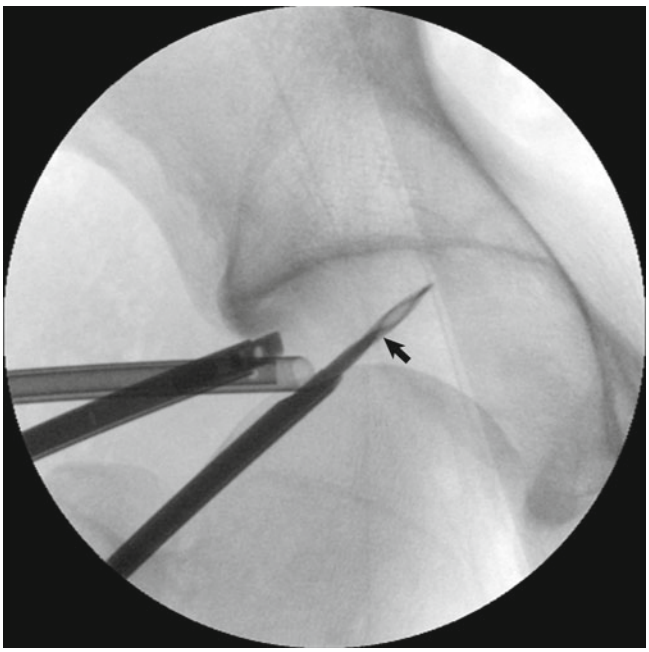

Fig. 17.16 Fluoroscopic image of a right hip drilling for placement of an anchor in the anterior rim of the acetabulum (*arrow*). Fluoroscopy does not help in assessing the anchor position. (All rights are retained by Dr. Byrd)

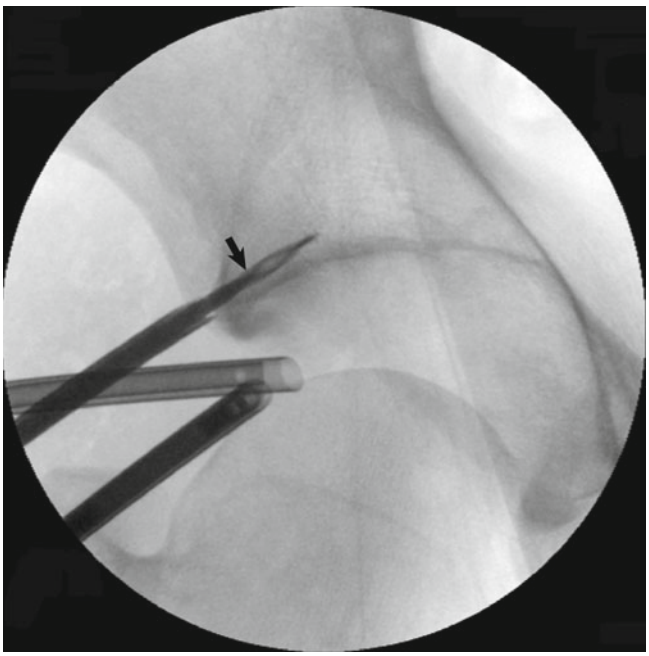

Fig. 17.17 AP fluoroscopic image of a right hip drilling for an anchor in the lateral acetabulum (*arrow*). From this angle, the image helps to assure that the drill does not violate the subchondral surface. (All rights are retained by Dr. Byrd)

well preserved but, with time, progressive fragmentation occurs. Often, the damaged articular edge of the labrum can be selectively debrided, preserving the capsular margin and potentially some of its labral seal function. If there is good quality tissue that has been detached, repair can be performed with suture anchors (Fig. 17.21). If pincer impingement is not present, the anchors can be placed adjacent to the articular surface, between the acetabulum and the labrum (Video 17.10: http://goo.gl/hDbFw). The suture limbs can be grasped through the labrum with a penetrator device and tied with the knots on the capsular side of the labrum. Passing both limbs of the suture in a mattress fashion avoids suture rubbing against the femoral head, but occasionally, looping the sutures may be necessary to assure that good substance of the tissue is secured to the rim of the acetabulum. The articular pathology is addressed with chondroplasty and microfracture as dictated by its severity.

After completing arthroscopy of the central compartment, the cam lesion is addressed from the peripheral compartment. A capsulotomy is created by connecting the anterior and anterolateral portals (Fig. 17.22). The amount of

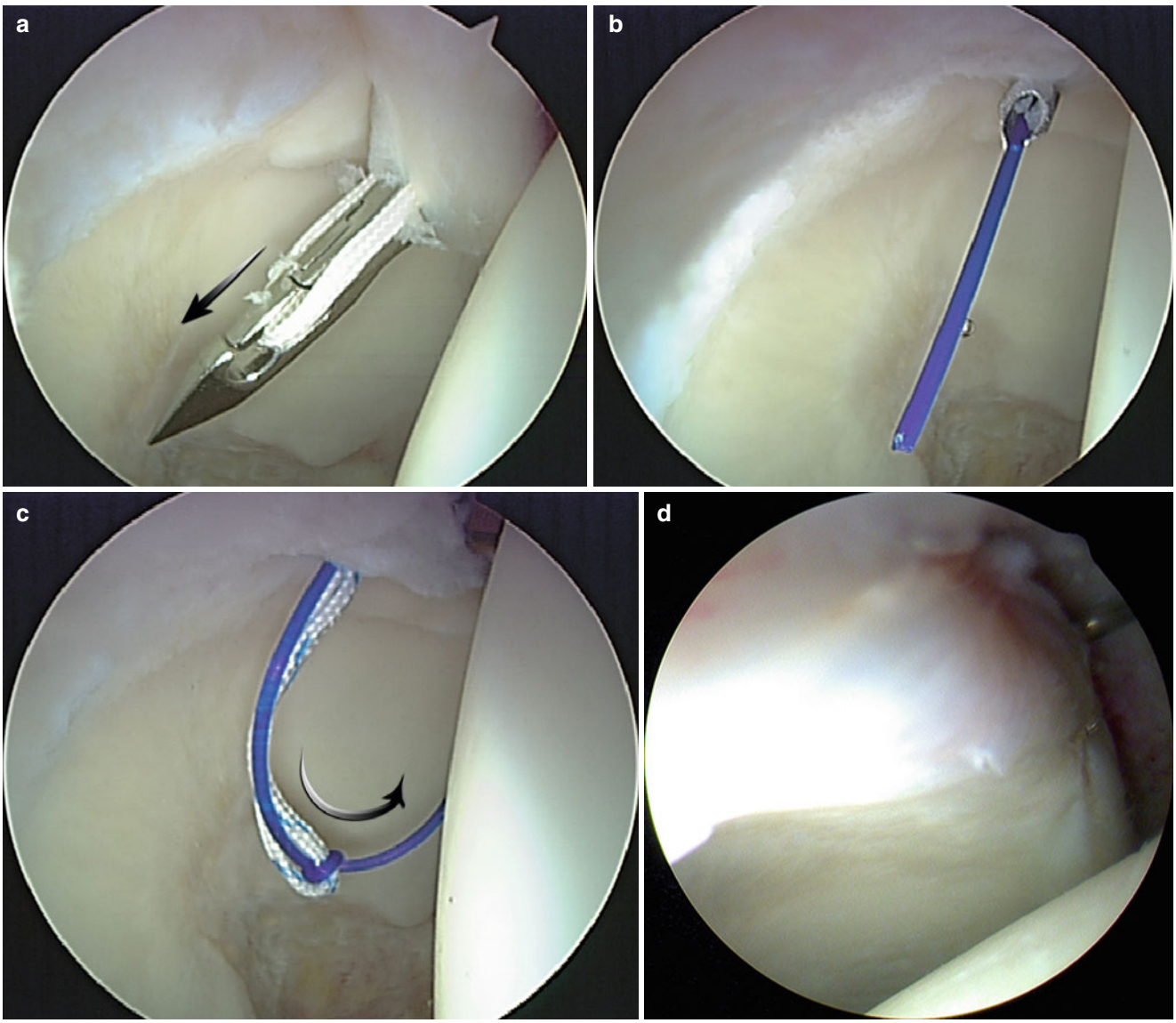

Fig. 17.18 Arthroscopic view of a right hip. Acetabuloplasty has been completed, and the anchor has been seated in the anterior acetabulum. The chondrolabral junction is preserved. (**a**) A soft tissue-penetrating device is used to push the suture limb through the labrum. (**b**) As an alternative method, a suture passing device is placed to introduce a monofilament suture. (**c**) The braided anchor suture is then shuttled through the labrum, secured to the monofilament with a single half-hitch. (**d**) Three anchors have been placed with sutures tied, reapproximating the labrum to the rim of the acetabulum. (All rights are retained by Dr. Byrd)

capsulotomy is titrated to the specifics of the case. For a tight hip with restricted rotational motion, the capsulotomy becomes more of an aggressive capsulectomy, which is partly therapeutic in helping to regain better mobility as well as pain relief. It may be extended posterolaterally and anteromedially. For hips where instability may be a concern, the capsulotomy can be limited to simply connecting the two portals with an incision of only 1.5–2 cm. This may be necessary, for example, in a hip where dysplasia coexists with a cam lesion. By titrating the capsulotomy to the needs of the case, capsular repair has rarely been necessary in our experience. If more exposure is needed in a hip that might be susceptible to instability, then a vertical T-shaped capsulotomy can be extended distally. The flaps are preserved, and the vertical limb can be reapproximated at the completion of the procedure.

After preparing the capsulotomy, the posterolateral portal can be removed, and the anterior and anterolateral cannulas are simply backed out of the central compartment. The traction is released, and the hip flexed approximately 35°. As

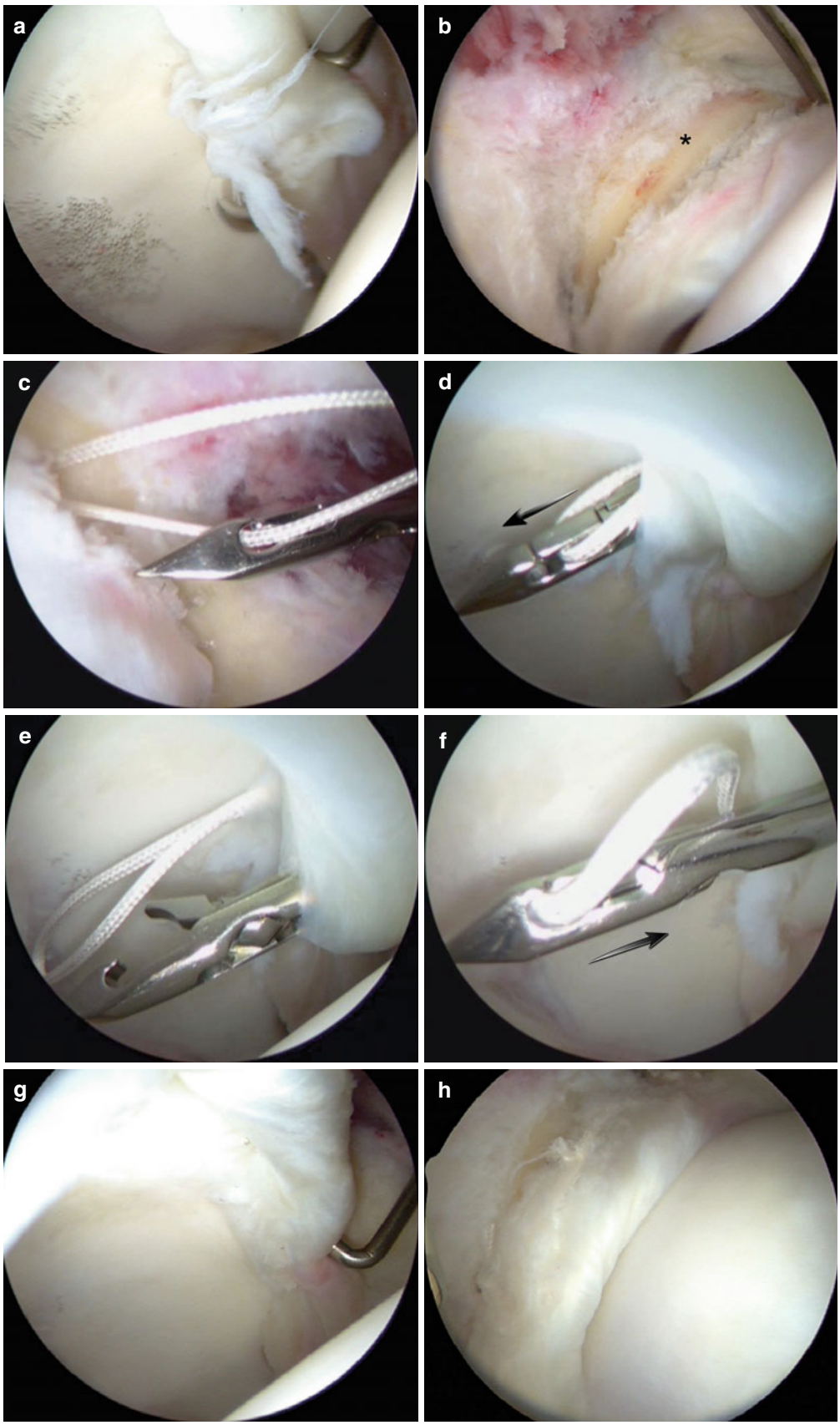

Fig. 17.19 Arthroscopic view of a right hip from the anterolateral portal. (**a**) The labrum is robust with disruption of the chondrolabral junction. (**b**) Viewing peripheral to the labrum, the acetabuloplasty (*asterisk*) has been completed. (**c**) A suture anchor has been seated in the bony rim and one limb of the suture is grasped with a soft tissue-penetrating device. (**d**) With the penetrator, the suture has been passed into the joint at the chondrolabral junction. (**e**) The penetrator has been repositioned through the midsubstance of the labrum, preparing to grasp the suture limb. (**f**) The suture has been grasped and is withdrawn back out to the capsular rim. (**g**) Three anchors have been placed with sutures tied, restoring the labrum and the chondrolabral junction. (**h**) Labral restoration is further observed peripherally with reconstitution of the labral seal. (All rights are retained by Dr. Byrd)

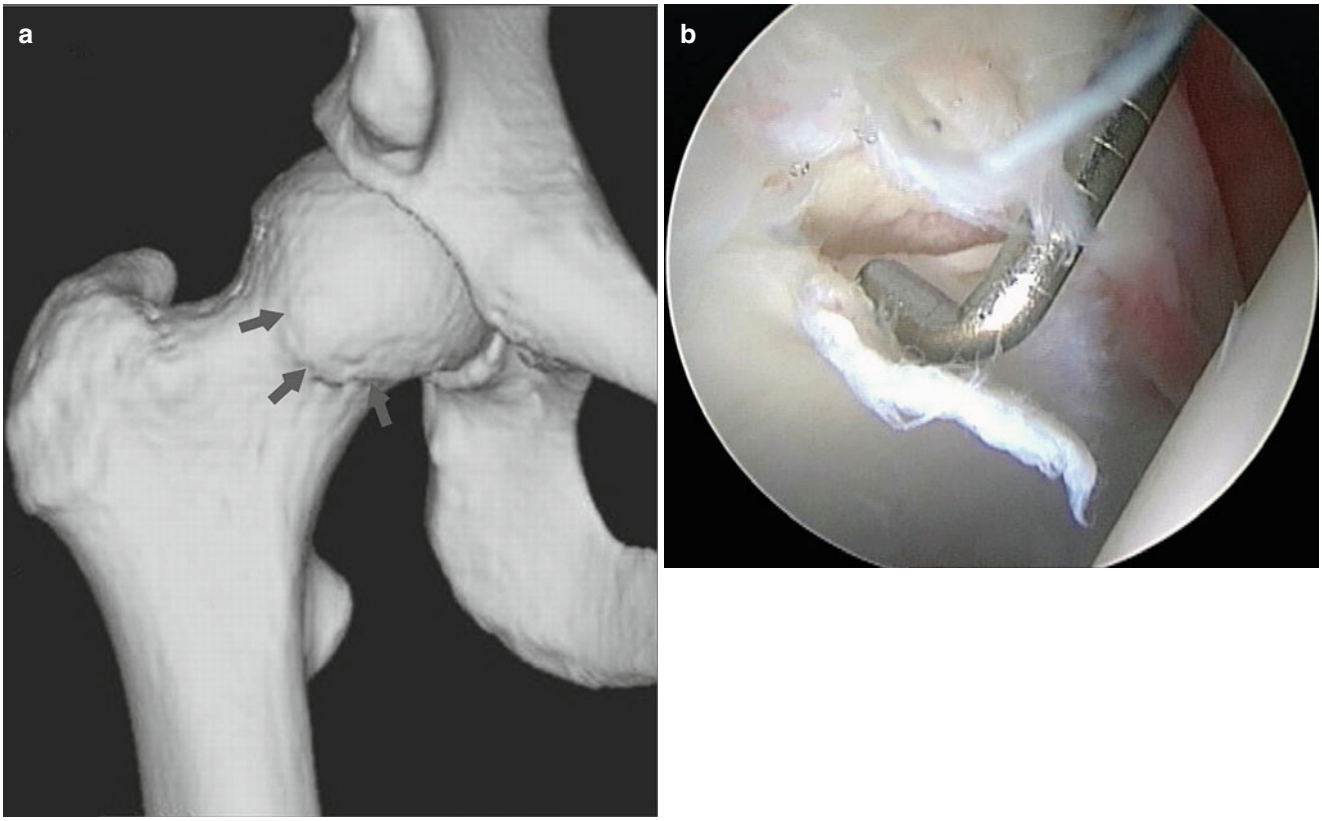

Fig. 17.20 A 20-year-old hockey player with a 4-year history of right hip pain. (**a**) A 3D CT scan defines the cam lesion (*arrows*). (**b**) Viewing from the anterolateral portal, the probe introduced anteriorly displaces an area of articular delamination from the anterolateral acetabulum characteristic of the peel-back phenomenon created by the bony lesion shearing the articular surface during hip flexion. (All rights are retained by Dr. Byrd)

the hip is flexed under arthroscopic visualization, the line of demarcation between healthy femoral cartilage and abnormal fibrocartilage that covers the cam lesion can usually be identified. Flexing the hip too far can cause part of the cam lesion to disappear under the acetabulum. In general, slightly more or less flexion may be necessary, just depending on the position that best brings the cam lesion into view.

A cephalad anterolateral portal is established approximately 5 cm above the anterolateral portal, entering through the capsulotomy that has already been established. These proximal and distal anterolateral portals work well for accessing and addressing the cam lesion (Fig. 17.23). Removing the anterior portal provides an unobstructed image for the C-arm, although the portal can be maintained if it is needed for better access to the medial side of the femoral neck.

Most of the work for performing the recontouring of the cam lesion (femoroplasty) lies in the soft tissue preparation. This includes capsular resection as necessary to assure complete visualization of the lesion and then removal of the fibrocartilage and scar that covers the abnormal bone (Fig. 17.24). With the hip flexed, the proximal portal provides better access for the lateral and posterior portion, while the distal portal is more anterior relative to the joint and provides best access for the anterior part of the lesion. The lateral synovial fold is identified as the arthroscopic landmark for the retinacular vessels, and care is taken to preserve this structure during the recontouring (Fig. 17.25). Switching between the portals is important for full appreciation of the three-dimensional anatomy of the recontouring.

Once the bone has been fully exposed, recontouring is performed with a spherical burr. The goal is to remove the abnormal bone identified on the preoperative CT scan and recreate the normal concave relationship that should exist where the femoral neck meets the articular edge of the femoral head. It is best to begin by creating the line and depth of resection at the articular margin. The resection is then extended distally, tapering with the normal portion of the femoral head (Figs. 17.26a, b and 17.27a, b). We recommend beginning the resection at the lateral/posterior limit of the cam lesion with the arthroscope in the more distal portal and instrumentation in the more proximal portal. The posterior extent of the resection is usually the most difficult; the resection is also the most critical to avoid notching the tensile surface of the femoral neck, and particular attention must be given to avoid and preserve the lateral retinacular vessels. Then, switching the arthroscope to the proximal portal, the

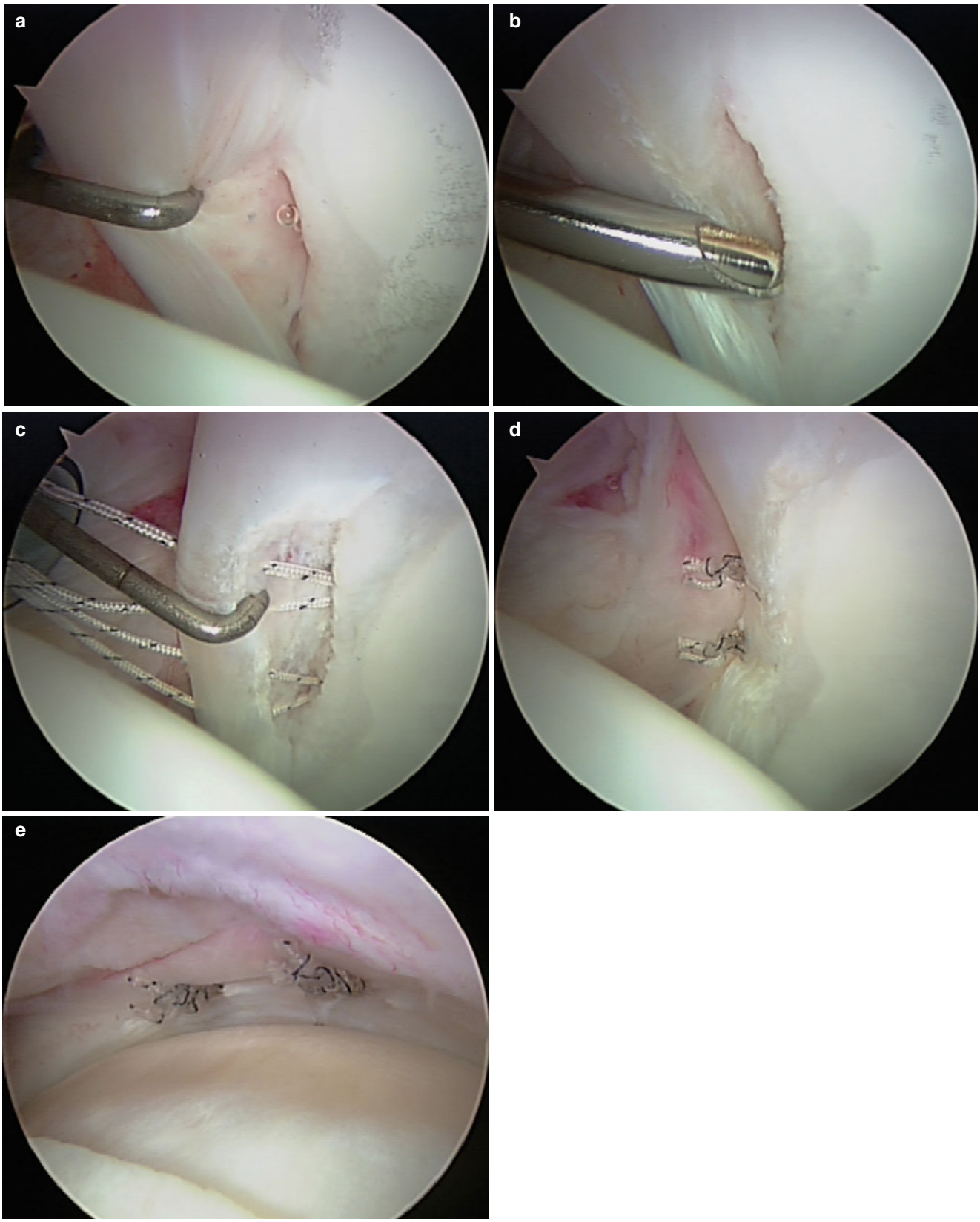

Fig. 17.21 An anterior labral tear of a right hip is being viewed from the anterolateral portal. (**a**) Pathological detachment of the labrum from the rim of the acetabulum is being probed. (**b**) Freshening the rim of the acetabulum, creating a bleeding bony surface, aids in potentiating healing of the repair. (**c**) Two anchors have been placed in the rim of the acetabulum with the sutures passed through the labrum in a mattress fashion. (**d**) The sutures have been tied securely reapproximating the labrum to the rim of the acetabulum. (**e**) Now viewing from the peripheral compartment, the repair is inspected showing approximation of the labrum against the femoral head with the sutures well removed from the articular surface. (All rights are retained by Dr. Byrd)

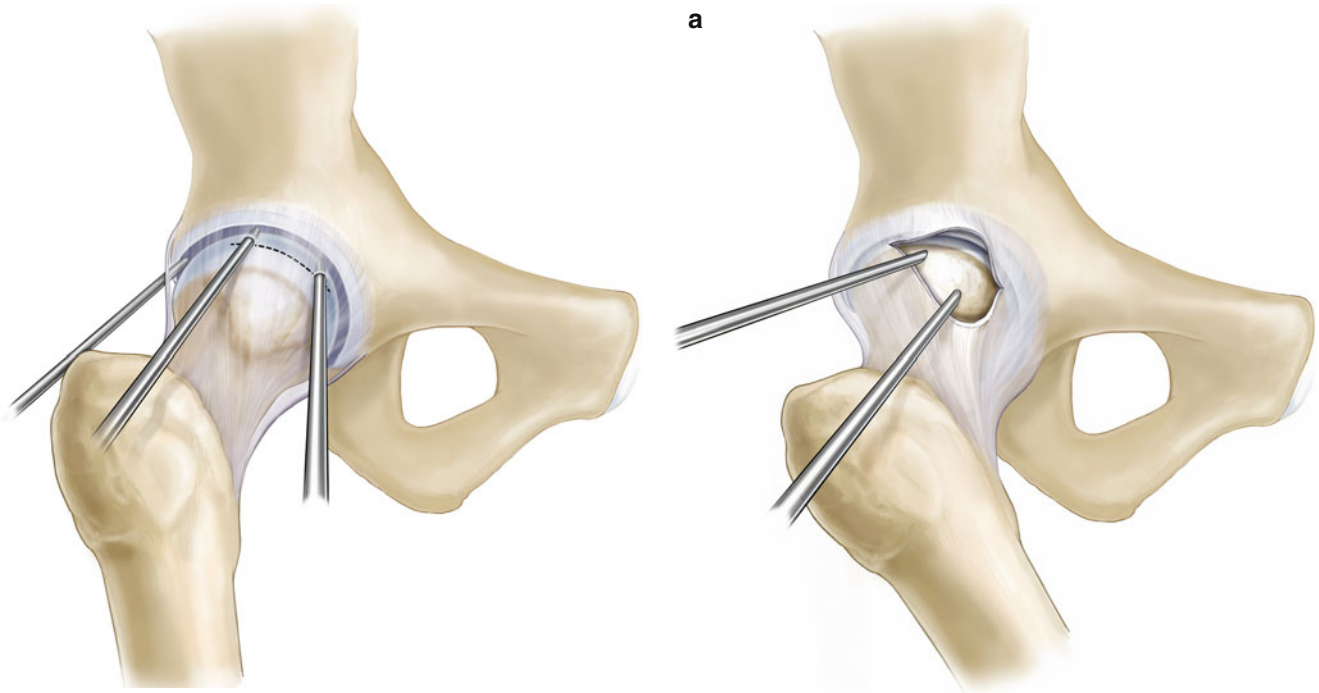

Fig. 17.22 A capsulotomy is performed by connecting the anterior and anterolateral portals (*dotted line*). This is geographically located adjacent to the area of the cam lesion. This capsulotomy is necessary in order for the instruments to pass freely from the central to the peripheral compartment as the traction is released and the hip flexed. (All rights are retained by Dr. Byrd)

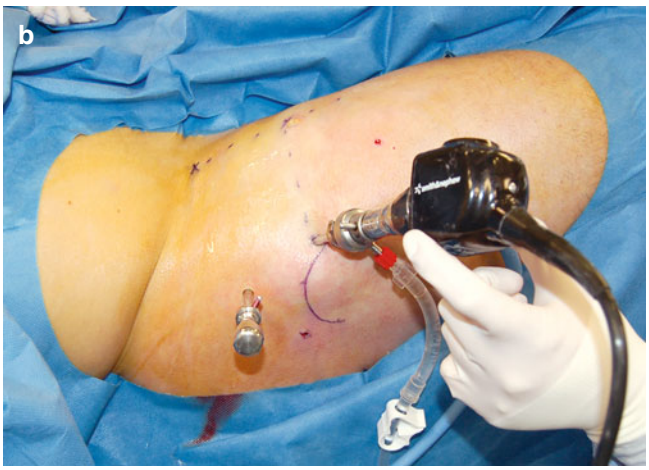

Fig. 17.23 (**a**) With the hip flexed, the anterolateral portal is now positioned along the neck of the femur. A cephalad (proximal) anterolateral portal has been placed. These two portals allow access to the entirety of the cam lesion in most cases. Their position also allows an unhindered view with the C-arm. (**b**) Photograph illustrates the proximal and distal anterolateral working portals for the peripheral compartment. (All rights are retained by Dr. Byrd)

burr is introduced distally, and the reshaping is completed along the anterior head and neck junction. Lastly, attention is given to make sure that all bone debris is removed as thoroughly as possible to lessen the likelihood of developing heterotopic ossification. The quality of the recontouring is assessed, and preservation of the lateral retinacular vessels is confirmed (Fig. 17.28a–c). Closure of the capsulotomy is not routinely performed. In cases where instability might be a potential concern, a T-shaped capsulotomy is used, and the vertical limb can be closed with single interrupted braided absorbable sutures (Fig. 17.29a–d).

Comments on Determining the Correct Amount of Bone to Remove

With proper exposure and meticulous technique, the entirety of the bony impingement can be identified for precise resection. What is less clear is knowing the exact amount of bone to remove. Presently, 3D CT scans provide the clearest image of the bony lesion. Thus, we use this as the principal determinant for interpreting the bone to be removed. The goal is not so much to recreate a standard-looking hip but to remove the offending bone and, on the femoral side, recreate the normal concavity that should exist at the head/neck junction. In the near future, computer navigation will assist in accurately quantitating the amount of removal that must now be done by subjective interpretation. This will be performed with 3D MRI that will supplant computed tomography. For the present, one must be cautious about relying much on intraoperative fluoroscopy. The line of resection

does not parallel the x-ray beam, and thus, it is easy to go astray relying solely on fluoroscopy. We find fluoroscopy most helpful in assessing the posterior limit of the resection. Sometimes the lateral aspect of the cam lesion starts to disappear underneath the posterior acetabular rim. Fluoroscopy can be helpful to make sure that adequate proximal resection has been performed. In some cases, briefly reapplying traction may be helpful to fully access this posterior limit. Intraoperative range of motion is not a substitute for complete visualization of the abnormal bone. Our goal is, again, to remove the abnormal bone and recreate the normal concavity. Once this has been accomplished, it is unlikely that greater resection would be of more benefit. It is also unclear how well passive range of motion of an anesthetized patient with a joint distended with fluid equates with how the patient's hip functions in vivo.

Post-op Rehabilitation

The recovery strategy depends on the extent of pathology that is encountered at the time of arthroscopy and what is done to address it. For simple labral debridement and recontouring of the acetabular rim, the patient is allowed to weight bear as tolerated, with an emphasis on range of motion and joint stabilization. If the labrum is refixed, then precautions are necessary to protect the repair site during the early healing phase. This includes protected weight bearing and avoiding extremes of flexion and external rotation for the first 4 weeks. Among patients requiring a second-look arthroscopic procedure, rarely is failure of a labral repair found to be a problem. Thus, our rehab strategy protecting the repair site may still be too conservative when we need to emphasize prevention of adhesions, but we are still careful not to be too aggressive.

Reshaping of the femoral head/neck junction necessitates some precautions. Fracture of the femoral neck is an unlikely, but potentially serious, complication. Full weight bearing is allowed, but crutches are used to avoid awkward twisting movements during the first 4 weeks. Once full motor control has been regained, the joint is adequately protected for light activities. If osteopenia is present, then these precautions become more imperative, especially in postmenopausal women and any patient over the age of 55. Full bony remodeling takes 3 months, during which time, some precautions are necessary to avoid high impact or torsional forces. If microfracture is performed, strict protected weight bearing is continued for 2 months to optimize the early maturation of the fibrocartilaginous healing response. During this time, gentle range of motion is emphasized to stimulate the healing process.

At 3 months, specific precautions are lifted, and functional progression is allowed. The rate at which the individuals advance is variable and may require another 1–3 months for full activities. Athletes are generally advised that return to sports following surgical correction of FAI can take 4–6 months.

Results

We have published two studies reporting the outcomes of our earliest experience in arthroscopic management of FAI [17, 18]. In a study of our first 100 consecutive patients with minimum 2-year follow-up, the median improvement was 21.5 points using the modified Harris hip score with 79% good and excellent results [17]. Ninety-two percent had grade III or grade IV acetabular articular damage, including 18 patients who underwent microfracture with a median improvement of 21 points. Twenty-three patients had concomitant articular damage to the femoral head demonstrating slightly lesser improvement of 17 points. No patient required conversion to total hip arthroplasty, although six underwent a subsequent arthroscopic procedure for recurrent or persistent symptoms. There were three complications: a transient neurapraxia of the pudendal nerve and the lateral femoral cutaneous nerve, both of which resolved uneventfully, and one mild case of heterotopic ossification within the capsule which did not preclude a successful outcome. In another study of our first 200 consecutive athletes with minimum 1-year follow-up, the median improvement was 24 points. Eighty-nine percent had grade III or grade IV articular damage with 49 undergoing microfracture and demonstrating a median improvement of 26 points [18]. Twenty percent had concomitant articular damage to the femoral head and demonstrated lesser improvement of 16 points. Overall, 90% returned to sport (95% professional, 85% collegiate). There were five transient neurapraxias that resolved. One athlete was converted to a total hip arthroplasty and four underwent repeat arthroscopy.

The results of our earliest experiences seem good, even though most of these included labral debridements. As we have recognized the healing capacity of the labrum and successful techniques for repair, the majority of patients now undergo labral repair or refixation. As evidenced by the work of others, it does appear that this may provide even more favorable results [19, 20]. Our observation has been that a high majority of patients have grade III or grade IV articular damage to the acetabulum by the time arthroscopic intervention is undertaken. Despite the severity of damage, our results are still good. This indicates that grade III and grade IV damage is not a contraindication to the procedure, but it also indicates that we are intervening late in the

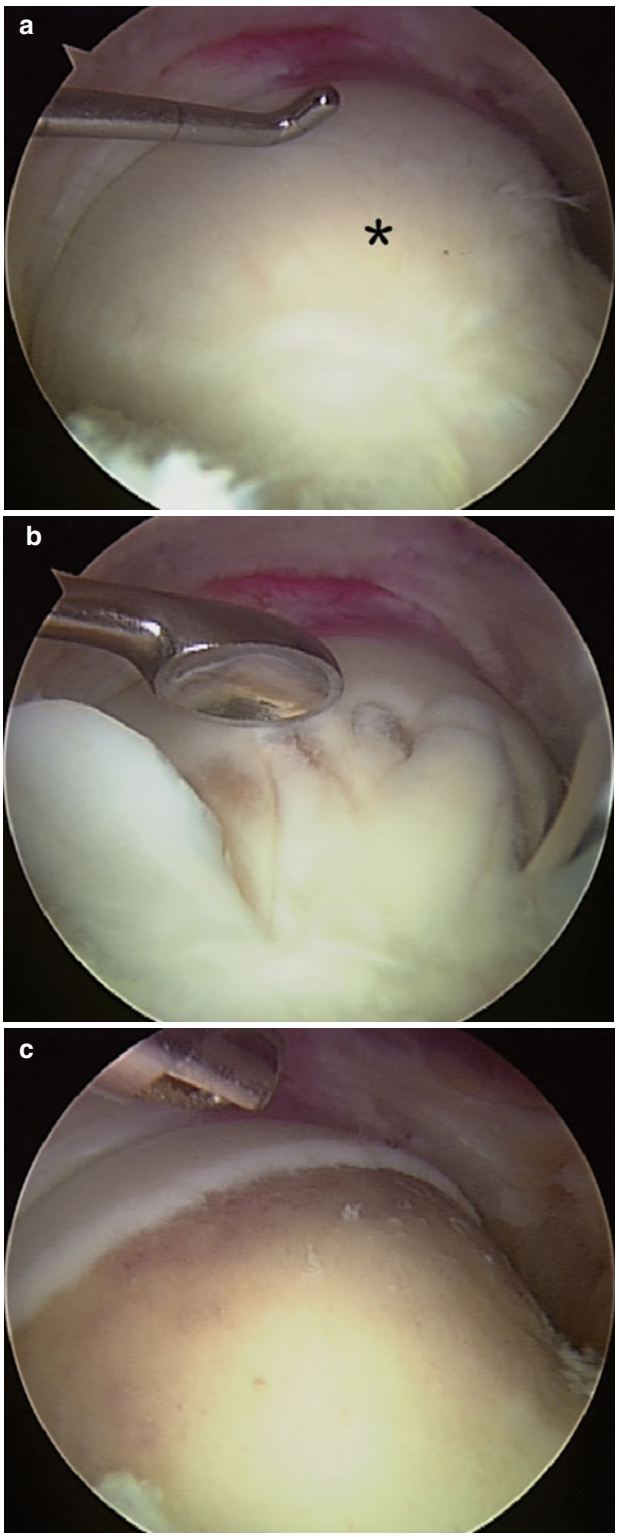

Fig. 17.24 The right hip is viewed from the anterolateral portal. (**a**) The cam lesion is identified, covered in fibrocartilage (*asterisk*). (**b**) An arthroscopic curette is used to denude the abnormal bone. (**c**) The area to be excised has been fully exposed. The soft tissue preparation aids in precisely defining the margins to be excised. (All rights are retained by Dr. Byrd)

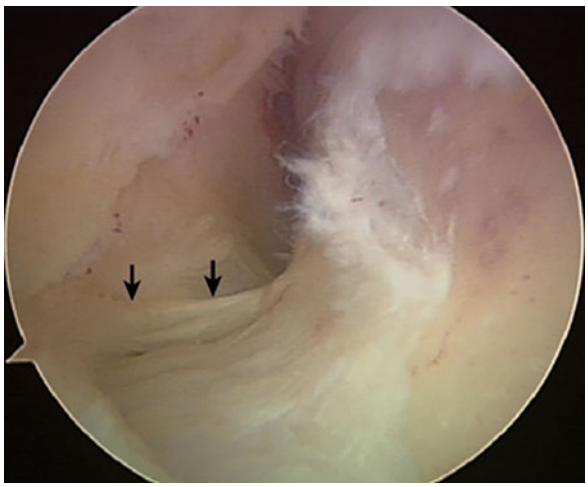

Fig. 17.25 Viewing laterally, underneath the area of the lateral capsulotomy, the lateral synovial fold (*arrows*) is identified along the lateral base of the neck, representing the arthroscopic landmarks of the lateral retinacular vessels. (All rights are retained by Dr. Byrd)

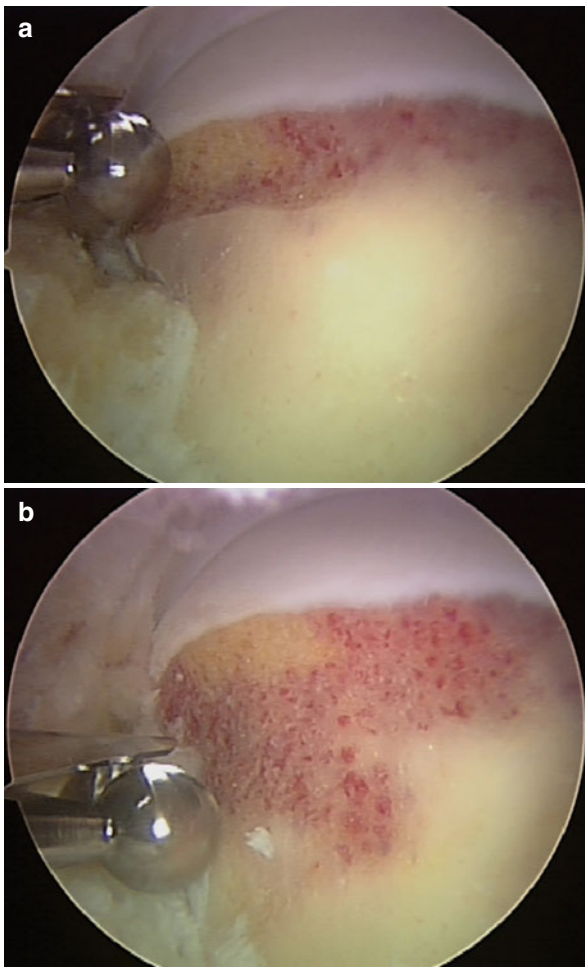

Fig. 17.26 The arthroscope is in the more distal (anterolateral) portal with the instrumentation placed from the proximal portal. (**a**) Bony resection is begun at the articular margin. (**b**) The resection is then carried distally, recreating the normal concave relationship. (All rights are retained by Dr. Byrd)

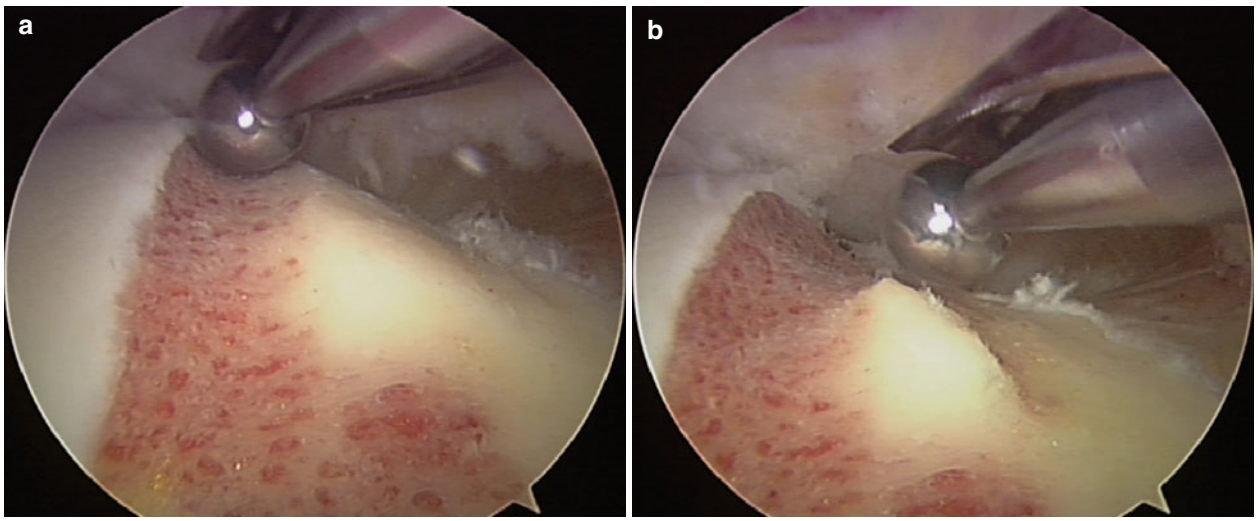

Fig. 17.27 The arthroscope is now in the proximal portal with the instrumentation introduced distally. (**a**) The line of resection is continued along the anterior articular border of the bump. (**b**) The recontouring is completed. (All rights are retained by Dr. Byrd)

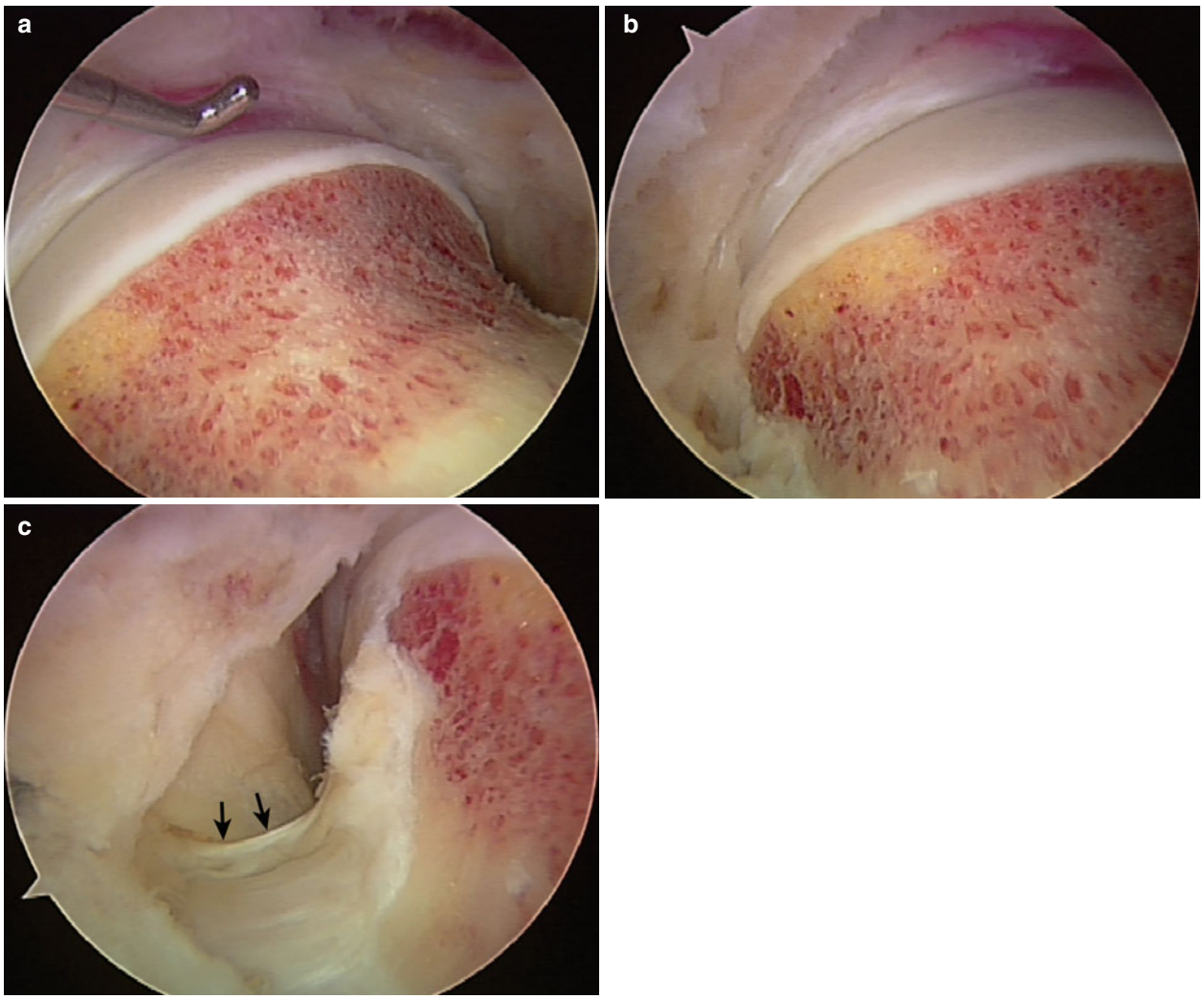

Fig. 17.28 The arthroscope has been returned to the distal portal for final survey, (**a**) viewing medially; (**b**) viewing laterally; (**c**) confirming preservation of the lateral retinacular vessels (*arrows*). (All rights are retained by Dr. Byrd)

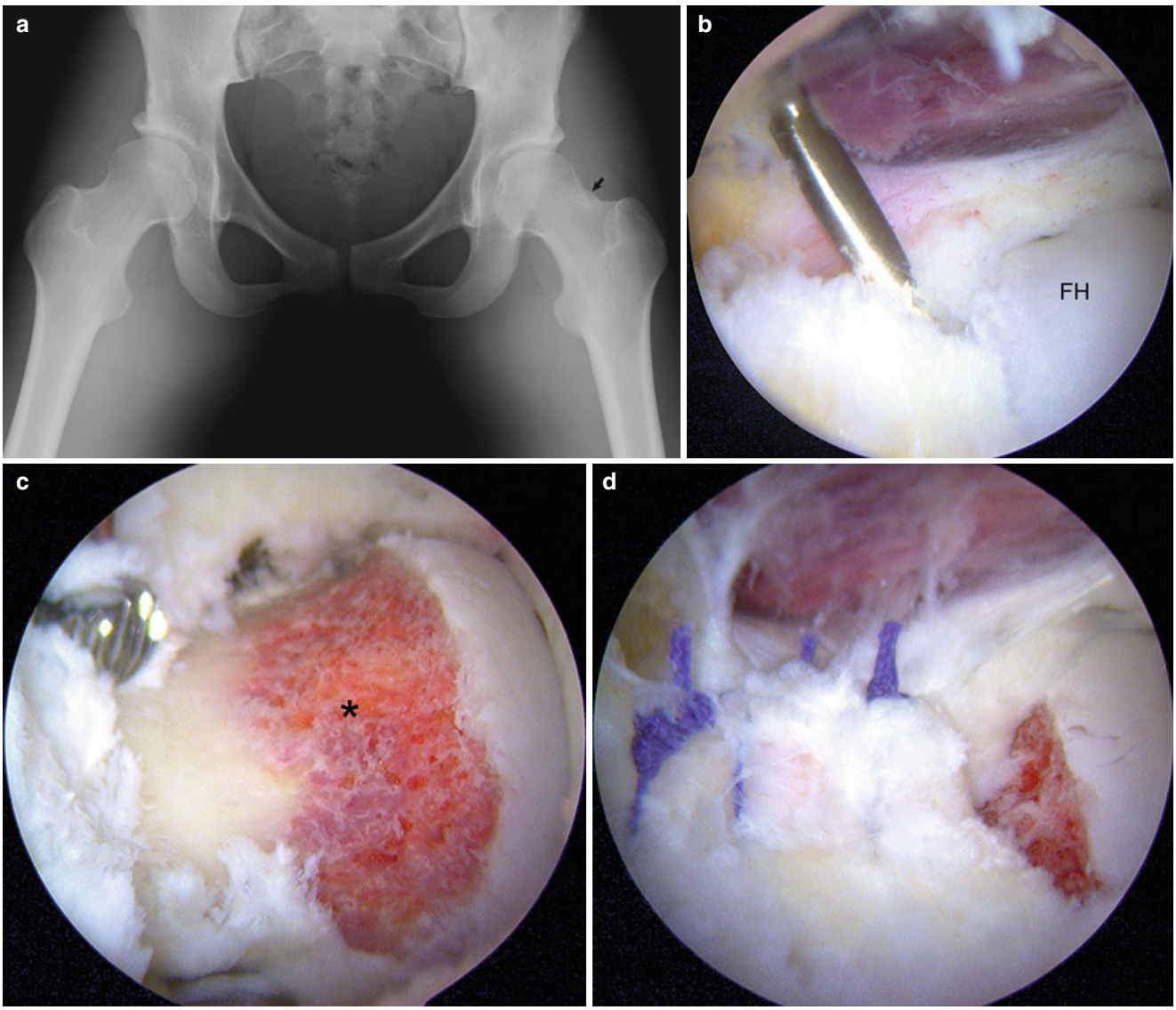

Fig. 17.29 (**a**) Dunn view of the pelvis of an elite level female hurdler with a symptomatic cam lesion (*arrow*) in her left lead leg associated with dysplasia (CD angle 20°). (**b**) Viewing the left hip from the anterolateral portal, a small capsulotomy has been made connecting the anterior and anterolateral portals, exposing the femoral head (*FH*). An arthroscopic knife is used to create a vertical T-limb to the capsulotomy to expose the cam lesion. (**c**) The cam lesion has been corrected (*asterisk*) recreating the normal concavity of the head/neck junction. (**d**) Same view with the vertical limb of the capsulotomy reapproximated with interrupted braided absorbable sutures. (All rights are retained by Dr. Byrd)

disease course. Thus, we need to learn how to detect and properly select patients for earlier intervention. Of course, we would not recommend surgery in someone who is asymptomatic, but patients who are minimally symptomatic should be educated on warning signs of progressive damage that might necessitate a proactive approach. Microfracture is perhaps an imperfect solution for full-thickness articular loss, but our results have still been quite favorable. With FAI, the articular surface of the femoral head tends to remain well preserved until very late in the disease course. Our observation is that once the femoral surface starts to fail, the results, although favorable, are not as good. In fact, for cases with mixed findings of impingement and dysplasia, the arthroscopic findings may aid in determining the principal culprit. With impingement, the femoral surface will remain well preserved despite advanced acetabular changes while, with dysplasia, articular erosion is more equally distributed to both surfaces. Among athletes, 95% returned to sport at the professional level and 85% at the collegiate level. It is unlikely that this difference indicates that we were doing a better surgical procedure among the professional athletes but indicates the reality that there are numerous other factors beyond just the surgical procedure itself that can influence successful outcomes. Our very low rate of conversion to

total hip arthroplasty seems to indicate that we are doing a good job properly selecting patients who are potentially candidates for arthroscopic correction of FAI, but our modest reoperation rate indicates that we could also be doing a better job with the technical aspects of the procedure.

We concur with others that grade III Tonnis changes are a contraindication to surgical correction of FAI. However, grade II changes are less clear. By definition, a severe cam lesion fulfills the criteria for grade II Tonnis. Many patients with grade II changes do well while others do not. In our opinion, this reflects that grade II Tonnis encompasses a broad spectrum of disease and reflects the inadequacies of plain radiography to accurately reflect the extent of intra-articular pathology.

Conclusions

Most cases of FAI can be managed with arthroscopic surgery. This can be a technically challenging procedure, but these challenges are lessened by a methodical, systematic approach to accessing the joint and addressing the pathology. Severe protrusio and cases that require a periacetabular or a proximal femoral osteotomy represent contraindications. The favorable aspect of the arthroscopic approach is its less invasive nature, avoiding the problems of open surgery, hospitalization, and rehabilitation. However, arthroscopy exposes the patient to risks not associated with the open procedure. The biggest concerns are problems associated with traction, iatrogenic injury to the joint, or less well-executed correction of the bony anatomy. These problems are accentuated in stiffer hips. There are further steps that can be taken to address these added challenges and a thoughtful, experienced approach in weighing the benefits of arthroscopy over an open procedure is required.

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