Femoroacetabular Impingement (FAI)

14

Zongping Xie

Femoroacetabular impingement is a suggested diagnosis for pain in the hip and hip joint dysfunction caused by eccentric loading of the joint or actual impingement of the proximal femur against the acetabular rim when joint motion reaches to a certain degree, which is further traced from irregular development of the fine structure in femoral head and neck and (or) acetabulum. First defined by Smith Petersen in 1936, FAI was reported in 11 cases featuring abnormality in the hip joint and (or) acetabulum. He suggested that the pain would be relieved apparently and the joint motion degree be recovered to some extent via a partially cutting of the anterior wall of the acetabulum, or the sclerotin of the front side of femur neck. His definition and suggestion, however, failed to attract attention. In 1975, Stulberg et al. proposed that primary osteoarthritis in the hip joint was probably associated with the irregular shape of proximal femur and acetabulum. And he called this deformity of proximal femur as "pistol grip deformity," without analyzing the mechanism of how bone shape abnormality causes joint degeneration though. In 1999, it was found by Mayer et al. that the ongoing hip pain appeared in those patients with hip dysplasia who had had periacetabular osteotomy was caused by the eccentric loading of the proximal femur and acetabulum. Again, Mayer et al. proposed that the causes of hip pain is FAI, which can be treated through femoroplasty. Based on this, Ganz et al. conducted observation and treatment for over 600 cases, and systematically illustrated the cause, pathological mechanism of FAI as well as the final result. For the first time, FAI was mentioned as the cause of primary osteoarthritis and a satisfactory treatment effect can be realized via acetabular plasty, femoroplasty, and labral repair under surgical dislocation. The study attracted peer attentions and spread over. With more support from other researchers, this theory was widely accepted.

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14.1 Classification and Pathogenesis of FAI

14.1.1 Classification of FAI

There are three types of FAI. The first, known as cam lesions, is attributed to a nonspherical portion of the femoral head abutting against an acetabular rim, resulting in denudation of glenoid labrum and adjacent acetabular cartilage. It shows wave sign under arthroscope without apparent glenoid labrum tears though. The second of FAI, known as Pincer lesions, are due to an over-covered acetabular rim, such as an abnormal anterior inferior iliac spine, partial excess of the acetabular rim, acetabular retroversion, or extreme depth of acetabulum. These lesions cover more anterosuperior region of the femoral head and repeating impingement of the glenoid labrum of the anterior acetabulum against femoral head and neck when the hip joint flex, adduct and internally rotate, may cause visible glenoid labrum tear and calcification, sometimes accompanied by cartilage damage and contrecoup injury of inferior acetabular cartilage. The third is a combination of the previous two, generally referred to as "Mixed," with deformities in both femoral head and neck and acetabulum, as well as injuries in them. More cases of FAI are found "mixed" (Figs. 14.1 and 14.2).

14.1.1.1 Cam Lesions

This type can be caused in physical development (femoral head not round, hip varus), by invasive reason (deformed heal after femoral neck fracture, or backward leaning of the femoral head after injury), hip damage at young age (slipped epiphysis, Perthes), and iatrogenic reason (femoral osteotomy).

14.1.1.2 Pincer Lesions

This type can be caused in physical development (hip varus, acetabular retroversion, extreme depth, partial excess of the acetabulum, and abnormal anterior inferior iliac spine), malunion of acetabular fracture, and iatrogenic reason (acetabular osteotomy).

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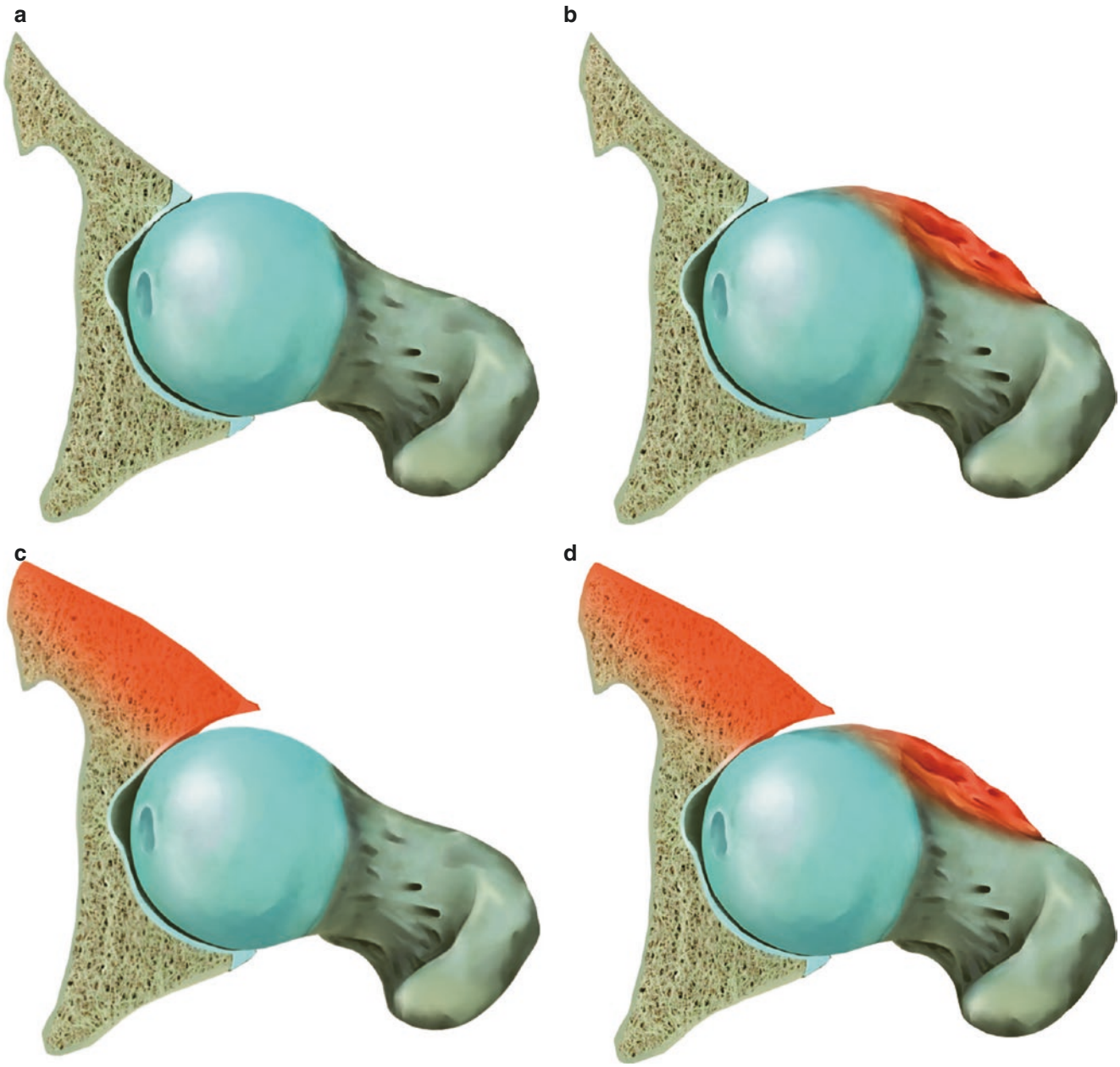

Fig. 14.1 Types of FAI. (**a**) Healthy hip joint; (**b**) Incisure disappearance at joint section of femoral head and neck (Cam deformity); (**c**) Excess of front acetabular rim (Pincer deformity); and (**d**) Abnormality at both acetabular and femoral head and neck (mixed)

14.1.2 Role of Acetabular Labrum

Acetabular labrum mainly plays the following roles:

1. Absorb impingement received when hip joint moves.
2. "Seal" between the femoral head and acetabular rim like a sealant to avoid joint fluid outflowing when carrying weight and make even distribution of the pressure between acetabular and femoral head joint through fluid transmission.
3. Contain nociceptor and proprioceptor for hip joint.

14.2 Clinical Manifestations, Diagnosis, and Treatment Principle of FAI

14.2.1 Patient History

A patient mostly feels discomfort at the groin or the buttock when the hip flexes at the first beginning. This attacks intermittently. Gradually, the pain goes mostly to the thigh root, buttock, and (or) groin (Cam deformity) as movement. In lesser situations, pain is felt at the lower abdomen or lumbo-

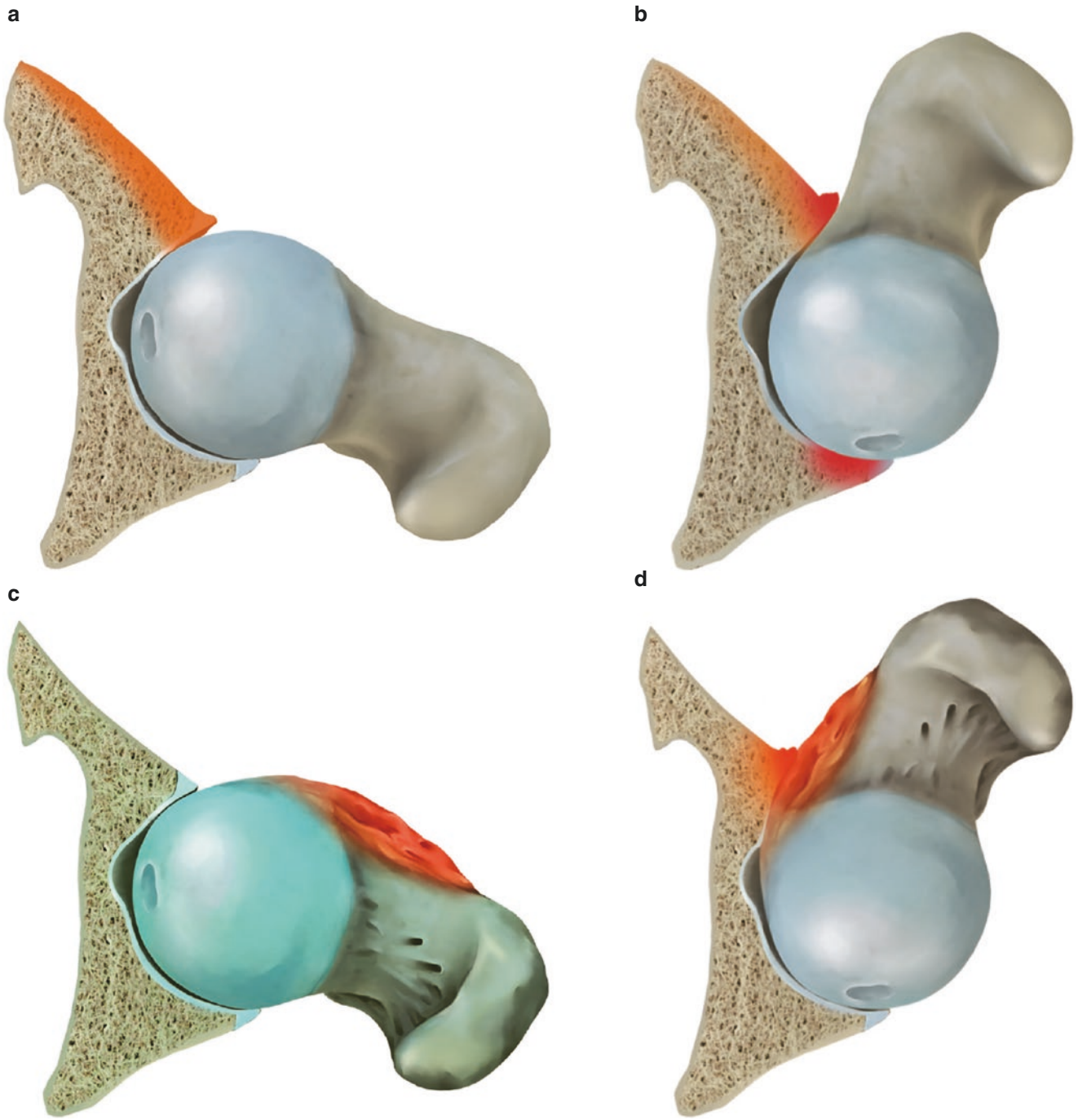

Fig. 14.2 FAI pathogenesis. (**a**, **b**) Regarding the injury mechanism of "Pincer" deformity of FAI, the excess of front acetabular rim repeatedly impinges femoral head and neck, resulting in injury at partial labrum and adjacent cartilage, sometimes accompanied by contrecoup injury of cartilage at the back and lower side; (**c**, **d**) Regarding the injury mechanism of "Cam" deformity, the excess of the joint section at femoral head and neck intrudes into acetabulum when hip joint flexes and rotates internally, resulting in cartilage damage at acetabular rim

sacral area, and it worsens after long-time sitting; hip joint flection, hip adduction, and internal rotation become limited gradually. Joint stiffness, sense of interlocking, and snapping hip may accompany. As the disease grows, pain will develop wider to the lumbosacral area, pubovisceral area, thigh, knee joint, and even to the shank.

14.2.2 Physical Findings

In many cases, tenderness is felt at the groin area, hip joint movement is limited, and limping may accompany. The most important finding is that it shows positive in impingement experiment (Fig. 14.3), i.e., deep hip flexion and adduction

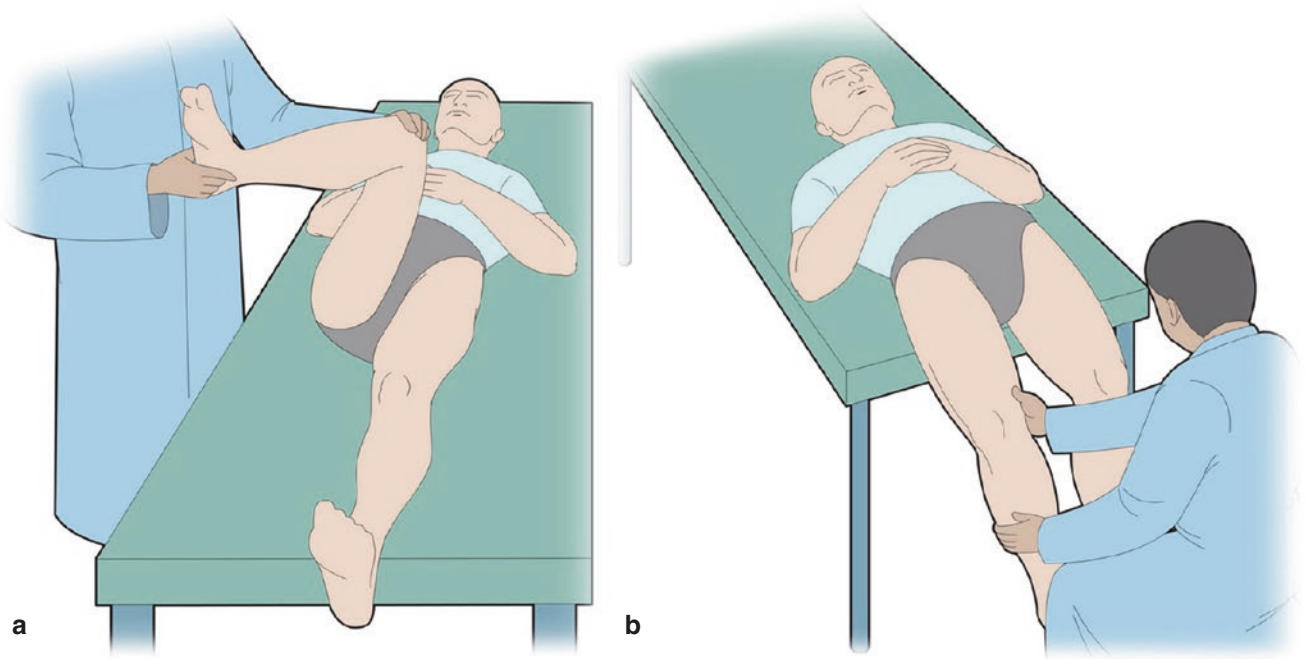

Fig. 14.3 Impingement experiment for glenoid labrum. (**a**) Anterior impingement experiment; (**b**) posterior impingement experiment

and internal rotation to the lying patient may induce pain, strongly indicating the labral tear at the front acetabular rim (most commonly seen). When the hip is gradually stretched to an angle of 90° and extended or rotated externally to a further degree, pain may also be induced. Few patients only have this positive sign. If the hip impingement proves to be the main cause of posterior and upper labral tear, then pain can be induced when the hip is overextended and externally rotated.

14.2.3 Intra-Articular Local Anesthetic

It is helpful to differentiate if the pain is caused by disease within or without the joint by observing on how much the hip pain is relieved 5–10 min after injection of local anesthetic into hip joint, and at the same time by comparison of the change of the signs of hip joint impingement before and after anesthetic injection. This is because sometimes the hip pain is synergistically caused by the pathological changes both inside and outside the hip joint. This diagnostic injection can not only help to diagnose the direct linkage between FAI and pain, but also help to assess how much pain can be relieved after the operation.

14.2.4 Imaging Study

X-ray photography has a special requirement. In order to improve its diagnostic value, imaging of the regular anteroposterior radiograph of pelvis requires overlap of the coccyx and the pubic symphysis (preventing pelvic rotation). The distance between the coccygeal tip and the upper edge of the pubic symphysis should be 4–5 cm, in order to avoid the error when evaluating the anterior and posterior acetabular rim.

The anteroposterior radiograph is mainly used to evaluate the deformity of the acetabulum in "Pincer lesion," including the acetabular retroversion which is characterized by crossover of the acetabular anterior and posterior walls, acetabular posterior wall sign (the posterior wall sign of the acetabulum located at the inner side of the femoral head center), and/or ischial spine sign (Fig. 14.4). Except for the anteroposterior radiograph, to assess the "Cam" deformity of the femoral head and neck, it also needs to take Dunn view: the patient is asked to stand or lie down, flex hip to a degree of 45° or 90°, abduct 40°. This is because "Cam" deformity can mostly be located in the anterosuperior region of the femoral head and neck. Some researchers apply alpha to assess (mostly measured on Dunn view) the degree of "Cam" deformity. Most of them believe that "Cam" deformity exists when the angle is more than 50° (Fig. 14.5). The role of CT is to help to

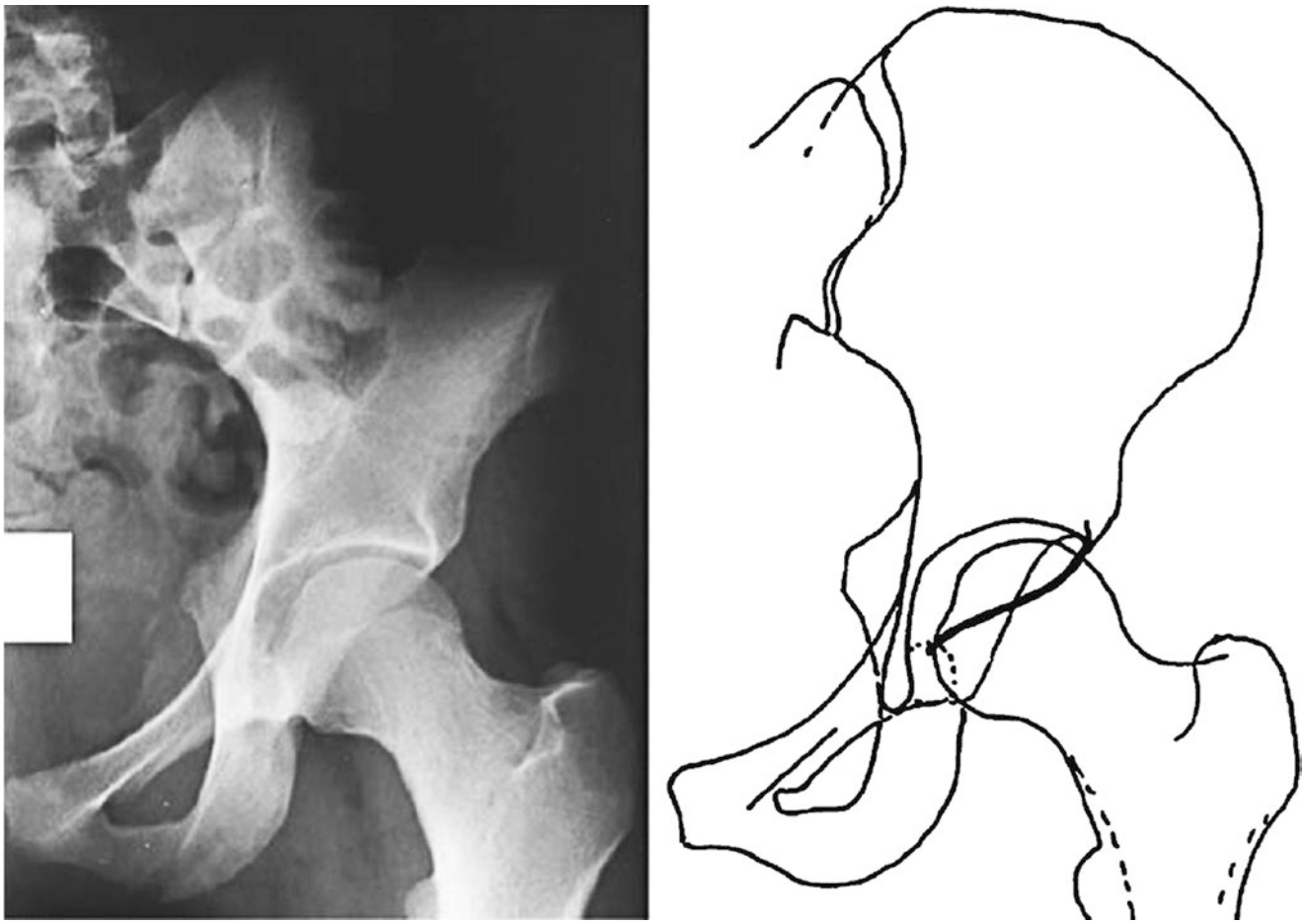

Fig. 14.4 Typical Acetabular Retroversion. crossover of the acetabular anterior and posterior walls, ischial spine (excess toward pelvic cavity), and acetabular posterior wall (the posterior wall of the acetabulum is located at the inner side of the femoral head center)

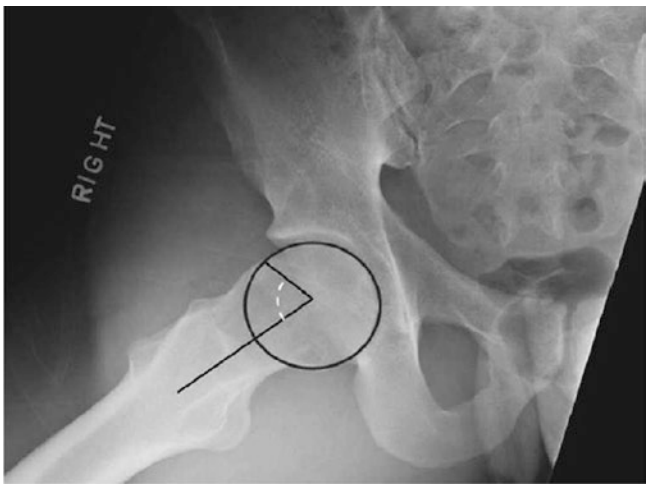

Fig. 14.5 Measuring the alpha angle of the femoral head

precisely find the location and degree of "Pincer" deformity of acetabulum and "Cam" deformity of the proximal femur through the three-dimensional rebuilding of the acetabulum and proximal femur. It also helps to accurately measure the alpha angle, observe fracture, and cystic change of acetabular rim as well as the cystic change of the femoral head and neck, which are caused by impingement. Furthermore, the degradation of joint cartilage can be observed, which will be greatly helpful for osteoplasty in operation (Fig. 14.6).

MRA is a major means of FAI diagnosis as it can substantially improve the accuracy (90% of sensitivity and 91% of specificity) of labral injury diagnosis (location and size) (Fig. 14.7). Meanwhile, it can be more accurate in diagnosing the injury of the femoral head and acetabular cartilage, and be helpful to diagnose teres ligament injury, intra-articular free body, synovial chondromatosis, pigmented villonodular synovitis (PVNS), etc.

14.2.5 Principles of FAI Treatment

14.2.5.1 Nonoperative Treatment

The key to nonoperative treatment is to avoid painful movements for a period of time, avoid squatting and sitting on low stools, strengthen muscle strength training, and take oral

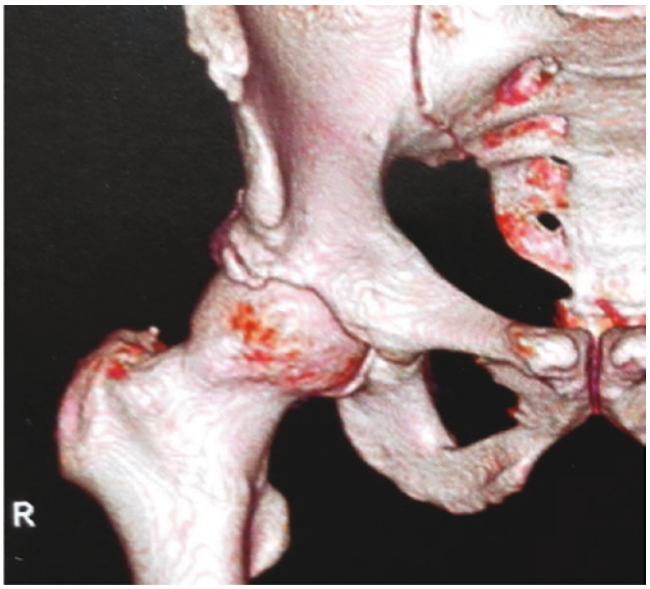

Fig. 14.6 FAI has shown in 3D CT. It shows clear "Pincer" deformity at the anterior rim of the right-side acetabulum of a 38-year-old male patient and slight fracture caused by repeated impingement as well as "Cam" deformity on the anterior and upper side of femoral head and neck

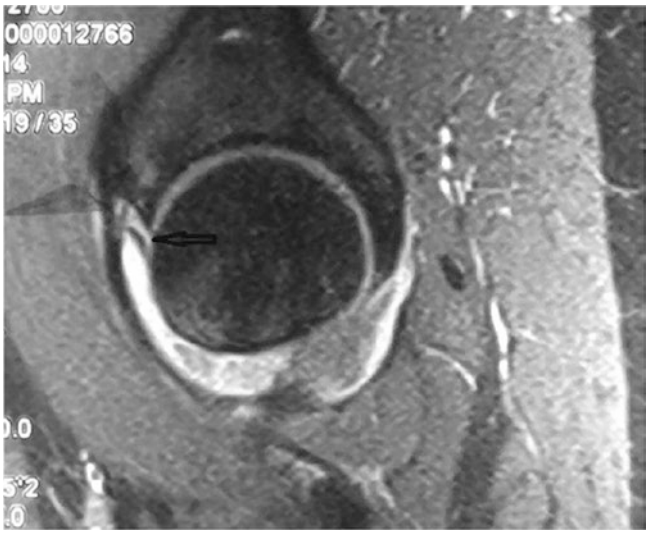

Fig. 14.7 MRA manifestation of FAI. It shows a clear labral tear at the anterior rim of the left-side acetabulum of a 24-year-old female patient (as indicated by the black arrow)

anti-inflammatory analgesics. Some doctors have tried to inject platelet-rich plasma (PRP) into the hip joint cavity. The author also attempted to conduct anti-inflammatory treatment within the joint cavity in the early stage with the ultrasonic guidance. A small number of patients showed to have a pretty long-term improvement while a larger number would recur and get worse after weeks to months. As no change happens to the shape of the bone, nonoperative treatment only works for a small number of patients.

14.2.5.2 Operative Treatment

There are two types of surgical treatment for FAI, one is open surgery (surgical dislocation of the hip joint), and the other is arthroscopic surgery. In the earlier stage, the former was used as the main treatment, i.e., the femoral head was disengaged forward firstly, then osteoplasty was performed in femoral head and neck and acetabulum, and then the torn labrum was repaired. These years, however, with the advancement of hip arthroscopy instruments and technology, most of the FAI can be treated by arthroscopic surgery.

14.3 Surgical Dislocation of Hip Joint

14.3.1 Surgical Indication

If FAI was confirmed and nonoperative treatment does not work, surgical dislocation of the hip joint can be taken when there is no obvious surgical contraindication in both whole and partial body. Surgical contraindications include poor general condition, high risk of surgery; combined with obvious joint space stenosis, age over 50 years old; local or systemic infection.

14.3.2 Blood Supply of Femoral Head

The main blood supply of the femoral head starts from medial circumflex femoral artery (MFCA) between the iliopsoas and the pectineus. It reaches the posterior aspect of the hip joint after running through obturator externus and adductor brevis. The ending branch turns upward to the trochanteric fossa from the deep side of quadratus femoris along the lower edge of the obturator externus. It finally extends over the superficial or deep surface of the obturator externus and becomes a deep branch of MFCA, which enters the femoral head at the femoral head-neck junction through the upper part of the femoral neck (Fig. 14.8). MFCA deep branch is the main source of femoral head blood supply. That is to say, any injury of the MFCA deep branch to enter the femoral head at the outer side of the femoral head-neck junction will lead to femoral head necrosis. Therefore, it is crucial to protect the perforator of the blood vessel into the femoral head in surgical hip dislocation approach.

14.3.3 Surgical Techniques

The patient is asked to take a lateral position. The incision is taken anterior one-third of the greater trochanter as center point and made vertically with a length of approximately

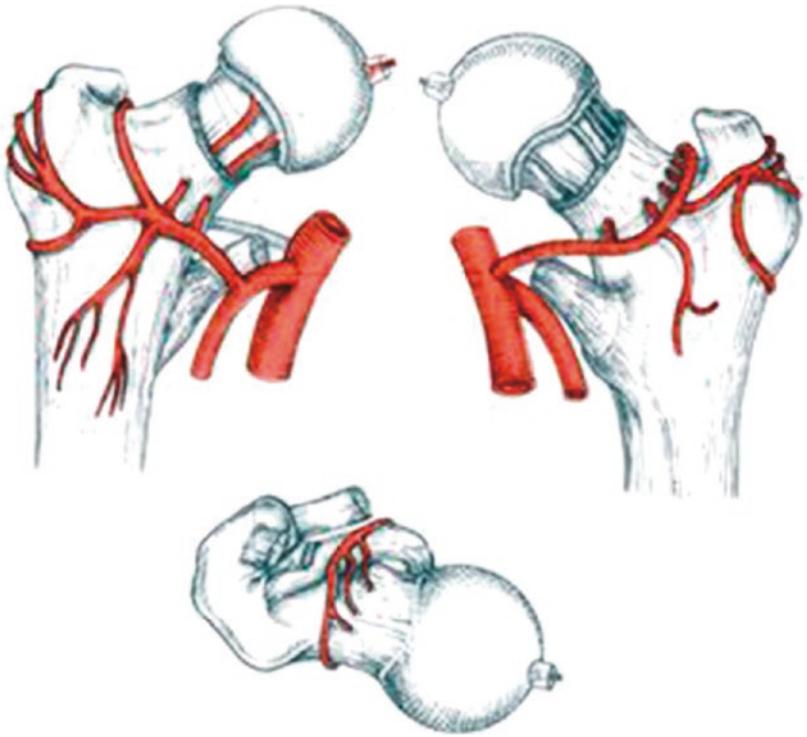

Fig. 14.8 Main Blood Supply of Femoral Head: MFCA Deep Branch. MFCA deep branch is the main blood supplier to the femoral head, which must be highly protected in the surgery

Fig. 14.9 Patient positioning and incision. The patient is asked to take a lateral decubitus position. The incision is centered on greater trochanter, and extends 9-cm proximally and 6-cm distally along the anterior 1/3 of the greater trochanter

15 cm (Fig. 14.9). Cut the skin and reach the shallow and deep fascia layer by layer, cut off the gluteus maximus by its insertion of the fascia and retract it backward. Then rotate the thigh internally to find the posterior rim of gluteus medius and the Trochanteric fossa in the upper rear of greater trochanter. Use an oscillating saw to make a large trochanter osteotomy with a thickness of about 1.5 cm, retaining gluteus medius, pectoralis minor, and the endpoint of vastus lateralis muscle while paying attention to maintaining the integrity of the bone tissue next to the major trochanteric fossa, and avoiding damage to the MFCA deep branch below it. Retract the separated trochanter major, along with the gluteus medius, pectoralis minor, and vastus lateralis muscle toward the anterior side of the hip joint (Fig. 14.10). Sometimes piriformis tendon is seen attaching to it, which affects its movement. If this happens, the piriformis tendon can be cut off.

Find the gap between the piriformis tendon and the gluteus minimus, and peel off the attachments on the joint capsule of gluteus minimus from the rear to the front, pay attention to protecting the piriformis tendon as well as the MFCA deep branch supporting the femoral head below it. Make the anterior, superior, and posterosuperior parts of the joint capsule exposed. In order to avoid damage the MFCA branch in the femoral head, it is necessary to cut the joint capsule longitudinally to the forward of the greater trochanter along the long axis of the femoral neck, and then cut and extend in the "Z" shape at the attachment in the inner side of the femoral neck of the joint capsule. At the acetabular junction, turn to the rear to open the joint capsule on the posterior aspect of the femoral head (Fig. 14.11a).

When cutting the joint capsule, attention must be paid to protect the structure of the cartilage of the femoral head as well as the labrum. By extremely flexing, externally rotating femoral bone and cutting the teres ligament, the femoral head can be pulled out. Since the teres ligament artery is not the main source of blood supply to the femoral head, the residual portion of the teres ligament in the femoral head should be removed, which will not affect the blood supply of the femoral head. The lever is placed in the anterior and inferior transverse ligaments of the acetabulum. Now the acetab-

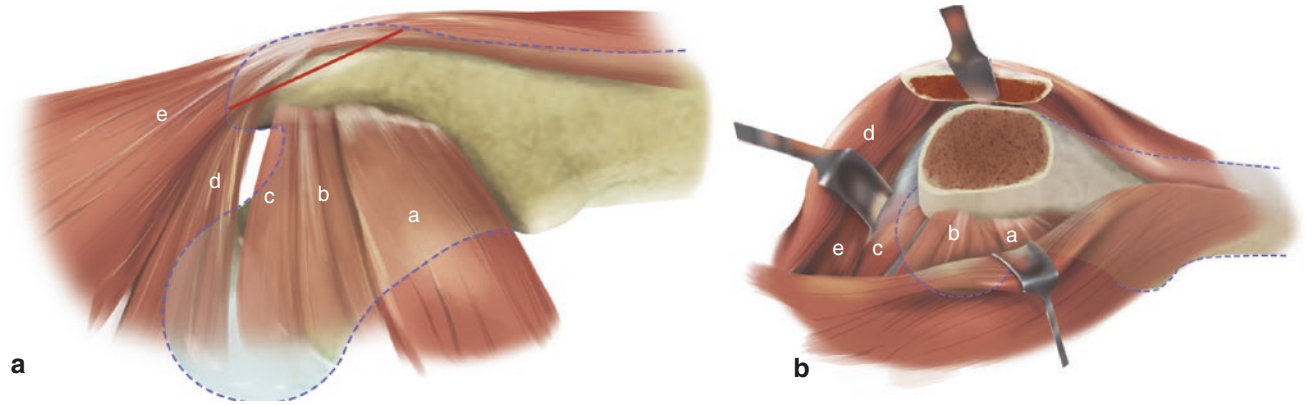

Fig. 14.10 Schematic pictures of trochanter major osteotomy. (**a**) Toward trochanter major osteotomy. (**b**) Retract the greater trochanter forward after osteotomy (a. Quadratus femoris; b. Superior gemellus and inferior gemellus; c. Piriformis; d. Gluteus minimus; e. Gluteus medius)

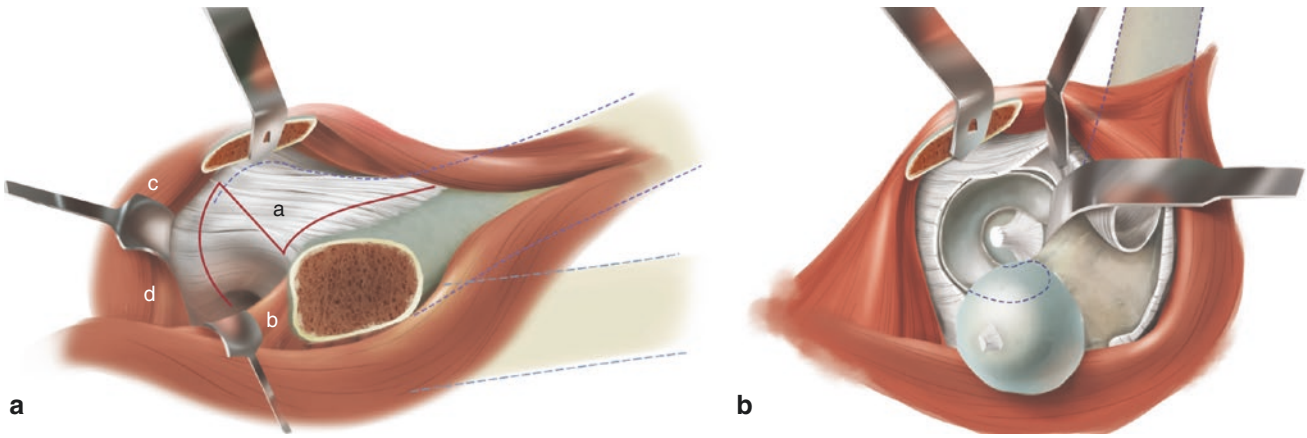

Fig. 14.11 Schematic pictures of pulling out femoral head by cutting the joint capsule. (**a**) "Z"-shape cutting of joint capsule (a. Joint capsule; b. Piriformis; c. Gluteus medius; d. Gluteus minimus). (**b**) Pull out the femoral head, reveal the acetabulum and glenoid labrum in 360° view

ulum and the femoral head and neck structures are fully revealed (Fig. 14.11b).

The teres ligament of the femoral head can be first removed to examine the position of acetabular and labral tear as well as the position and degree of acetabular "Pincer" deformity. Preoperative 3D CT assessment can be consulted to determine the width of the acetabular rim to be cut.

Thereafter, the torn part of the labrum is removed by a sharp blade, and the excess portion of the acetabular rim is removed. After the appropriate examination, fix the free labrum to the acetabular rim with the anchoring bolt. Again, according to the assessment, remove the abnormally prominent cartilage surface and the underneath bone of the femoral head and neck. After that, straightened the joint, rotate internally to reposition the joint and activate the hip joint toward all directions to check whether there is any impingement. If yes, do it again by pulling out the femoral head and make further osteoplasty till no abnormal contact exists between the head and neck of the moving joint and the acetabular rim (Fig. 14.12)

After trimming the femoral head and neck junction, observe whether there is obvious oozing on the surface of the cancellous bone to help determine the blood supply to the femoral head. During the surgical procedure, a Doppler flowmeter can be used to understand the dynamic profile of blood perfusion in the femoral head. To prevent articular cartilage from drying, the articular cartilage is continuously moistened with physiological saline.

After the operation of the hip joint is completed, pull the lower limbs, bend the knees, and rotate internally to reposition the hip joint. Seaming of the joint capsule should not be too tight; otherwise, it will increase the tension of retinacular artery, resulting in a decrease in perfusion of the femoral head. Use 3.5 mm cannulated screws to fix osteotomy piece of the greater trochanter.

14.3.4 Postoperative Treatment

From the second day after surgery, the patient can walk with a pair of crutches. Keep walking on the toes for 6

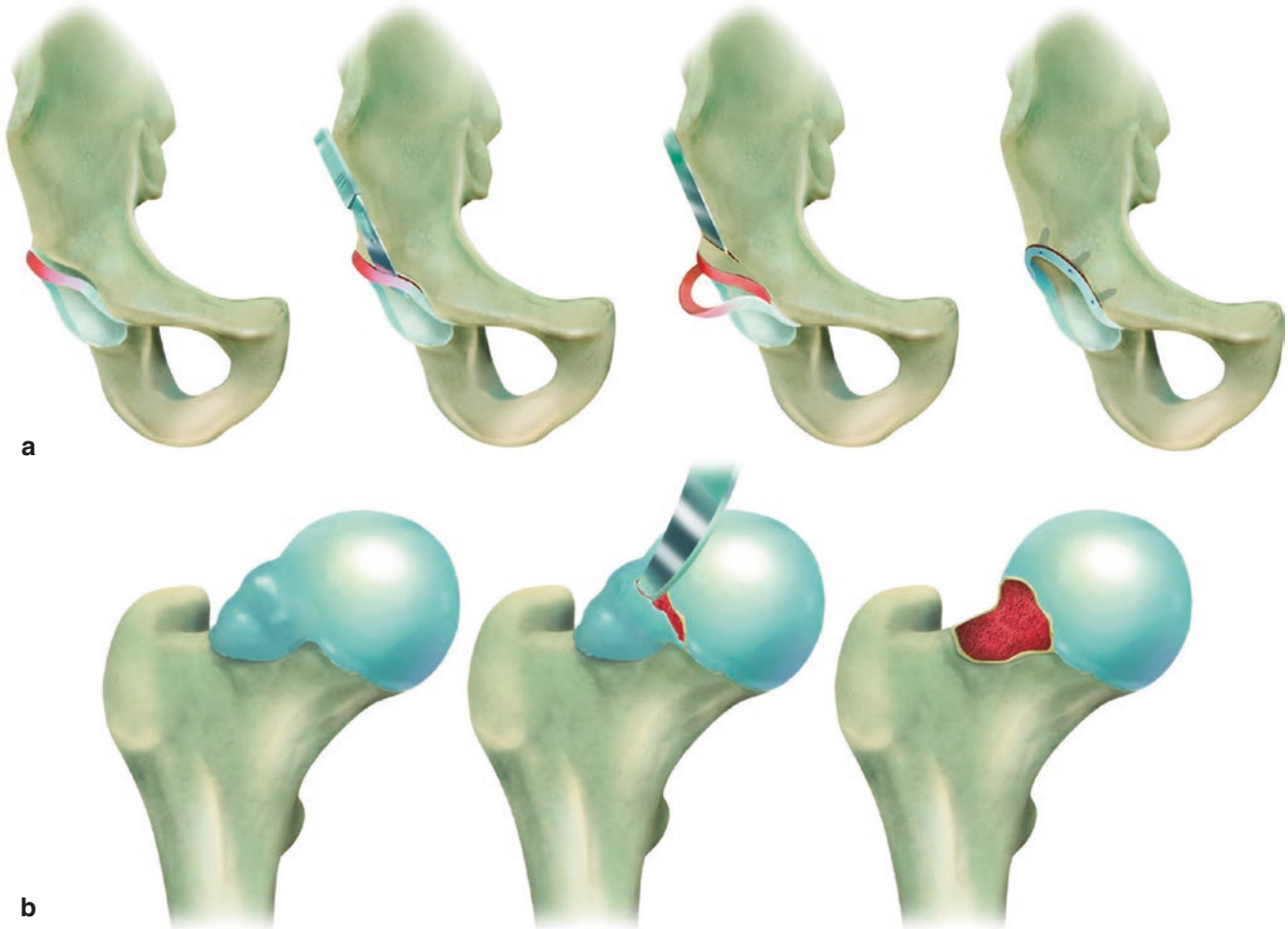

Fig. 14.12 Femoroplasty of acetabulum and femoral head and neck, and remedy of the labrum. (**a**) Femoroplasty of the acetabulum and fixing the free labrum with anchoring bolt; (**b**) Osteoplasty of femoral head and neck

weeks and then walk on the whole feet until the osteotomy is healed and the crutches are not needed any more. Do not make hip flexion more than 90° within 4 weeks after surgery to avoid affecting the healing of the labrum. Step-by-step muscle strength training is needed after surgery.

14.3.5 Typical Cases

14.3.5.1 Case 1

14.3.5.1.1 Medical History

A male, 30 years old, was hospitalized after suffering from 2-year lasting and aggregating pain at groin and hip accompanied by 1-month limp. His pain worsens after long-time sitting and walking. He was only able to walk for 500 m at the time he started hospitalization.

14.3.5.1.2 Physical Examination

The patient was crippling, unable to squat to a low level. The hip impingement signs for both sides were strongly positive, with the right side worse; the hip joints on both sides were obviously limited for flexion and internally adduction, flexion on the right was about 80° and the adduction was 0°; flexion on the left was about 100°, and the adduction was about 5°. VAS pain score: 9 points on the right, 7 points on the left; HHS score: 42 points on the right and 60 points on the left.

14.3.5.1.3 Diagnosis

Bilateral femoroacetabular impingement syndrome (FAI).

14.3.5.1.4 Treatment

After admission, the patient was given the right hip surgical dislocation. During the operation, the acetabulum and femoral head cartilage were obviously found degenerated

and thinned, but there was no obvious exfoliation. The anterior and external glenoid labrum was torn, and the acetabular rim was abrased and repaired with an anchor. The acetabular fossa round ligament and proliferative synovium were cleared; the abnormal bone excess of the femoral head and neck was removed; but the posterior superior bone was not disturbed in order to avoid postoperative femoral head necrosis as it was close to the main blood supply, and the corresponding glenoid labrum was intact (no manifestation of impingement).

14.3.5.1.5 Prognosis

After 3 months of follow-up, the right hip VAS score was 0. Walking was normal and the impingement syndrome disappeared; the flexion was about 120°, and the adduction was about 20°. Four months after surgery, the left side pain was reported unbearable, and the patient strongly requested to have surgery for the left-side acetabulum and femoroplasty. Follow-up after 20 months showed that the bilateral hip activity was completely normal without obvious discomfort. The preoperative and postoperative X-ray findings and intraoperative photos are shown in Fig. 14.13.

14.3.5.2 Case 2

14.3.5.2.1 Medical History

A male, 30 years old, was hospitalized after suffering from 5-year lasting and aggregating pain at right hip accompanied by 2-month limp. His pain worsens after long-time sitting and walking. He was only able to walk for 1000 m at the time he started hospitalization.

14.3.5.2.2 Physical Examination

The patient was crippling slightly, unable to squat to a low level. The right hip impingement syndrome was strongly positive; the hip joints on the right were slightly limited for flexion and internal adduction. VAS pain score: 8 points, and HHS score: 52 points.

14.3.5.2.3 Diagnosis

Femoroacetabular impingement syndrome (FAI) on the right side.

14.3.5.2.4 Treatment

After admission, the patient was given the right hip surgical dislocation. During the operation, the anterior and upper side labrum was torn in a large area (areas 1 and 2), the adjacent cartilage was damaged, and there was apparent "Cam" deformity on the anterior and upper side of the femoral head and neck. Acetabular rim bone was cut by some 2 mm near the torn labrum; the torn labrum was fixed with anchor; "Cam" deformity of the femoral head and neck was cut; acetabular fossa was cleaned; and resumed the position and activated the joint to see if there was still deformity remained that could cause impingement.

14.3.5.2.5 Prognosis

After 3 months of follow-up, walking was normal and the hip pain disappeared; follow-up after 12 months showed that VAS score was 0 and the HHS score was 100.

The preoperative and postoperative X-ray findings, preoperative CT and MRI manifestation, as well as in-operation photos, are shown in Figs. 14.14 and 14.15.

14.4 Arthroscopic Surgery

14.4.1 Surgical Indication

When the well-diagnosed FAI cannot be effectively treated by conservative treatment, and there are no obvious surgical contraindications in the whole body and local conditions, arthroscopic surgery can be taken if the labrum is torn at the anterior, lateral, or posterolateral positions.

14.4.2 Surgical Contraindications

Surgical contraindications include: (a) the diseases presented with hip joint ankylosis, stiffness, or capsule contracture limited joint retraction; (b) heterotopic ossification joint cannot be retracted or filled, arthroscopic instruments cannot enter; (c) skin disease or ulcer adjacent to the incision; (d) labrum tear locating on the posterior side of the acetabulum; (e) combined with obvious joint space stenosis; (f) over 50 years of age; (g) poor general physical condition or high risk of surgery; and (h) combined with other systemic diseases that are not suitable for an operation.

14.4.3 Equipment and Instrument

X-ray image intensifier is essential to ensure accurate access to the hip joint cavity; A distraction system allows a patient properly positioned; 70° and 30° arthroscopes, cold light sources, camera imaging systems, a high-definition flat screen monitor, manual instruments, and motorized shaver blades, radiofrequency (RF) instruments are among the necessary equipment and instruments; the 70° arthroscopes are mainly used in the central compartment, in most cases it can also be used in the peripheral compartment; the 30° arthroscopes can get a better vision in the peripheral compartment; 18-gauge 25-cm long special needle, switching stick, cannulas and dilators with various diameters and lengths and their supporting tools can help to dilate the arthroscopic portals and facilitate the passage. Other tools include joint

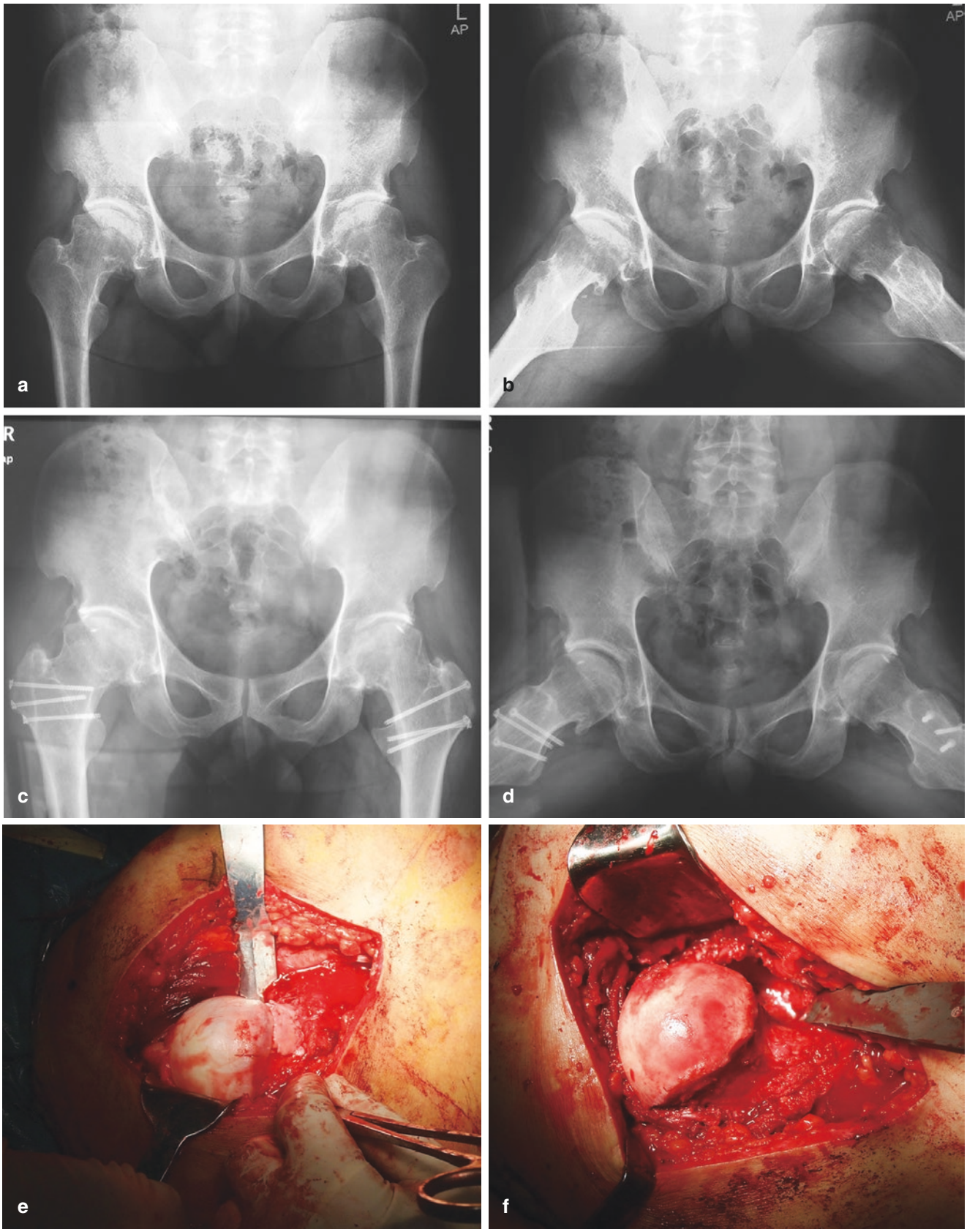

Fig. 14.13 X-ray manifestation and in-operation photos of Case 1. (**a**, **b**) X-ray posteroanterior radiograph and Dunn view; (**c**) X-ray radiograph 20 months postoperative right hip; (**d**) X-ray radiograph 16 months postoperative left hip; (**e**) "Cam" deformity on the right femoral head by straight sight; (**f**) Manifestation after femoral head and neck deformity resection

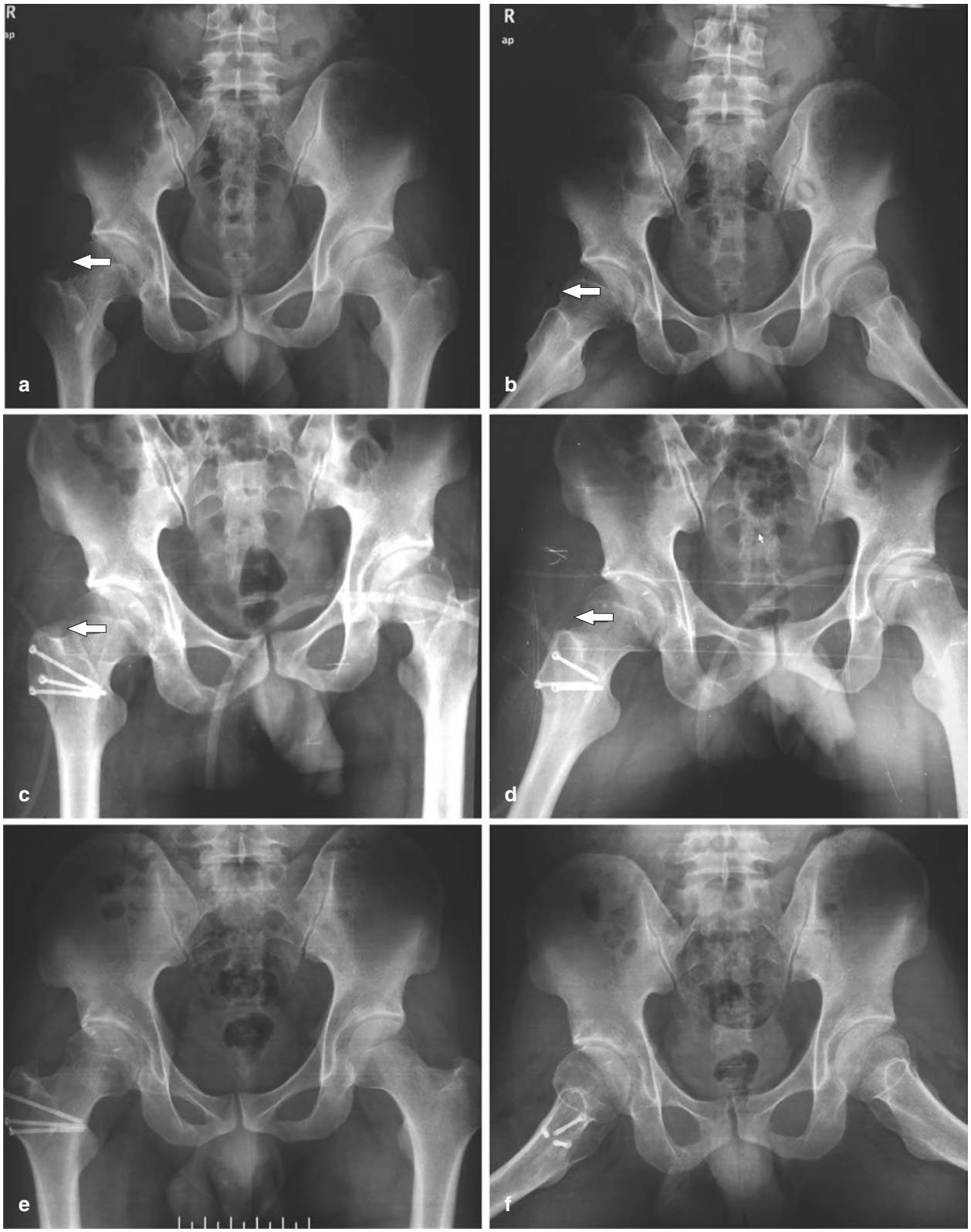

Fig. 14.14 Postoperative and preoperative X-ray manifestation of the two cases. (**a**, **b**) X-ray preoperative radiograph showed slight acetabular retroversion and apparent "Cam" deformity at anterior and upper femoral head and neck (as the arrow shows); (**c**, **d**) X-ray postoperative radiograph showed the deformity was cut and the exterior form of the acetabulum and the femoral head recovered to normal; (**e**, **f**) X-ray radiograph showed that the hip recovered well 12 months after the operation

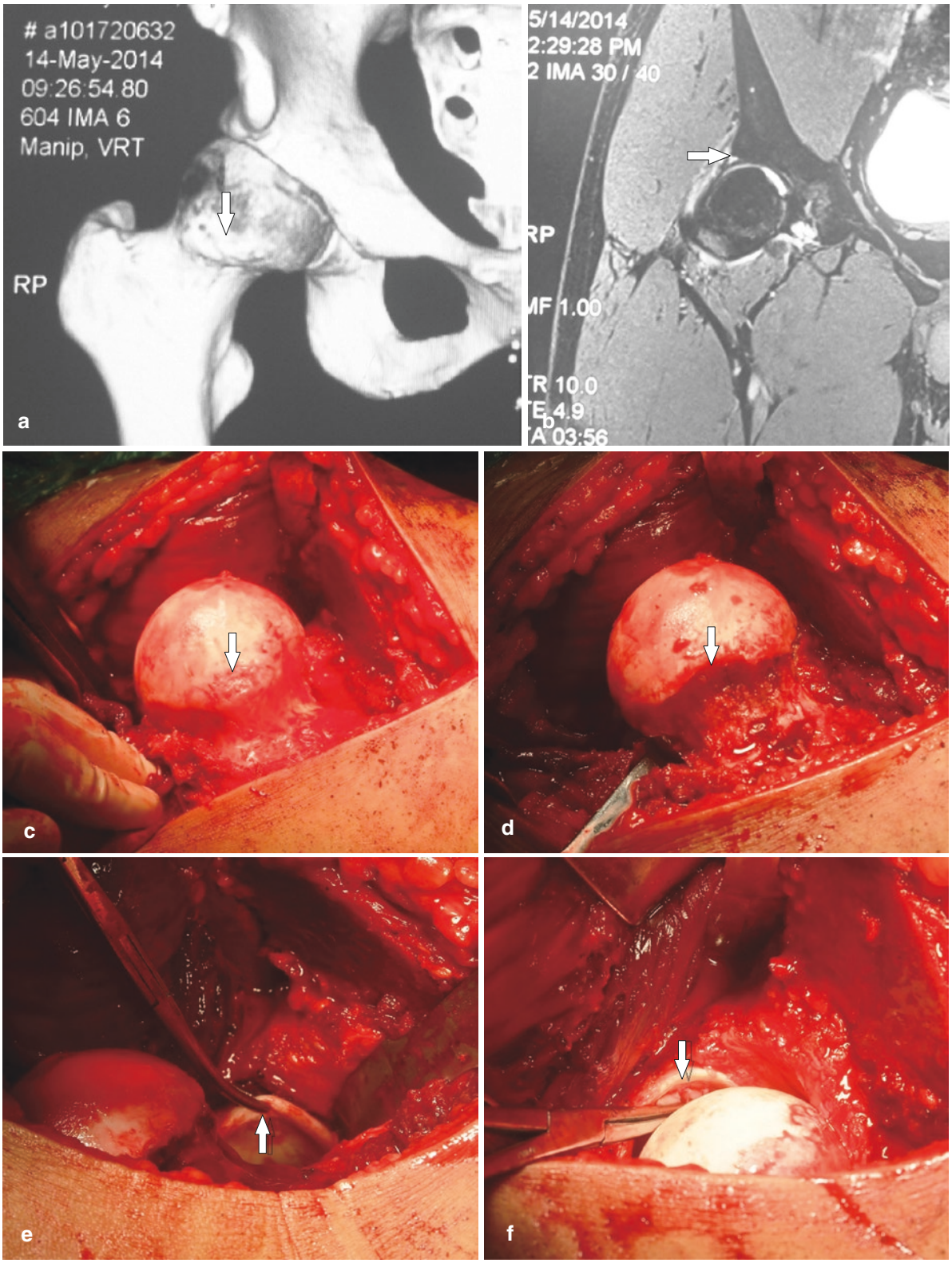

Fig. 14.15 Preoperative CT, MRI manifestation and in-operation photos of Case 2. (**a**) 3D CT showed apparent "Cam" deformity at anterior and upper femoral head and neck; (**b**) MRI imaging of the hip joint showed clearly the torn anterior and upper labrum; (**c**, **d**) The arrow shows the manifestation before and after cutting "Cam" deformity at the femoral head and neck in the operation by straight sight; (**e**, **f**) The arrow shows the torn anterior and upper labrum and adjacent cartilage damage in operation

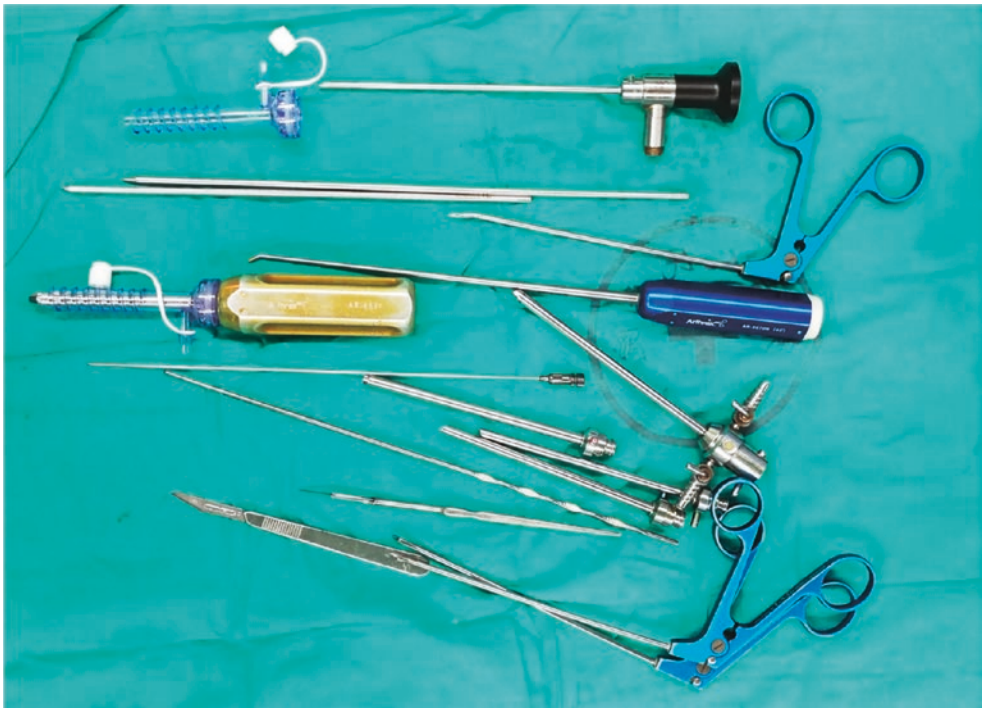

Fig. 14.16 Surgical instrument commonly applied in hip arthroscopy

capsule cutting instruments; micro-bone chisel of various angles for the repair of acetabular cartilage defects; probes for detecting labrum and cartilage damage; and rasp, basket scissors, suture cutters, grasping instruments, suture retrievers, graspers, suture passers and knot pusher, etc. (Fig. 14.16).

14.4.4 Surgical Steps and Techniques

14.4.4.1 Anesthesia and Positioning

General anesthesia or spinal anesthesia is applied to adequately block the motor nerves to ensure muscle relaxation. The patient is placed in the distraction system in the supine position, one important advantage of which is that it can avoid liquid leakage, and that it is convenient to position the body. The affected hip is placed in a straight, abducted neutral position, with a mild internal rotation, and the lower limbs are straightened and abducted for about 60° (Fig. 14.17).

14.4.4.2 Preoperative Body Surface Positioning

Mark the top of the greater trochanter of femur, the anterior superior iliac spine, and the upper section of the linkage line of the anterior superior iliac spine to the midpoint of patella. The three commonly used portals are: the anterolateral portal, the most common used one, at the superior margin of the greater trochanter in line with its anterior border; the anterior portal, 1cm lateral and 1cm distal from the intersection of a sagittal line drawn from the superior border of the greater trochanter to the superior aspect of the pubic bone; The midanterolateral portal, halfway between the anterior and anterolateral portals, about 2 cm distal to a line connecting the 2 portals. Occasionally, an additional access may need on the posterior upper edge of the greater trochanter in case of a posterolateral labral tear (posterolateral portal) (Fig. 14.17).

14.4.4.3 Traction

The main complications of using a distraction system are the compression of the pudendal nerve by the perineal column and the pulling of the sciatic nerve. Therefore, traction should not be longer than 2 hours. In order to protect the pudendal nerve from injury, the perineal column should be wrapped well (at least 9–12 cm in diameter) to effectively disperse the pressure on the perineum. The contralateral limb should be as far-reaching as possible, and an image intensifier can be placed between the legs. Mild traction should be applied when the contralateral foot is fixed to create a reverse traction force, which will maintain the position of the pelvis on the operating bed so that it does not shift due to traction on the affected side. The traction force exerted on the limb and the degree of hip joint retraction can be further determined by fluoroscopy. If the joint is too tight, the traction can be further strengthened, but very carefully. If the joint now still cannot be smoothly retracted, liquid or air can be injected into the joint to relieve the negative pressure in the joint cavity, and the joint can be retracted in this way. Control the hip joint retraction gap to 1–1.5 cm, do not exceed 1.5 cm.

14.4.4.4 Build the Surgical Accesses

The hip puncture is performed with a special 18-gauge 25-cm long puncture needle. The puncture needle is inserted along the anterior edge of the apex of the femoral greater trochanter and is penetrated into the hip joint along the ace-

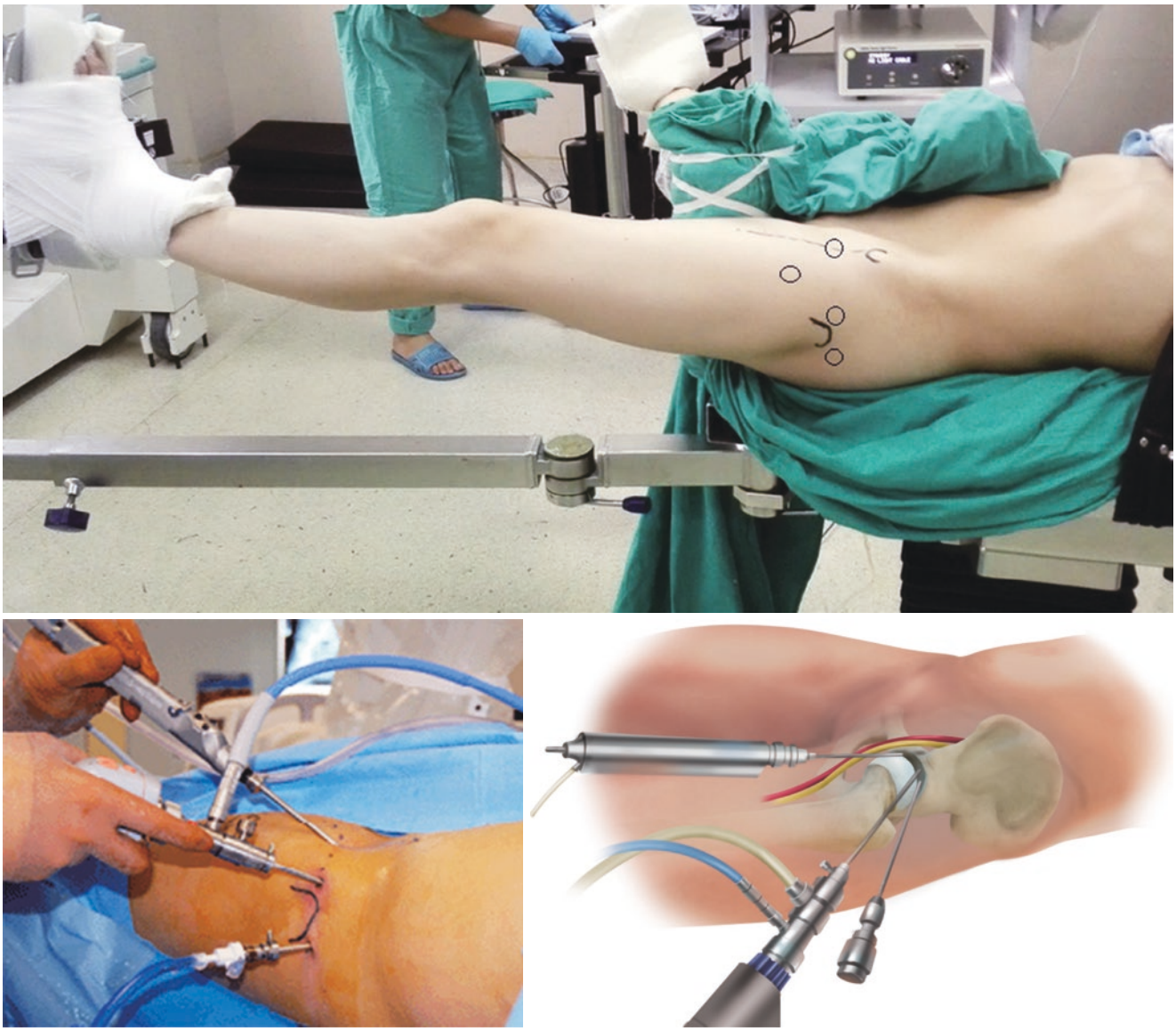

Fig. 14.17 Patient's body positioning in hip arthroscopic surgery and the body-surface marking of the 4 major portals for operation

tabular rim. If the hip joint is successfully punctured, the saline in the syringe connected to the needle will be automatically inhaled into the hip joint cavity by 10–15 ml.

Liquid injection into the hip joint cavity will automatically reverse, indicating that the needle is already in the hip joint cavity. Use a syringe to inject 10–15 ml of water into the joint to relieve the negative pressure in the joint cavity for easier traction. Pull out the puncture needle and penetrate into the joint cavity along the anterior lateral entrance with a single switching stick under fluoroscopy. This step should be very careful to avoid injury to the femoral head cartilage and the acetabular labrum. A small incision of about 1.5 cm long is made for anterolateral portal, and a small metal cannula is placed over the switching stick to establish a passage. When the fluoroscopy proves that it is in the joint cavity, remove the switching stick, insert the 70° arthroscopic lens, and reach the anterosuperior femoral head straightly. The instrument should be kept at a certain distance from the femoral head to avoid joint surface wear. After the arthroscope is placed, the anterior portal is also established under the monitoring of the arthroscopy. Thereafter, the joint capsule between the two portals is cut transversely with a special knife to facilitate the movement of the lens and the instrument. If necessary, an anteroinferior portal and a posteolateral portal can also be built under the athroscope's monitoring (Fig. 14.18).

14.4.4.5 Surgical Techniques

After the portals and passages are established, surgical instruments and arthroscopes can be interchanged to

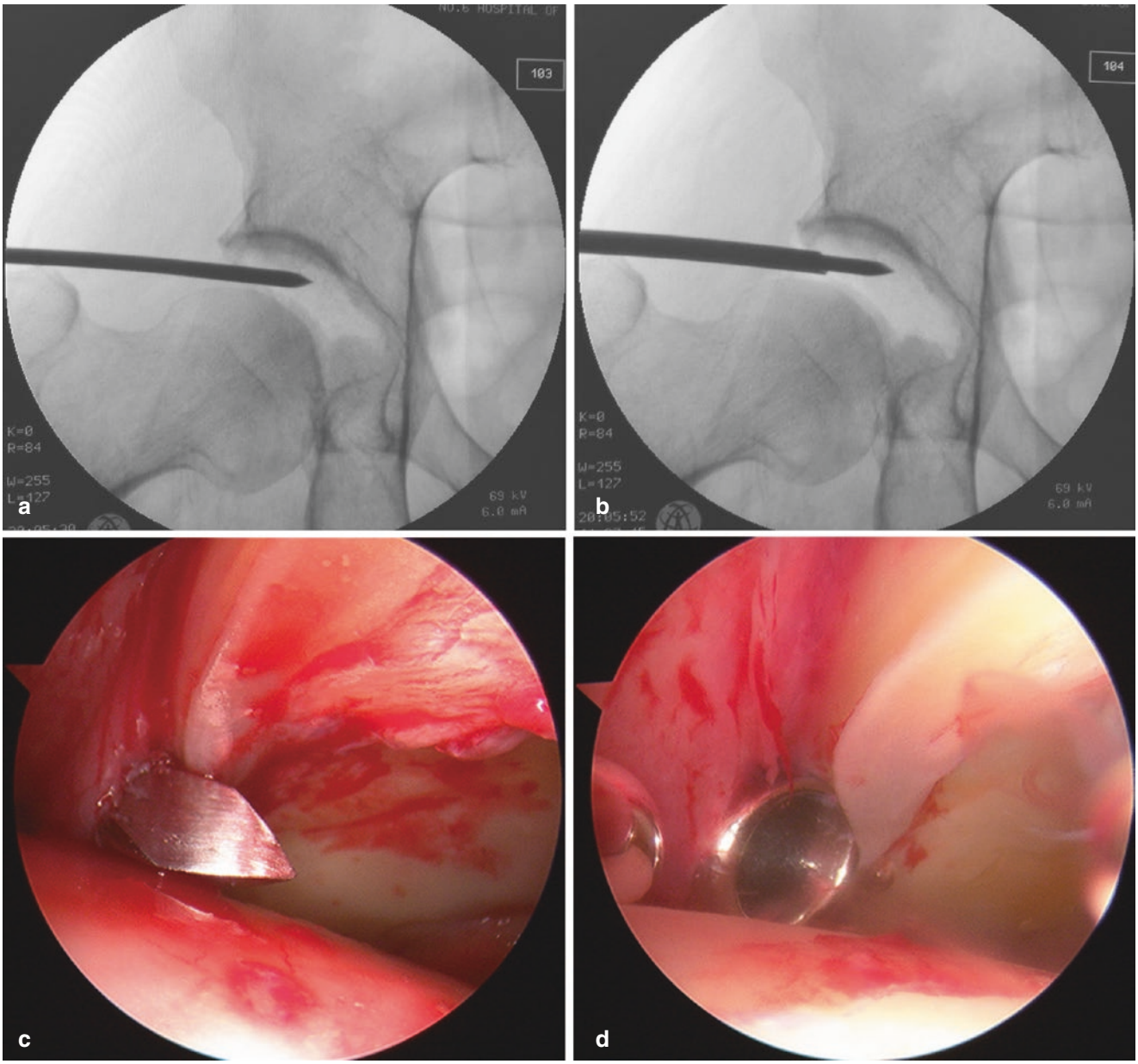

Fig. 14.18 Access establishment. (**a**, **b**) Anterior lateral access established under the monitoring of the fluoroscopy. (**c**, **d**) Anterior access established under the arthroscopy

facilitate systemic examination and arthroscopic operation about the hip joint. With the 30° and 70° arthroscopes, the internal and external rotation of hip joints accurately enables observation of the synovial membrane, the teres ligament, which are in the weight-bearing area of the superior acetabulum, and the anterior, posterior and lateral sides of the acetabular labrum as well as the major part of the weight-bearing surface of the femoral head. The anterolateral portal is most suitable for observing the anterior wall of the acetabulum and the anterior labrum; the posterolateral portal is best for observing the posterior wall of the acetabulum and the posterior labrum; and the anterior portal is most suitable for observing the lateral labrum and joint capsule reflexes. If the labrum is difficult to expose, a suture passer can be used to pass a suture through the nearby joint capsule as a traction line. The suture is pulled out of the passage to retract the joint capsule and assist in revealing the labrum. When exposure is done, comprehensively assess the injury of the labrum,

acetabulum, and femoral head cartilage, the injury of the teres ligament as well as the synovial inflammation. After determining the position of the labral injury, the synovial membrane is cleaned by motorized shaver or radiofrequency ablation till the acetabular bony edge. The acetabular bony excess is abrased based on preoperative imaging assessment. During the operation, use the fluoroscopy to prove if the abrasing is sufficient or not.

The torn labrum is then anchored to the abrased acetabular rim with an anchor. Use a shaver to clean the severe synovial membrane and the damaged teres ligament, and the cartilage damage as well, if there is. In case of severe cartilage defects, a microfracture surgery needs to be performed after clearance to promote cartilage regeneration. After that, the traction is completely relieved, and the abnormality and location of the femoral head and neck are observed under arthroscopy. The planned abrased location and depth of the femoral head and neck are determined by imaging evaluation. Osteoplasty is performed in the same way with a burr, the effect of which should be cross-checked with the fluoroscopy till it is satisfactory. Lastly, the joint capsule is sutured (or not), the surgical instrument and the traction line are removed, and the skin incision is closed.

14.4.5 Postoperative Treatment

On the second day after the surgery, the patient could walk with double crutches, with his toes bearing weight for 3–4 weeks. After that, his feet could bear weight with a single crutch for 2 weeks before abandoning the crutch completely. Do not make hip flexion more than 90° within 4 weeks after surgery to avoid affecting the healing of the labrum. Muscle strength training should be taken step by step after surgery. Physical exercise can be resumed 3 months after surgery.

14.4.6 Typical Cases

14.4.6.1 Case 1

14.4.6.1.1 Medical History

A male patient, 58 years old, was hospitalized after suffering from 6-month progressing and aggregating hip pain on the right side. His pain worsens after long-time sitting and walking. He was only able to walk for 800 m at the time he started hospitalization.

14.4.6.1.2 Physical Examination

The patient was crippling, unable to squat to a low level. The right hip impingement syndrome was strongly positive, with obviously limited for flexion and internally adduction on the right. Flexion was about 100° and the adduction was about 5°; VAS pain score: 8 points; HHS score: 56 points; both X-ray and 3D CT showed "Pincer" deformity at acetabulum, "Cam" deformity at femoral head and neck, and MRA showed torn labrum at anterior acetabulum on the right (Fig. 14.19).

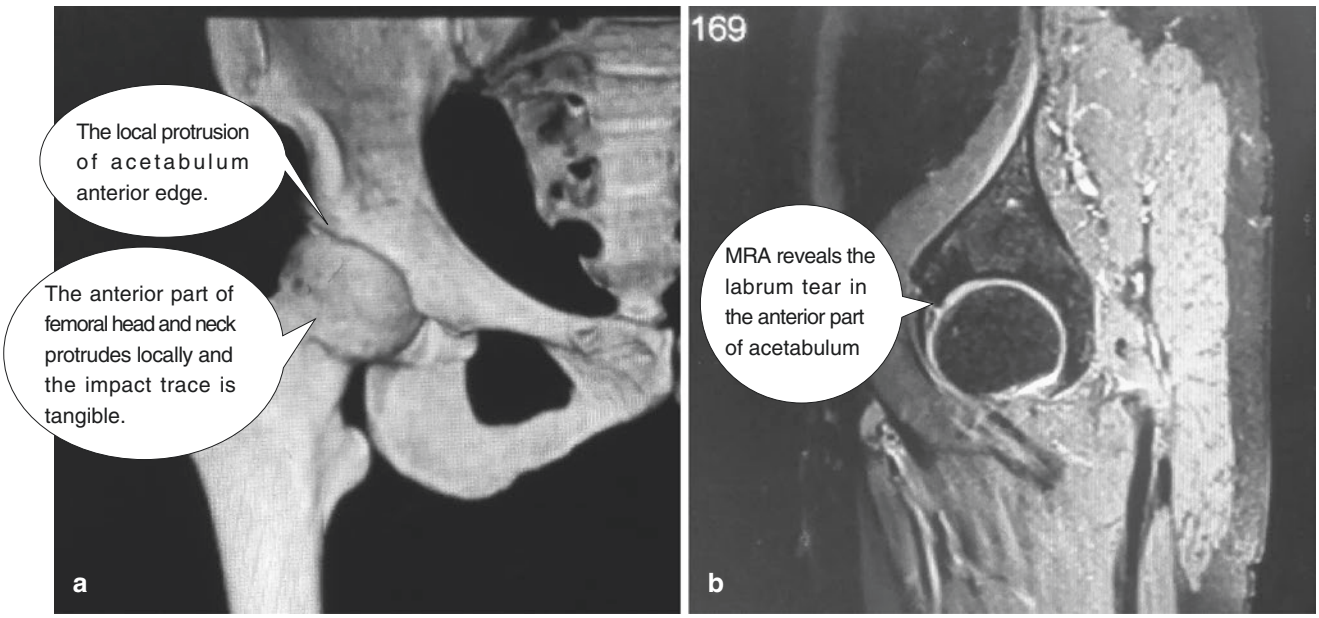

Fig. 14.19 Preoperative Check by 3D CT and MRA. (**a**) Preoperative 3D showed typical "Pincer" and "Cam" deformities at right hip; (**b**) MRA showed anterosuperior acetabular labral tear

14.4.6.1.3 Diagnosis

Femoroacetabular impingement syndrome (FAI) on the right side.

14.4.6.1.4 Treatment

After admission, the patient was given right arthroscopic femoroplasty and labral repair. During the operation, the acetabular and femoral head cartilage was obviously found degenerated, thinned, and partly incomplete. The anterior and lateral labia were severely torn. The acetabular rim was slightly abrased, and the torn labrum was repaired with anchor nails. The abnormal excess of the femoral head and neck was abrased.

14.4.6.1.5 Prognosis

After 3 months and 12 months, the patient had follow-ups respectively. It showed that the right hip VAS score was 0 and HHS score 96. Walking turned normal and the impingement syndrome disappeared; the flexion was about 120°, and the adduction was about 20°.

14.4.6.2 Case 2

14.4.6.2.1 Medical History

A male patient, 43 years old, was hospitalized after suffering from 4-month right hip pain and 1-month aggregation accompanied with activity limit. In the last month, he was unable to walk and the pain had been lasting.

14.4.6.2.2 Physical Examination

The patient was brought to the hospital in a wheelchair. The right hip impingement syndrome was strongly positive; the right hip activities to all directions, both positive and passive, were severely limited. VAS pain score: 10 points, and HHS score: 2 points. Both X-ray radiograph and 3D CT showed obvious "Cam" deformity at the femoral head and neck; and MRA indicated a torn labrum on the right acetabular anterior rim.

14.4.6.2.3 Diagnosis

Femoroacetabular impingement syndrome (FAI) on the right side.

14.4.6.2.4 Treatment

After admission, the patient was given right hip joint arthroscopic femoroplasty and glenoid labrum repair. During the operation, the acetabular cartilage was obviously found degenerated, and the anterior and lateral labia were severely torn. The acetabular rim was slightly abrased, and the torn labrum was repaired with anchor nails. The abnormal excess of the femoral head and neck was abrased.

14.4.6.2.5 Prognosis

After 3 months and 12 months, the patient had follow-ups, respectively. It showed that the right hip VAS score was 0 and HHS score 92. Walking turned normal and the impingement syndrome disappeared; the flexion was about 130°, and the adduction was about 15°.

The preoperative and postoperative X-ray findings and intraoperative photos are shown in Figs. 14.20, 14.21, 14.22, 14.23, 14.24, and 14.25.

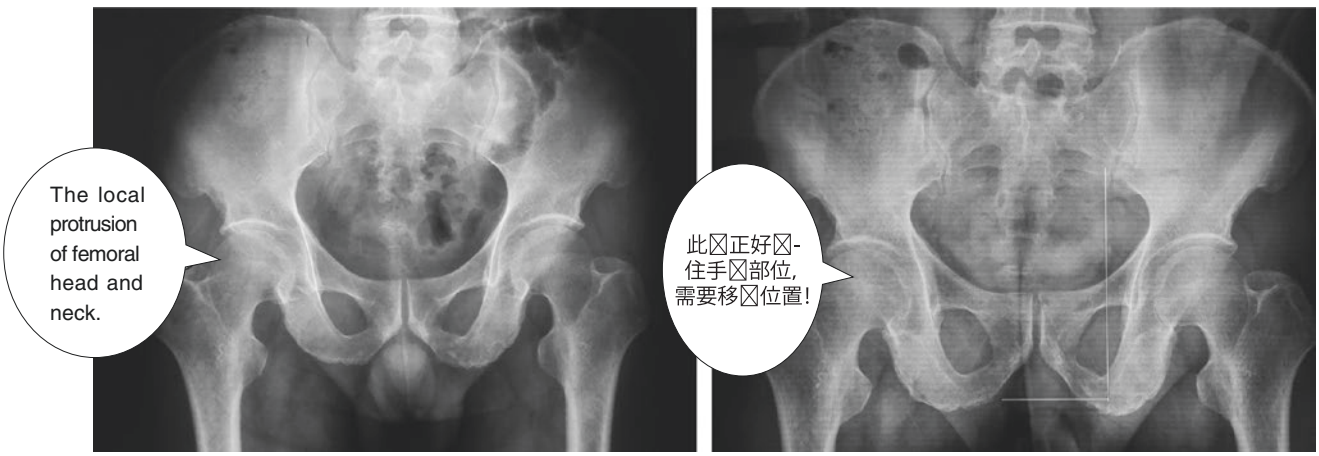

Fig. 14.20 X-ray indication of hip joint front and back before and after surgery. The surgery rectified the "Cam" deformity at the right femoral head and neck

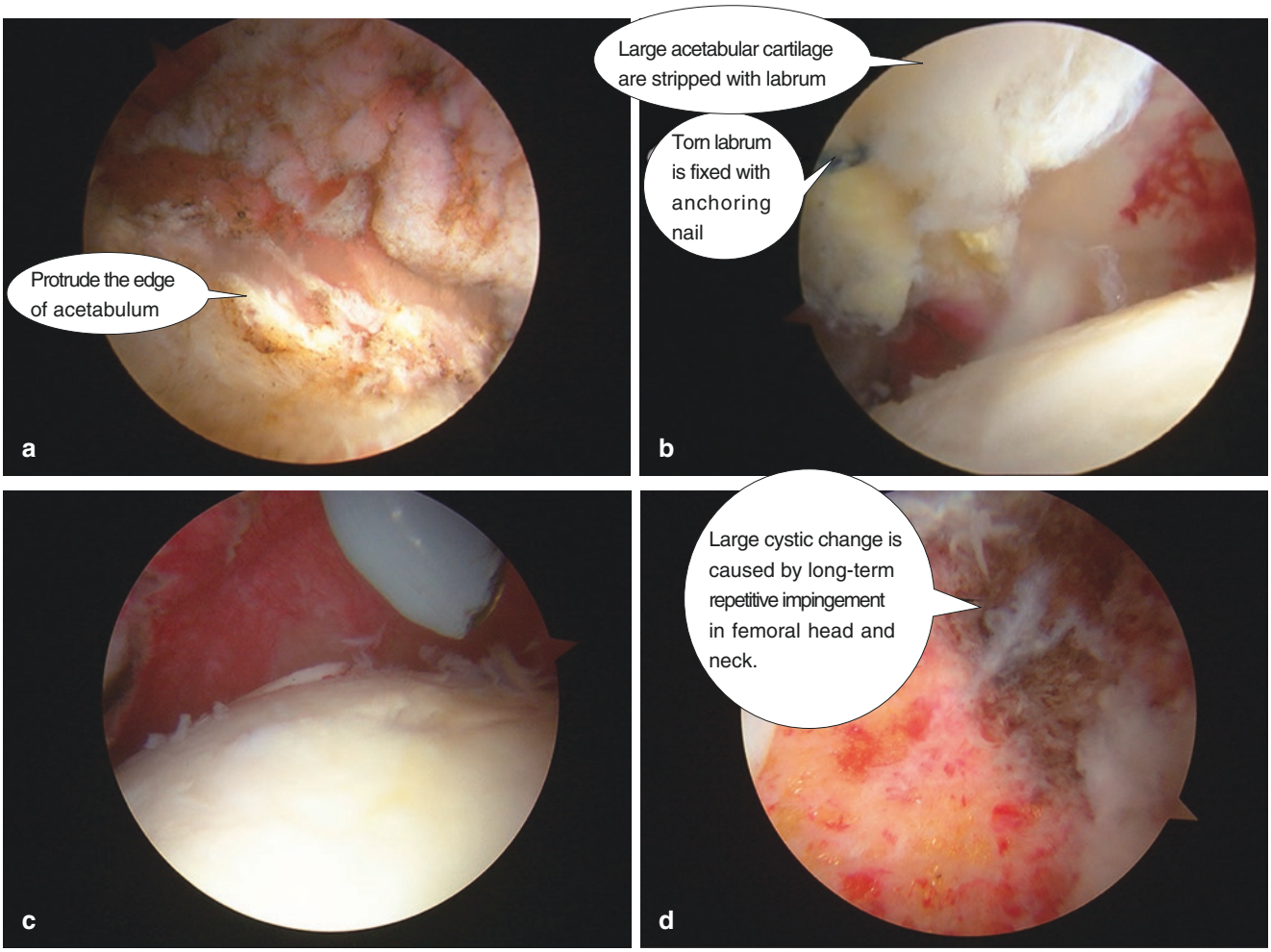

Fig. 14.21 Arthroscopic osteoplasty and labral repair. (**a**) Arthroscopic "Pincer" deformity; (**b**) After osteoplasty, labral and chondral repair; (**c**, **d**) Arthroscopic indication of "Cam" deformity before and after surgery

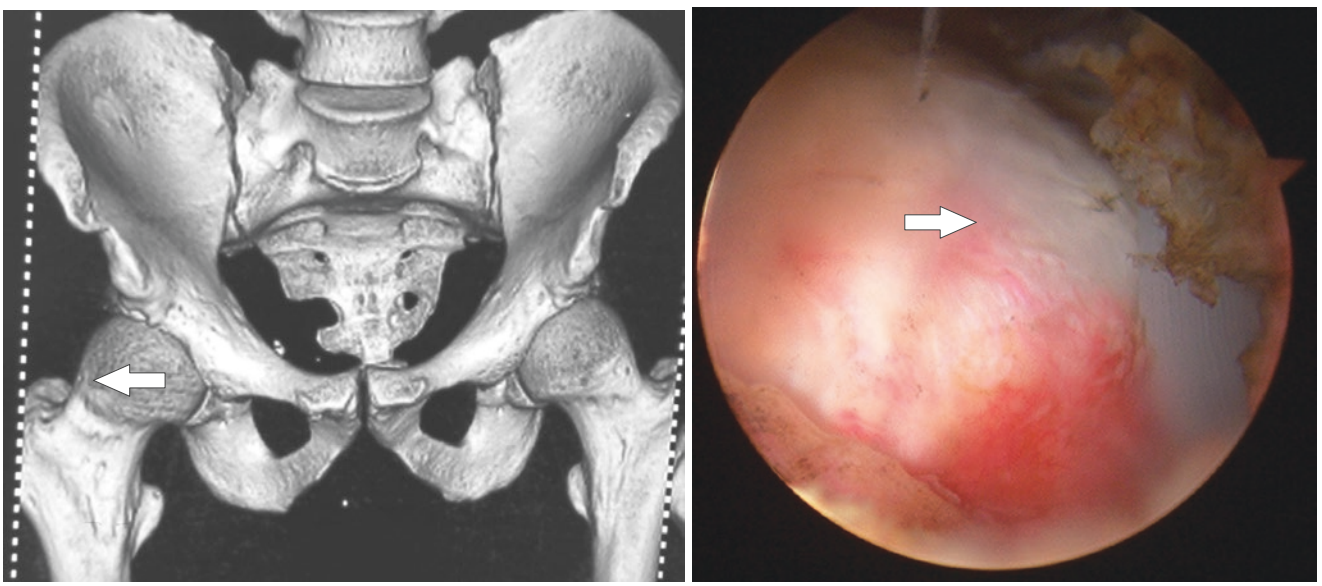

Fig. 14.22 Preoperative 3D CT and in-operative arthroscopic image showed typical "Cam" deformity at right femoral head and neck (as the arrow shows)

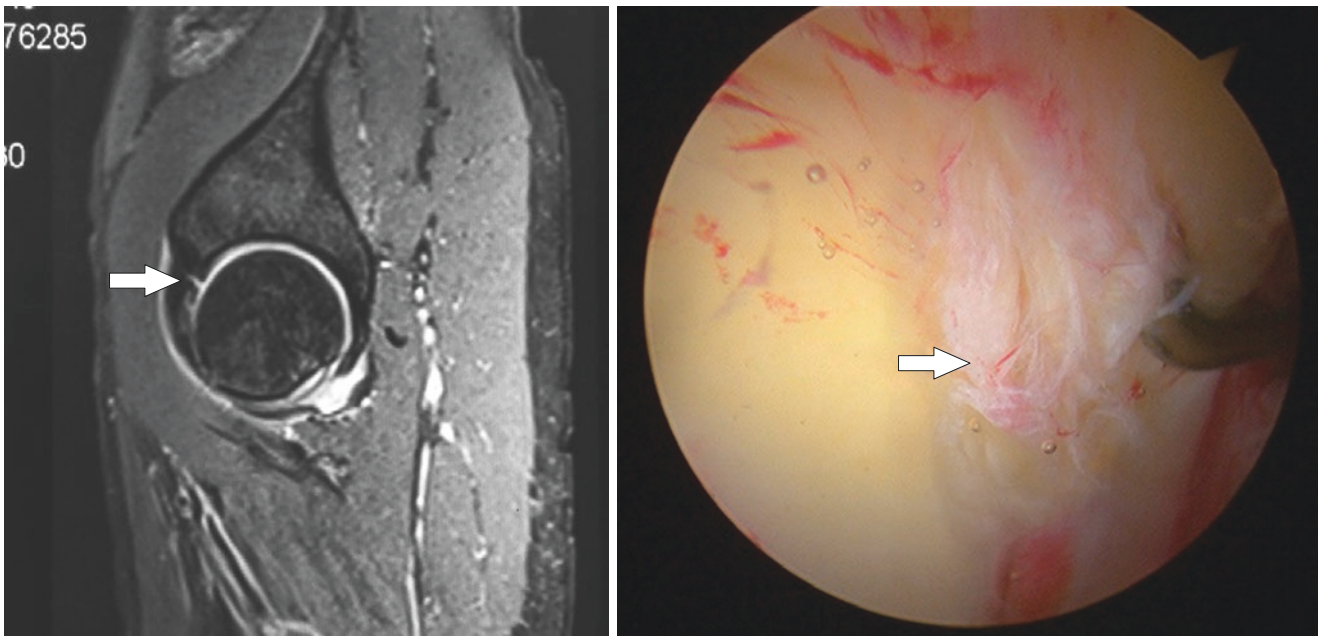

Fig. 14.23 Preoperative MRA and in-operative arthroscopic image showed anterior labrum tear (as the arrow shows)

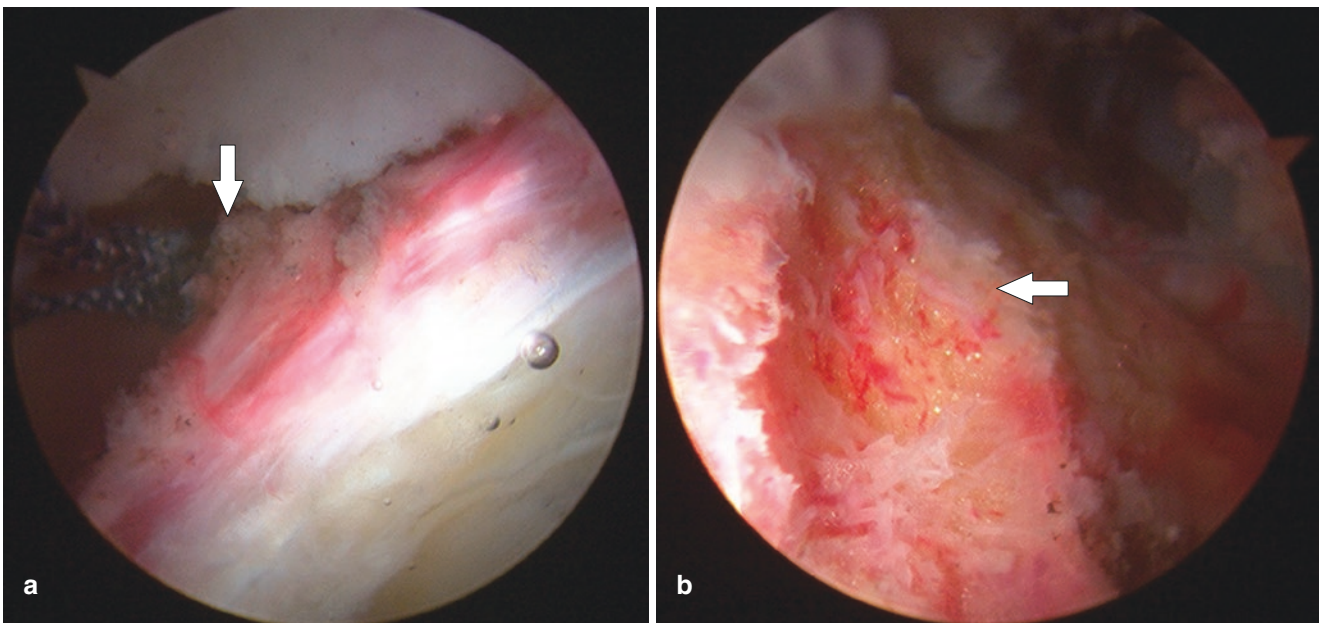

Fig. 14.24 Glenoid labrum neoplasty and femoral osteoplasty under arthroscopy

Fig. 14.25 Postoperative X-ray radiograph. Indication: By comparison, "Cam" deformity on right femoral head and neck had been fully rectified (as the arrow indicates)

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