Chapter 6
Complications of Arthroscopic Surgery

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Abstract The technique of arthroscopic shoulder surgery requires extreme caution, because complications have often been reported. Serious sequelae may occur in hypoxic encephalopathy, and pulmonary embolism caused by upper limb deep vein thrombosis may result in mortality. This chapter briefly describes rare complications as well as frequent complications that have been reported to date. Also, we describe our experience with complications of arthroscopic shoulder surgery, such as deviation of the anchor, breakage of surgical instruments, burns from heated irrigation fluid from a radiofrequency device, bone absorption in areas surrounding the absorbable anchor, osteolysis of the undersurface of the acromion from knot impingement, postoperative infection and pneumothorax, and subcutaneous emphysema after arthroscopic rotator cuff repair. Especially, we had 15 patients of pneumothorax or subcutaneous emphysema after arthroscopic rotator cuff repair. The incidence of pneumothorax or subcutaneous emphysema after arthroscopic rotator cuff repair was 2.3 %. Possible causes of pneumothorax and subcutaneous emphysema include the following: (1) positive pressure on the lung from the respirator under endotracheal intubation; (2) extensive infiltration of irrigation fluid into subcutaneous tissue in the thoracic wall, thereby diminishing movement of the thorax, resulting in insufficient extension of the thorax; (3) load imposition on the thoracic region from water pressure of the perfusion pump; and (4) low-temperature burn in the thoracic region by heated irrigation fluid from using a radiofrequency device.

Keywords Complication • Arthroscopic shoulder surgery • Pneumothorax

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6.1 Introduction

Arthroscopic surgery of the shoulder is minimally invasive and provides a good, as well as broad, view. This form of surgery is particularly useful for repairing rotator cuff tears (arthroscopic rotator cuff repair) and recurrent dislocation of the shoulder joint (arthroscopic Bankart repair), that is, the two main disorders handled by shoulder surgery specialists. The arthroscopic surgical technique is indispensable for the shoulder surgeon. However, this technique requires extreme caution, because complications have often been reported. It can be difficult to identify the causes of complications such as postoperative infection and intraoperative pneumothorax, and they are difficult to prevent. Serious sequelae may occur in hypoxic encephalopathy, and pulmonary embolism caused by upper limb deep vein thrombosis may result in mortality.

This chapter briefly describes rare complications as well as the frequent complications that have been reported to date. We also provide detailed descriptions of complications we have experienced in actual cases undergoing arthroscopic surgery of the shoulder.

6.2 Axillary Nerve Injury

In cases undergoing circumferential articular capsule release for the treatment of shoulder contracture, caution is required when dissecting the lower part of the articular capsule because the axillary nerve runs in its vicinity. In cases receiving arthroscopic Bankart repair, caution is also necessary to avoid damaging the axillary nerve while detaching the inferior labrum and periosteum and dissecting the articular capsule.

6.3 Suprascapular Nerve Injury

Because the suprascapular nerve runs 2 cm medially to the edge of the glenoid, caution is required during mobilization of the rotator cuff when conducting arthroscopic rotator cuff repair [1]. When resecting the ganglion that is around the scapular notch, caution should be exercised to avoid damaging the suprascapular nerve.

6.4 Musculocutaneous Nerve Injury

Preparation of a medial portal in distal area of the coracoid process may result in musculocutaneous nerve damage. Therefore, the entire procedure should be performed in a blunt manner, with the course of the musculocutaneous nerve kept in mind.

6.5 Vascular Injury

The axillary artery and the brachial plexus run medially to the coracoid process, requiring caution in the preparation of a portal. Caution should also be exercised to avoid damaging the suprascapular artery running in parallel to the suprascapular nerve and to the posterior circumflex humeral artery that runs parallel to the axillary artery.

6.6 Tendon Injury

Rotator interval is sometimes dissected using a knife when preparing an anterior portal. At this time, attention should be paid to the possibility of inadvertently cutting the long head of the biceps tendon.

6.7 Acromion Fracture

If the undersurface of the acromion is excessively scraped during subacromial decompression, acromial fracture may occur. In particular, in elderly patients with osteoporosis, applying special considerations in the following manner is also necessary: the procedure should be limited to scraping of the acromial spur alone and not extended to the undersurface of the acromion.

6.8 Humerus Fracture

Manipulation may be carried out immediately after arthroscopic capsular release in patients with shoulder contracture. At this time, excessive manipulation is contraindicated in elderly patients with osteoporosis because they are at risk of humerus fracture.

6.9 Shoulder Contracture

The shoulder joint should be immobilized for a certain period of time after tissue repair, and temporary contracture is therefore inevitable. Hurberty et al. implemented rehabilitation training after arthroscopic rotator cuff repair, and reported that surgery for shoulder contracture was performed in 4.9 % of patients, with risk factors for the postoperative stiffness being calcific tendinitis, adhesive capsulitis, single-tendon cuff repair, PASTA repair, being under 50 years of age, and having Workers' Compensation insurance [2]. We also have the impression that contracture is particularly likely to persist in patients who have undergone repair of an articular side cuff tear.

6.10 Complex Regional Pain Syndrome (CRPS)

CRPS should be suspected in patients who have swelling, numbness, and contracture in the fingers and who complain of severe shoulder pain after arthroscopic surgery of the shoulder. CRPS is a relatively common postoperative complication. Treatment consists of oral therapy with antiinflammatory analgesics and opioids and gentle range-of-motion (ROM) exercises. Swelling of the fingers and joint contracture often persist for about 3 to 6 months.

6.11 Anterior Interosseous Nerve Palsy

Difficulty in active flexion of the thumb and index finger may occur on very rare occasions, rather abruptly, 1–2 weeks after surgery. Although a causal relationship with surgery is unclear, it is possible that surgical stress is involved in the occurrence of peripheral neuritis. Oral administration of vitamin B_{12} and rehabilitation training for the thumb and index finger should be conducted. Spontaneous recovery usually occurs in 6 to 12 months, but residual paralysis can be problematic in some cases.

6.12 Upper Limb Deep Vein Thrombosis and Pulmonary Embolism

When marked swelling has occurred in the upper limb on the side where arthroscopic shoulder surgery was conducted, upper limb deep vein thrombosis should be suspected, and ultrasonography and computed tomography (CT) of the upper limb should be performed to assess the presence or absence of thrombus and its size.

Blood tests for D-dimer measurement should be conducted. When a detached blood clot travels to the pulmonary artery, it can occlude the artery, leading to chest pain, dyspnea, and polypnea. The presence/absence of pulmonary embolism should be evaluated immediately by blood gas analysis, chest X-ray examination, and contrast-enhanced CT as well as contrast-enhanced magnetic resonance imaging (MRI) of the lung. The mortality rate of pulmonary embolism is as high as about 10 %, requiring emergency care. Treatment consists of drip infusion of an anticoagulant such as heparin. If possible, the patient should be transferred to a department of cardiovascular medicine or respiratory medicine. Kuremsky reported low prevalence (0.31 %) of imaging-confirmed thromboembolic events [3].

6.13 Hypoxic Encephalopathy

Neurological ischemic symptoms such as cerebral infarction and hearing loss have been described as possibly occurring after arthroscopic shoulder surgery in the beach-chair position. Koh et al. have reported that cerebral oxygen saturation was significantly lower in patients who underwent surgery in the beach-chair position under general anesthesia than in those who had received operative treatment under interscalene block, pointing out the risk of general anesthesia in the beach-chair position [4].

In addition, Moerman et al. reported that cerebral oxygen saturation decreased by more than 20 % in 80 % of patients in response to a postural change from the supine position to the beach-chair position [5].

Caution is required to limit the angle of the sitting position to 60° or less when the beach-chair position is used.

6.14 Airway Narrowing

Perfusate infiltrates the surrounding soft tissue from the portal entry site or the subacromial space and causes edema around the shoulder. Such edema, on rare occasions, extends to the cervical region and causes airway narrowing [6]. Because of the gravity effect, airway narrowing is more likely to occur in patients who had surgery in the lateral decubitus position than in those who underwent their operations in the beach-chair position. In particular, attention should be paid to swelling around the neck when surgery is prolonged.

6.15 Deviation of the Anchor

Deviation of the anchor from the bone may be identified by X-ray examination or MRI at some time point after surgery. This deviation is more likely to occur in women of advanced age with osteoporosis. If there are symptoms such as pain or discomfort, another arthroscopic operation should be performed to remove the anchor. If there is retearing of the repaired rotator cuff, the cuff is usually repaired again with another anchors. Case 1 was a 75-year-old woman who underwent reoperation to remove a deviated CorkScrew (Fig. 6.1a, b), case 2 was a 70-year-old woman who underwent a second arthroscopic rotator cuff repair after removal of a deviated Fastin (Fig. 6.1c, d), and case 3 was a 74-year-old woman who underwent a second arthroscopic rotator cuff repair after removal of a deviated Versalok (Fig. 6.1e, f).

6.16 Breakage of Surgical Instruments

Advances in surgical instruments have allowed us to conduct more rapid and precise arthroscopic surgery of the shoulder, but breakage of instruments does occasionally occur. A broken instrument, if it remains in the patient's body

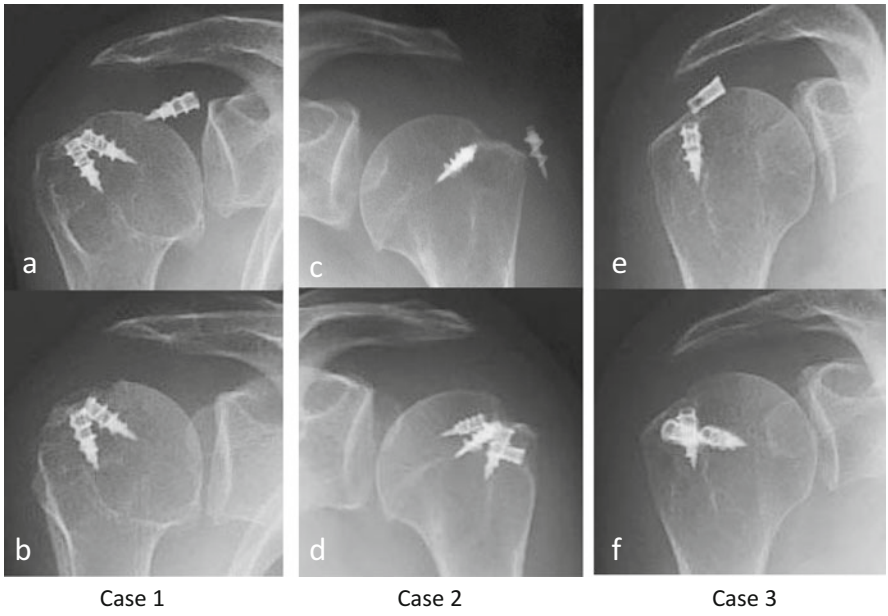

Fig. 6.1 Deviation of the anchor after arthroscopic rotator cuff repair. (**a**, **b**) Case 1. A 75-year-old woman. The deviated CorkScrew was removed by reoperation. (**c**, **d**) Case 2. A 70-year-old woman. After removal of the deviated Fastin, another arthroscopic rotator cuff repair was performed. (**e**, **f**) Case 3. A 74-year-old woman. After removal of the deviated Versalok, another arthroscopic rotator cuff repair was performed

postoperatively, may cause postoperative pain as well as legal problems. Therefore, the surgeon should endeavor to remove the broken foreign body during the surgery. If it is difficult to remove the broken foreign body, the surgeon should show the relevant X-ray image to the patient and family, and attempt to obtain their understanding by explaining the circumstances that prevent removal of the foreign body.

6.16.1 Breakage of Anchor Inserter Tip

When the inserter of the JuggarKnot was drawn, the inserter became twisted because there was resistance, which resulted in breakage of the inserter tip. Fortunately, a metal fragment was identified in the field of view (Fig. 6.2a) and could easily be removed by holding it with curette forceps (Fig. 6.2b). The metal fragment was very small (Fig. 6.2c), but might have caused injury to the articular cartilage if it had remained in the joint as a loose foreign body.

6.16.2 Breakage of Suture Punch Needle

The needle of a suture punch was broken off at the root during rotator cuff repair. The needle was embedded in the rotator cuff and could not be found under arthroscopic view. Using an image intensifier (fluoroscopic apparatus) (Fig. 6.3a), the needle in the rotator cuff was identified under fluoroscopic guidance. The rotator cuff was evaporated using VAPR (Fig. 6.3b); the needle was exposed (Fig. 6.3c) and removed with curette forceps. The rotator cuff was repaired to finish the operation.

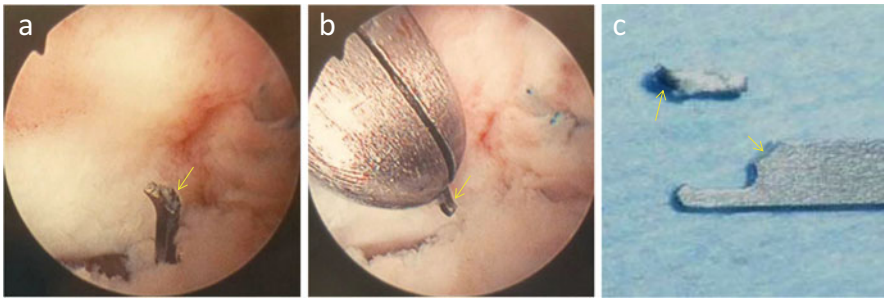

Fig. 6.2 Breakage of anchor inserter tip. (**a**) The tip of the JaggerKnot inserter was broken during arthroscopic Bankart repair, and a small metal fragment remained in the joint. (**b**) The metal fragment was held with curette forceps and removed. (**c**) Breakage of inserter tip is shown

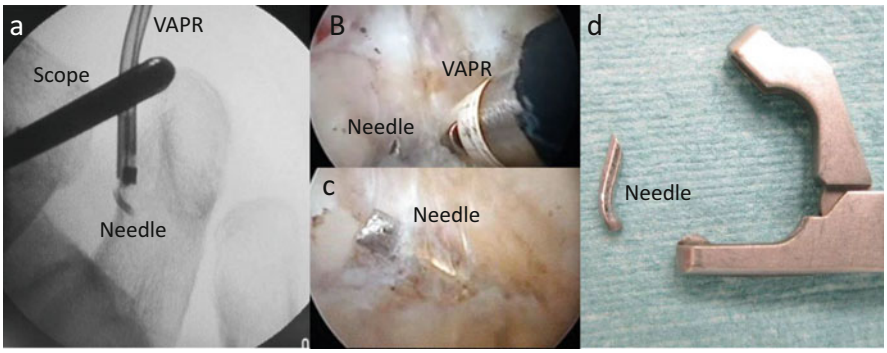

Fig. 6.3 Breakage of a suture punch needle. (**a**) Breakage of needle in the rotator cuff was confirmed under X-ray fluoroscopy, and the rotator cuff was ablated using VAPR, toward the direction of the existing needle. (**b**) A portion of the needle was confirmed under arthroscopy after ablation of the rotator cuff by VAPR. (**c**) The needle was exposed and removed using curette forceps. (**d**) The suture punch and the broken needle are shown

6.16.3 Breakage of the Suture Passer Needle Tip

The tip of a Scorpion needle was broken during arthroscopic rotator cuff repair (Fig. 6.4b). The needle tip remained in the rotator cuff and could not be identified under arthroscopic view. We abandoned retrieving the needle tip from inside the rotator cuff because it was too small. The patient and family were informed of the situation, using the X-ray image that showed the needle tip after the operation (Fig. 6.4c): the needle tip was virtually nonremovable, and it was unlikely to become a problem because it was presumably embedded in the rotator cuff. Fortunately, the patient's postoperative course was favorable, without troubles.

6.16.4 Dropping of the Lid Portion of a Suture Passer

The lid portion of a BiPass tip was dropped during arthroscopic rotator cuff repair (Fig. 6.5a). Fortunately, it was immediately identified under arthroscopic view (Fig. 6.5b), and this lid portion was removed using curette forceps. It was presumed that repeated opening and closing of the lid had caused metal fatigue at the root portion of the lid (Fig. 6.5c), resulting in a breakage.

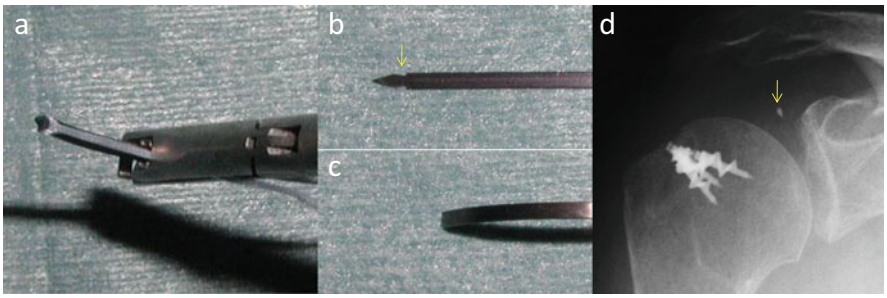

Fig. 6.4 Breakage of suture passer needle tip. (**a**) Suture passer (Scorpion) is an implement for passing the thread through the rotator cuff. (**b**) The Scorpion needle before use. Breakage may occur at the constricted portion indicated by the *arrow*. (**c**) A needle lacking its tip, which was broken at the constricted portion of the needle. (**d**) X-ray image after arthroscopic rotator cuff repair. The broken needle tip was still in the rotator cuff

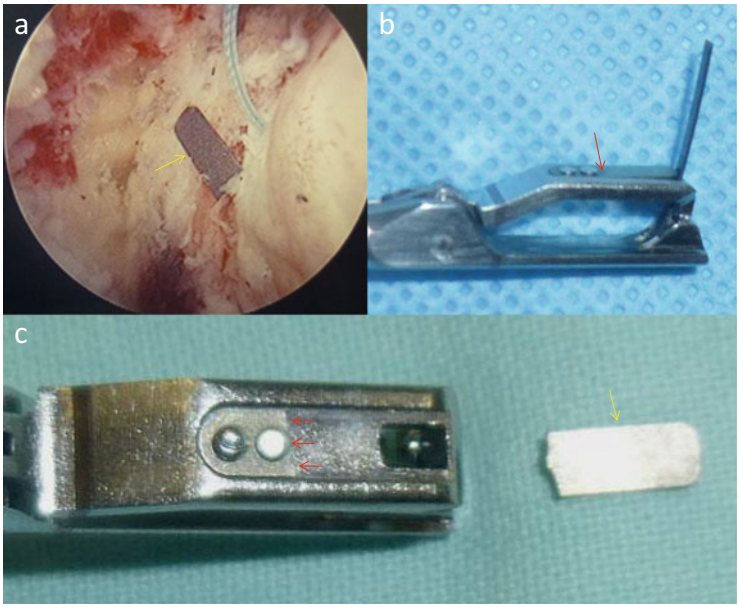

Fig. 6.5 Breakage of the lid portion of a suture passer tip. (**a**) The lid portion of the BiPass was found in surface of the rotator cuff. (**b**) The root of the lid portion of the BiPass has an opening and closing function (*arrow*). (**c**) The breakage root of the lid portion (*arrow*)

6.17 Burn Caused by Heated Irrigation Fluid from VAPR

We formerly used irrigation fluid heated in a warmer box to prevent the patient's body from cooling excessively (Fig. 6.6a, b). However, the subacromial irrigation fluid was heated employing VAPR to a high temperature, and hot irrigation fluid

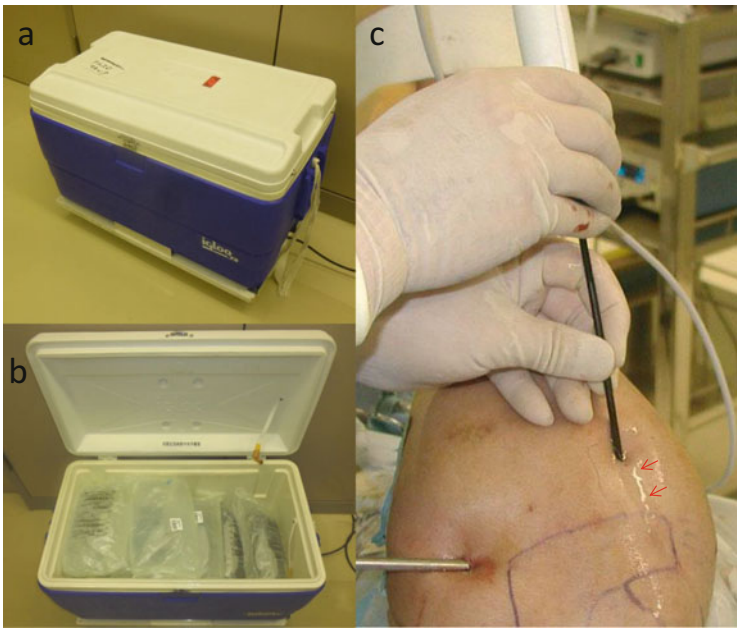

Fig. 6.6 Burn from heated irrigation fluid from VAPR. (**a**, **b**) We formerly used irrigation fluid warmed in a warmer box to avoid lowering the patient's body temperature. (**c**) The irrigation fluid in the subacromial region was heated employing VAPR to a high temperature. The hot irrigation fluid exiting the portal caused the skin burn pictured (*arrows*)

exiting the portal (Fig. 6.6c) occasionally caused skin burns. Fortunately, such burns were mild and restricted to a small area, but such burns can be very dangerous. The synovial membrane and rotator cuff in the subacromial space and the articular cartilage and articular capsule in the shoulder are at risk of sustaining burn injuries. Diffuse chondrolysis reportedly occurred as a result of arthroscopic thermal capsulorrhaphy [7, 8].

6.18 Bone Absorption and Osteolysis in Areas Surrounding the Absorbable Anchor

It has been reported that bone absorption and osteolysis may occur in the anchor hole when an absorbable anchor is used employing the arthroscopic Bankart repair [9–11]. We also experienced a case with enlargement of the anchor hole and formation of a concavity in the anteroinferior part of the glenoid. Case 4 was a 45-year-old man in whom four absorbable anchors (Panalok Loop) were used. Two threads were passed through each loop, and the capsular ligament and labrum were repaired using a total of eight threads (Fig. 6.7a). The postoperative course was

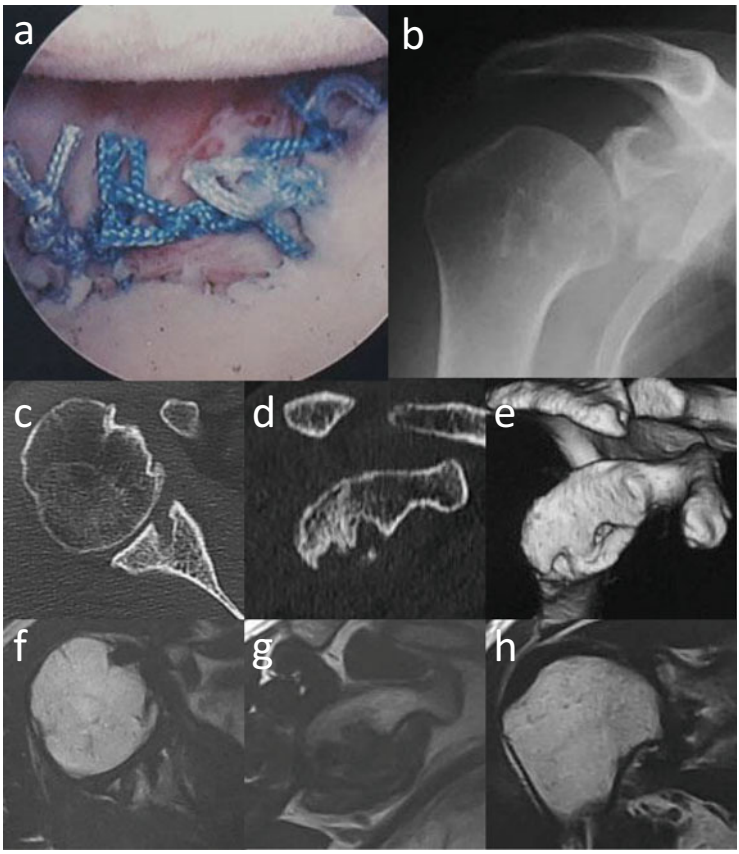

Fig. 6.7 Bone absorption and osteolysis in areas surrounding the absorbable anchor (**b**–**h** are images obtained 1 year and 3 months after surgery). (**a**) Case 4. A 46-year-old man. Arthroscopic Bankart repair was performed for the treatment of recurrent dislocation of the shoulder joint. Four absorbable anchors (Panalok Loop) were used. Two threads were passed through each loop, and the capsular ligament and labrum were repaired using a total of eight threads. (**b**) At 1 year and 3 months after surgery, the X-ray image showed concavity in the anteroinferior part of the glenoid. (**c**) Enlarged anchor holes can be seen in the CT image. (**d**, **e**) CT and 3D CT images demonstrated osteolysis in the anteroinferior part of the glenoid. (**f**–**h**) T_2-weighted MRI showed low signal intensity in the osteolytic area, without accompanying edema fluid

temporarily favorable, with no further dislocation and favorable conversion to a negative anterior apprehension test. However, 1 year and 3 months after surgery, the patient suffered pain and rotational motion disorder of the shoulder. The X-ray image obtained at the time showed concavity in the anteroinferior part of the glenoid (Fig. 6.7b), and enlarged anchor holes were observed on a CT image (Fig. 6.7c). The sagittal section of the CT image and the three-dimensional (3D) CT image demonstrated osteolysis in the anteroinferior part of the glenoid

(Fig. 6.7d, e). T_2-weighted MRI showed low signal intensity in the osteolytic area without accompanying edema fluid (Fig. 6.7f–h). Thereafter, the pain resolved after about 6 months of follow-up, achieving restoration of the range of rotational motion.

6.19 Osteolysis of the Undersurface of the Acromion from Knot Impingement

It has been reported that osteolysis may occur in the undersurface of the acromion, causing pain, several months after arthroscopic rotator cuff repair [12]. Case 5 was a 39-year-old man who underwent arthroscopic repair surgery for a bursal side tear of the rotator cuff, employing the single-row technique using two Ethibond threads and two FiberWire threads with two absorbable anchors (Panalok loop RC) (Fig. 6.8a). Acute pain in the shoulder occurred 5 months after surgery. X-ray, CT, and 3D CT images taken at the time showed concavity of the bone in the undersurface of the acromion and thinning of the acromion (Fig. 6.8b–d). MRI T_2-weighted images showed retention of edema fluid in the concave portion of the acromion (Fig. 6.8e). Because pain and swelling persisted, another arthroscopic

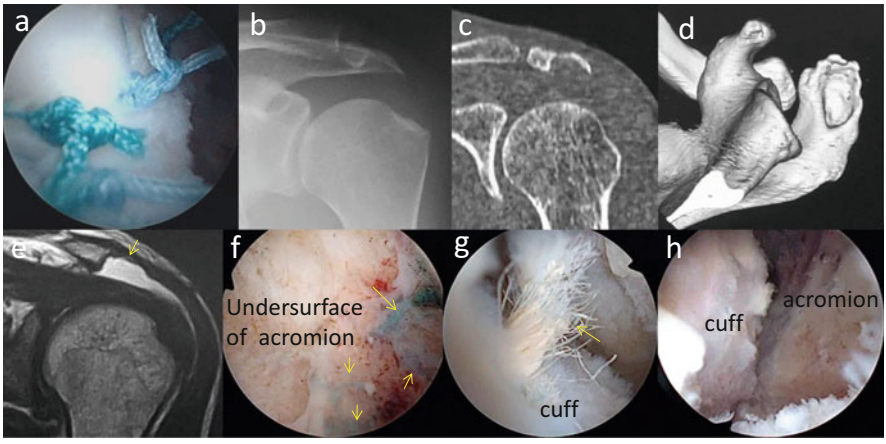

Fig. 6.8 Osteolysis of the undersurface of the acromion caused by knot impingement. (**a**) Case 5. A 39-year-old man underwent arthroscopic repair surgery for the bursal side tear of the rotator cuff, employing the single-row technique using two Ethibond threads and two FiberWire threads with two absorbable anchors (Panalok loop RC). (**b–d**) X-ray, CT, and 3D CT images showed concavity of the bone in the undersurface of the acromion and thinning of the acromion. (**e**) T_2-weighted MRI showed retention of edema fluid in the concave portion of the acromion. (**f**) Broken Ethibond thread was found to be adherent to the concave part of the undersurface of the acromion. (**g**) The FiberWire thread impinged at the undersurface of the acromion. (**h**) The thread was removed, and the absence of impingement was then confirmed

surgery was conducted. Broken Ethibond thread was found in the concave portion of the undersurface of the acromion (Fig. 6.8f). Although the rotator cuff had been repaired favorably, there was a hard protrusion in the rotator cuff surface. It was presumed that the tip of the hard protrusion and the undersurface of the acromion caused impingement. When this protrusion was shaved, a FiberWire thread emerged from inside (Fig. 6.8g). This thread was then entirely removed (Fig. 6.8h). Immediate pain alleviation was obtained with arthroscopic removal of the thread.

It was presumed that physical abrasion of the knot had caused scraping of the undersurface of the acromion, resulting in osteolysis. However, we recently experienced a case with osteolysis of the undersurface of the acromion occurring after rotator cuff repair employing the bridging suture technique without knot tying, and came to suspect that knot impingement might not be the only cause of osteolysis. Because there are reports raising doubts about knot impingement, further investigations are required to elucidate the cause of osteolysis [13].

6.20 Postoperative Infection

Although infection associated with arthroscopic shoulder surgery is rare, it may induce osteomyelitis or secondary osteoarthritis if not treated in an early phase. If there are signs of infection such as fever, pain, and redness, hematological examinations including C-reactive protein (CRP), sedimentation, and leukocytes should be carried out. X-ray examination should also be conducted to look for indications of bone absorption and downward shift of the humeral head. The presence/absence and extent of edema in the shoulder joint and the undersurface of the acromion should be examined by MRI. Shoulder joint puncture under X-ray fluoroscopy is necessary to conduct culture of joint fluid and antibiotic sensitivity studies. Culture of joint fluid is indispensable before the initiation of antibiotic therapy.

If pain, redness, and swelling are mild, intravenous drip infusion of an antibiotic chosen based on the results of sensitivity studies should be conducted for consecutive days. Oral antibiotic therapy employing a series with different sensitivity may also be given concomitantly.

If redness or swelling is severe, and antibiotic therapy alone is judged to be inadequate to treat the infection, irrigation and debridement under arthroscopy should be performed in an early phase. Whether to remove the anchor should be decided on a case-by-case basis. If there is evidence of bone absorption around the anchor, the anchor and thread should be removed. An antibiotic to which the pathogen is sensitive should also be drip infused postoperatively.

Case 6 was a 73-year-old woman who underwent arthroscopic rotator cuff repair. Three months after this surgery, there was redness at the wound site in the lateral portal, which gradually resulted in the formation of a subcutaneous abscess (Fig. 6.9a). Horizontal T_2-weighted MRI revealed continuity from the subacromial space to the subcutaneous abscess (Fig. 6.9b). Sagittal T_2-weighted MRI showed

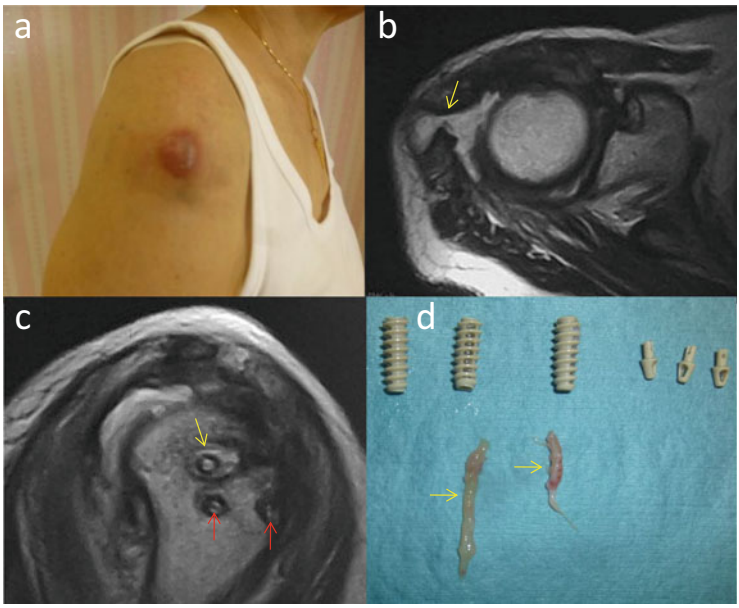

Fig. 6.9 Postoperative infection. (**a**) Case 6. A 73-year-old woman. Subcutaneous abscess developed at the wound site in the lateral portal after arthroscopic rotator cuff repair. (**b**) Horizontal T_2-weighted MRI revealed continuity from the subacromial space to the subcutaneous abscess. (**c**) Sagittal T_2-weighted MRI showed edema around the anchors. (**d**) After removal of the anchors, granulation tissue (*arrows*) was found in the lumen of the SwiveLock

edema around the anchors (Fig. 6.9c). *Pseudomonas aeruginosa* was detected by culture. The subacromial space and shoulder joint were irrigated under arthroscopy, and the anchors were removed under direct vision after slightly augmenting the skin incision at the site of abscess resection. Granulation tissue was found in the lumen of the SwiveLock (Fig. 6.9d). Intravenous antibiotic therapy to which the pathogen was sensitive was continued for 2 weeks postoperatively, leading to subsidence of the infection.

6.21 Pneumothorax and Subcutaneous Emphysema

It has been reported that pneumothorax and/or subcutaneous emphysema may occur in arthroscopic shoulder surgery [14–16]. We experienced 15 patients with pneumothorax or subcutaneous emphysema after arthroscopic rotator cuff repair.

We have consistently conducted arthroscopic surgery of the shoulder with patients in the lateral decubitus position under general anesthesia. Until 2009, no cases developed pneumothorax or subcutaneous emphysema after arthroscopic

surgery of the shoulder. However, there was one pneumothorax after arthroscopic rotator cuff repair in 2010 and 15 cases with pneumothorax or subcutaneous emphysema during the 6 years between 2010 and 2015. Among these cases, there were 11 with pneumothorax alone, 3 with pneumothorax accompanied by subcutaneous emphysema, and 1 with subcutaneous emphysema alone. In all 15 cases, pneumothorax or subcutaneous emphysema occurred on the side of arthroscopic rotator cuff repair, whereas neither occurred in cases undergoing surgery other than arthroscopic rotator cuff repair. As shown in Table 6.1, pneumothorax and subcutaneous emphysema occurred rather frequently, that is, in 4 patients in 2012 and 6 in 2013. Arthroscopic rotator cuff surgery was conducted in 646 patients during the 6 years between 2010 and 2015, and the incidence of pneumothorax or subcutaneous emphysema after arthroscopic rotator cuff repair was 2.3 %. During the same period of time, arthroscopic Bankart repair was performed in 177 shoulders, but neither pneumothorax nor subcutaneous emphysema was noted.

The 15 patients who suffered pneumothorax or subcutaneous emphysema were 69.6 years old (range, 54–84 years), with 8 men and 7 women. The affected site was the right shoulder in 11 cases and the left shoulder in 4. The size of the rotator cuff tear was medium in 2 cases, large in 9, and massive in 4, whereas neither pneumothorax nor subcutaneous emphysema occurred after surgery for small or incomplete rotator cuff tear. The mean surgical time was 138 min (range, 93–185 min). Interscalene block was conducted concomitantly in 3 cases.

We obtain X-ray images in every patient immediately after surgery before awakening from general anesthesia. If pneumothorax is confirmed in the X-ray image taken immediately after surgery, chest X-ray images are promptly ordered to confirm the size and site of pneumothorax. A surgeon is called into the operating room to decide whether to conduct chest tube drainage.

In 11 of our 15 patients, pneumothorax was confirmed in X-ray images of the shoulder immediately after surgery, and chest X-ray examination was performed (Fig. 6.10a, b). A chest drainage tube was inserted by a surgeon in the operating room before awakening the patient from general anesthesia, and the drainage tube was connected to a negative pressure pump. After confirming amelioration of the

Table 6.1 Number of cases undergoing arthroscopic shoulder surgery and the number and frequency of cases developing pneumothorax and subcutaneous emphysema by year

	2010	2011	2012	2013	2014	2015	Total
Arthroscopic shoulder surgery	160	168	167	156	150	150	**951**
Arthroscopic rotator cuff repair	93	110	110	112	116	105	**646**
Arthroscopic Bankart repair	30	42	34	29	21	21	**177**
Others	37	16	23	15	13	24	**128**
Pneumothorax and/or subcutaneous emphysema	1	2	4	6	1	1	**15**
Incidence of pneumothorax and/or subcutaneous emphysema in arthroscopic rotator cuff repair	1.1 %	1.8 %	3.6 %	5.4 %	0.9 %	1.0 %	**2.3 %**

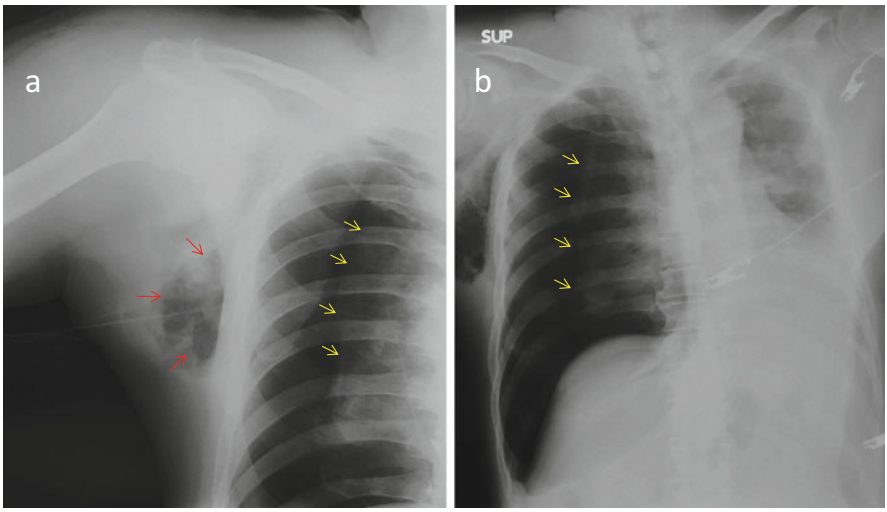

Fig. 6.10 Pneumothorax and subcutaneous emphysema after arthroscopic rotator cuff repair. (**a**) Case 7. A 84-year-old man. Arthroscopic rotator cuff repair was performed for the medium-sized rotator cuff tear. The surgical time was 93 min. Pneumothorax (*yellow arrow*) and subcutaneous emphysema (*red arrow*) were present based on the X-ray image of the shoulder taken immediately after surgery. (**b**) Chest X-ray examination showed marked pneumothorax (*arrow*). A trocar was inserted into the pleural space by a surgeon before awakening from general anesthesia

pneumothorax in the chest X-ray image, the patients were roused from anesthesia. Subcutaneous emphysema was present concomitantly in 2 of these 11 patients.

Pneumothorax was overlooked in the X-ray image of the shoulder immediately after surgery in 3 of our 15 patients. Oxygen saturation was as low as 95 in all 3 patients on the day after surgery. Therefore, chest X-ray examination was performed in 2 patients, and chest X-ray examination and CT of the lung in another patient, to confirm pneumothorax (Fig. 6.11a, b). Then, a chest drainage tube was inserted in each patient by a surgeon. In the 1 remaining patient, chest X-ray examination performed on the day after surgery revealed pneumothorax and subcutaneous emphysema. Because a surgeon judged there to be no space to insert a trocar, the patient was followed up without chest drainage until full resolution. No clinical symptoms associated with pneumothorax, such as chest pain and difficulty breathing, were present in the 2 patients in whom the chest drainage tube was inserted, whereas the other patient complained of mild chest pain.

In one of our 15 patients, subcutaneous emphysema alone was identified by X-ray examination of the shoulder immediately after surgery, and the patient was followed up under conservative treatment.

In these 15 patients, pneumothorax and/or subcutaneous emphysema resolved without causing residual disability. There were 2 smokers: 1 was a 54-year-old man and the other was a 74-year-old woman. No patient had a respiratory disease such as

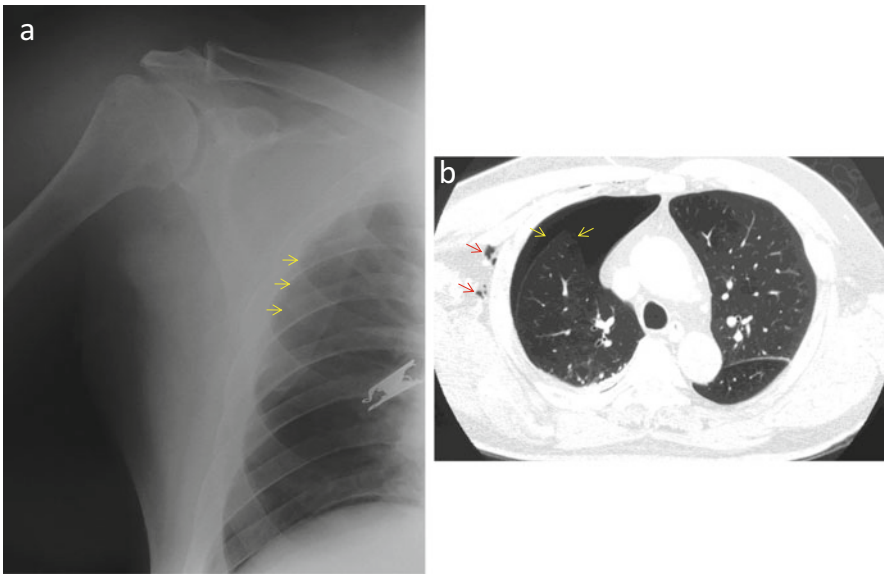

Fig. 6.11 Pneumothorax after arthroscopic rotator cuff repair. (**a**) Case 8. A 70-year-old man. Arthroscopic rotator cuff repair was performed for the large-sized rotator cuff tear. Operating time was 134 min. Pneumothorax was missed in the X-ray image of the shoulder obtained immediately after surgery. Careful retrospective study of the X-ray image led to the identification of a *subtle line* indicating pneumothorax (*arrows*). (**b**) Because oxygen saturation was as low as 95 on the day after surgery, chest X-ray and CT images were obtained, which confirmed obvious pneumothorax (*yellow arrows*) and emphysema outside the chest wall (*red arrows*). A trocar was inserted into the pleural space

asthma. No bullae were found by chest X-ray examination in any of our patients before surgery.

In three patients, interscalene block was combined with general anesthesia. However, because the needle was inserted under ultrasonic guidance, it is unlikely that interscalene block causes pneumothorax.

A needle is inserted from the lateral acromion to position the anchor portal, but there is virtually no possibility based on the anatomic positional relationship that the needle tip damages the pleural membrane.

Possible causes of pneumothorax and subcutaneous emphysema include the following: (1) positive pressure on the lung from the respirator under endotracheal intubation; (2) extensive infiltration of irrigation fluid into not only the area around the shoulder on the affected side but also subcutaneous tissue in the thoracic wall and the neck, which would cause edema, thereby diminishing movement of the thorax, resulting in insufficient extension of the thorax under positive pressure on the lung; (3) load imposition on the thoracic region because of water pressure of the

perfusion pump; and (4) low-temperature burn in the thoracic region by heated irrigation fluid because of the use of a radiofrequency device.

Pneumothorax occurred frequently in patients who had large or massive tears, and the surgical time was relatively long, 138 min on average. Therefore, it is inferred that a variety of factors can produce a load on the lung on the affected side for many hours, resulting in the occurrence of pneumothorax and subcutaneous emphysema.

6.22 Conclusion

Complications include those caused by anesthesia, surgical position, and the perfusate. The risk of developing complications rises as the surgical time increases. Efforts should be made to complete arthroscopic shoulder surgery within 2 h. If surgery is prolonged, edema of soft tissue caused by the perfusate impairs the operative view and leads to a longer surgical time with ever-increasing edema, that is, causing a vicious circle. In regard to nerve and vascular injuries, it is essential to fully understand the anatomic courses and variations of the nerves and blood vessels. Unreasonable manipulation should be avoided to prevent breakage of surgical instruments. When a part of a broken metal instrument remains in the body, every effort must be made to remove the fragment, using an image intensifier without hesitation. X-ray examination of the shoulder should be performed immediately after surgery to assess whether pneumothorax is present.

We hope that this chapter will help arthroscopic surgeons in obtaining informed consent and in other relevant situations.

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