J Shoulder Elbow Surg (2009) ■, 1-6

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Severe chondrolysis after shoulder arthroscopy: A case series

David S. Bailie, MD[a], Todd Ellenbecker, DPT, MS, SCS, OCS, CSCS[b,*]

[a]*The Orthopedic Clinic Association, PC, Scottsdale, AZ*
[b]*Physiotherapy Associates, Scottsdale Sports Clinic, Scottsdale, AZ*

Hypothesis: Chondrolysis has been observed after shoulder arthroscopy and results in severe glenohumeral complications.

Materials and methods: Twenty three cases of post-arthroscopic glenohumeral chondrolysis, occurring between 2005-2006, are reported following a variety of arthroscopic shoulder procedures. Presenting complaints, signs and symptoms, associated operative findings, and potential etiological factors are reviewed. Management options are summarized.

Results: Of the 23 cases of chondrolysis identified in our practice over a two year period, 14 occurred in patients following labral repair using a bioabsorbable device. Seventeen of the 23 patients used a high volume intra-articular pain pump for 48 hours after surgery. Seven of the 23 cases had documented use of a thermal probe. Four cases occurred in shoulders with no reported use of fixation anchors, pain pumps, or thermal probes. All cases had at least a 20 cc intra-articular bolus injection of 0.25% bupivicaine with epinephrine.

Discussion: This case series identifies several common factors that could be responsible for post-arthroscopic glenohumeral chondrolysis. No single mechanism can be implicated based on the results of this study. Although strong concerns are raised over the use of intra-articular local anesthetics, glenohumeral chondrolysis appears to be an unfortunate convergence of multiple factors that may initiate rapid dissolution of articular cartilage and degenerative changes.

Conclusion: Chondrolysis is a devastating complication of arthroscopic shoulder surgery that can result in long-term disabling consequences. Further research is required to specifically identify causative factors. Until this is a available, we strongly advise against the use of large doses of intra-articular placement of local anesthetics.

Level of Evidence: Level 4; Case series, no control group.

Keywords: Shoulder; chondrolysis; cartillage; glenoid; humerus; pain pump; anchor; thermal; arthroplasty

Chondrolysis is defined as the disappearance of articular cartilage as the result of lysis or dissolution of the cartilage matrix and cells. For our discussion, this definition should be further refined to include the term ''rapid'' (onset of radiographic loss of joint space within 12 months of documented normal joint during arthroscopy) to describe the dissolution of cartilage matrix and chondrocytes. Because ''acute'' typically indicates onset within several weeks to a few months and ''chronic'' implies long-term presence, we chose the term ''rapid'' to describe the onset of degeneration in cases of chondrolysis to emphasize the

*Reprint requests: Todd Ellenbecker, DPT, MS, SCS, OCS, CSCS, Physiotherapy Associates, Scottsdale Sports Clinic, 9917 N 95th St, Scottsdale, AZ 85258.

E-mail address: ellenbeckerpt@cox.net (T. Ellenbecker).

1058-2746/2009/$36.00 - see front matter © 2009 Journal of Shoulder and Elbow Surgery Board of Trustees.
doi:10.1016/j.jse.2008.10.017

difference from other more common reasons for degenerative disease of the shoulder. Historically, chondrolysis was mostly associated with the hip as an idiopathic disorder in the developing hip[5] or associated with slipped capital epiphysis.[16] The etiology remains elusive but may be multifactorial, given the variety of reported associations and presumed causes. Chondrolysis has been reported to occur after both physical and surgical trauma,[11] after meniscectomy,[1] and with the use of irrigation fluid,[25] thermal devices,[8,10,13,15,24] or bioabsorbable implants.[23]

Chondrolysis of the glenohumeral joint after arthroscopic surgery appears to be rare, being reported in only a few published studies.[2,8,14,19,22] The reported association of the occurrence of chondrolysis with high-volume intra-articular pain pumps, bioabsorbable labral fixation devices, and thermal probes is most concerning, given the frequency of use of these technologies in modern shoulder arthroscopy. However, the actual cause of even the reported cases has not been confirmed, and the associations are speculative at this juncture. No randomized or prospective studies have been performed. Given the severity of this devastating complication and the young patients affected, published anecdotal observations can be useful.

We report a series of 23 cases of chondrolysis of the glenohumeral joint occurring after shoulder arthroscopy in young patients. The suspected causative associations, presenting characteristics, and our treatment experience are discussed.

Materials and methods

We reviewed the records of suspected cases of glenohumeral chondrolysis that presented to our office after shoulder arthroscopy from 2005 to 2006. This research study was submitted to and approved by the Institutional Review Board of Physiotherapy Associates (Exton, PA) before the review of patient data. This time period was used because we had not been aware of a single case of glenohumeral chondrolysis in our clinic before 2005. A total of 23 cases were identified. Chondrolysis was suspected in those patients who presented with a delayed increase in shoulder pain after arthroscopy (typically 8-12 months after the index procedure) and whose radiographs showed a clear loss of joint space. In all of these cases, radiographs taken before the index surgery were interpreted as normal, that is, no radiographic evidence of loss of joint space, osteophytes, cystic changes, or other findings that could represent early arthritis.

Patients with any known history or diagnosis of arthritis or infection before the index surgery were excluded. All operative reports were reviewed, in addition to any available preoperative imaging studies and intraoperative photographs from the index surgery. A thorough history was obtained and physical examinations performed on all suspected chondrolysis patients. Additional radiographs and magnetic resonance imaging (MRI) scans were obtained in some cases. In addition, because of the concern initially over infection, the first 10 cases encountered had blood work performed, including complete blood count, sedimentation rate, and C-reactive protein level. None had a bone scan or nuclear white cell scan.

Eleven of the cases occurred in patients in whom the index operation was performed by the senior author. The remaining patients had been referred to us for further care and their surgery performed elsewhere. None of the latter had been given the diagnosis of chondrolysis before being evaluated in our clinic. The 11 cases represented less than 1% of the total shoulder surgeries performed during the time when an indwelling pain catheter was used. Although symptoms may have been present, they were not sufficient to warrant a return to our office before 8 months after the index surgery. In addition, these numbers do not account for patients in whom chondrolysis may have developed to a lesser degree and who did not feel the need to return to the clinic for evaluation or those who may have sought opinions elsewhere. We did not attempt to contact all shoulder surgery patients during a specific time period for this study.

We evaluated demographic data, including gender and age, time of onset (as indicated by the patient's history of a rapid change in pain) from the index surgery, and initial pathology. In addition, surgical variables of concern including the use of bioabsorbable fixation devices, intra-articular pain pumps, and thermal probes were documented from the patient history and medical records. Treatment methods are presented but outcomes are not yet available and are not the purpose of this report.

This study did not undergo Institutional Review Board approval.

Results

There were 23 documented cases of chondrolysis of the glenohumeral joint. The details are summarized in Table I. The mean age was 30.5 years (range, 15-47 years). The onset of symptoms occurred at a mean of 9.1 months after the index operation (range, 8-12 months). No patient indicated an intervening injury during the time from index surgery to presentation to our office. Review of all available preoperative and intraoperative data failed to show any evidence of degenerative arthritis, infection, or inflammatory condition before the index surgery in any patient.

There were 14 cases involving labral repairs with bioabsorbable fixation devices (suture anchors and/or tacks), including 5 Bankart-type tears and 9 superior labrum anterior-posterior tears. There were 7 cases with documented use of a thermal probe for capsular laxity (3 monopolar and 4 bipolar), but the wattage used was not documented in the medical records. Seventeen cases involved the use of an intra-articular high-volume pain pump catheter, with 250 to 300 mL of 0.25% bupivacaine administered over a 48-hour period. One of these catheters was reportedly placed in the subacromial space after a mini-open rotator cuff repair. The remainder had been placed within the glenohumeral joint itself. Epinephrine appeared to have been used in 6 known cases, but not all operative reports reflected the actual concentration or amount. Other records (ie, nursing operative records and anesthesia records) were not available, except in the patients who had their index surgery at our clinic. In addition, there were 4 cases in which there was no recorded use of fixation anchors, thermal probes, or pain pumps. Two of these had only an arthroscopic debridement of a frayed labrum and/or partial rotator cuff tear. However, all 4 did have a documented intra-articular bolus of

Table I Summary of chondrolysis cases including demographics, pathology, time of onset, and ultimate treatment

Age (y)	Sex	Original complaint/surgery	Onset	Anchor	Thermal	Pump	Treatment
40	M	Traumatic instability Bankart	9	BIOABS	Monopolar	IA	Arthroplasty
45	F	SLAP (thrower)	10	BIOABS		IA	Debridement
41	F	Traumatic instability Bankart	10	BIOABS		IA	Arthroplasty
47	M	P/O RTC repair	10	Metal		SUB AC	Arthroplasty
22	F	MDI with chondral blisters	12		Bipolar	IA	Debridement
27	M	SLAP (thrower)	9	BIOABS		IA	Arthroplasty
15	F	SLAP (direct blow impact)	8	BIOABS		IA	Debridement/HA
33	M	SLAP (fall)	10	BIOABS		IA	Arthroplasty
26	M	Posterior labrum	9	BIOABS	Bipolar	IA	Debridement/HA
47	F	PASTA/type I SAD	8				Arthroplasty
28	M	SLAP (fall)	10	BIOABS		IA	Debridement
29	M	Traumatic instability Bankart	12	BIOABS		IA	Debridement/HA
27	F	MVA partial bursal cuff	12				Debridement/HA
29	M	SLAP (fall)	7	BIOABS		IA	Arthroplasty
32	M	SLAP (thrower)	8	BIOABS		IA	Arthroplasty
46	F	Idiopathic frozen shoulder	9			IA	Arthroplasty
16	F	MDI (thrower)	9		Monopolar		Debridement/HA
18	M	SLAP (thrower)	8	BIOABS		IA	Debridement/HA
22	M	Bankart	10	BIOABS	Bipolar	IA	Debridement/HA
26	M	Bankart	10	BIOABS	Monopolar	IA	Debridement/HA
24	M	SLAP I/PASTA	9				Debridement/HA
31	F	MDI	8		Bipolar		Debridement/HA
30	M	Interval repair	8				Debridement/HA

BIOABS, Bioabsorbable anchor; *IA*, intra-articular pain pump; *SLAP*, superior labrum anterior-posterior; *HA*, injection series of hyaluronic acid; *p/o RTC*, post-op Rotator cuff repair; *MDI*, multidirectional instability; *SAD*, subacromial decompression; *PASTA*, partial articular surface tendon avulsion; *MVA*, motor vehicle accident.

20 to 30 mL of 0.25% bupivacaine with 1:200,000 epinephrine at the end of the procedure.

Initially, the first 10 cases were also evaluated for occult infection, despite a lack of constitutional symptoms, including a complete blood count, sedimentation rate, and C-reactive protein level, which were normal in all cases. In addition, 4 of these had a negative joint aspirate with no bacteria seen on Gram stain and no growth after 21 days' incubation (aerobic, anaerobic, and fungal). After these 10 negative infection workups, the remaining patients did not have these tests performed because of the lack of other clinical findings that would lead us to suspect an infectious etiology.

The clinical presentation was similar in all patients. All had initially done well after surgery, with nearly complete resolution of their original symptoms. Most had already completed a rehabilitation program and returned to preoperative levels of activity without limitations. At a mean of 9.1 months, they noticed an increase in pain that rapidly escalated over the next 4 to 6 weeks. Nine patients also had a rapid loss of function and loss of range of motion. The remainder described significant pain but had preserved motion and function.

Radiographic findings were similar as well. Compared with preoperative radiographs, there was a diffuse loss of joint space ranging from 1 mm to complete loss (Figure 1). None had any evidence of substantial bone loss develop on plain radiographs, and osteophytes were not apparent. In some cases, MRI scans were obtained. These showed profound loss of articular cartilage and symmetric subchondral cysts on both sides of the joint (Figure 2).

In all 23 cases, treatment initially consisted of the use of injected and/or oral corticosteroids, nonsteroidal anti-inflammatory medication, and/or physical therapy. This was not effective in any case to the point that patients could return to desired activity. Of the cases, 9 (39.1%) ultimately went on to undergo cementless humeral head resurfacing arthroplasty with the Copeland Macrobond Implant (Biomet, Warsaw, IN). These cases had initially presented with severe loss of motion and function and, at the time of surgery, had more diffuse loss of articular cartilage on the humeral head (Figure 3) and a contracted, thickened capsule. In 6 of these cases (26.1%), arthroscopic debridement and capsular release were performed before arthroplasty and had not improved their range of motion, and the patients had continued pain. The remainder (14 cases [60.9%]) underwent successful arthroscopic debridement and/or capsular release, with 11 also receiving subsequent hyaluronic acid injections beginning 6 weeks later.

Surgical findings at arthroscopy indicated a paucity of loose bodies, nearly complete dissolution of the articular cartilage on the glenoid, and more central cartilage erosion of the humeral head (Figure 4). None of the cases had evidence of mechanical abrasion by a pain catheter or broken labral fixation device, leading us to conclude that the etiology was biochemical. Furthermore, the surrounding intra-articular

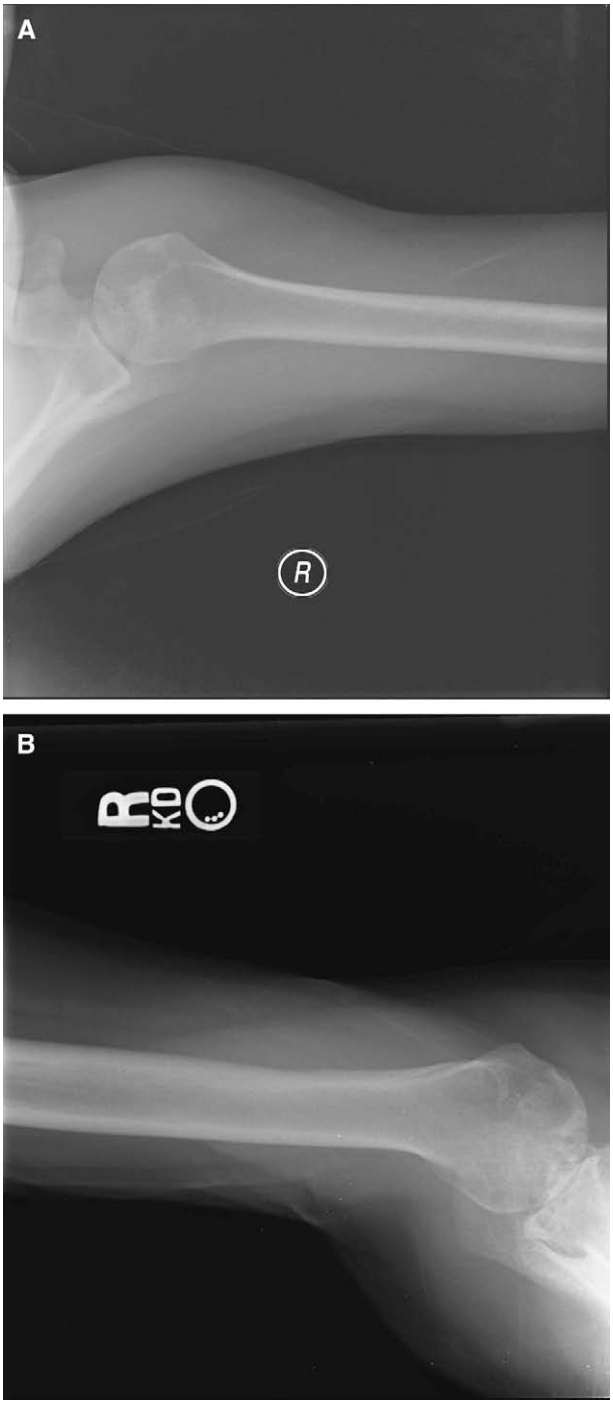

Figure 1 Axillary radiographs of same shoulder from Figure 1 preoperatively (**A**) and at 9 months postoperatively (**B**).

soft tissues appeared to be unaffected except in a few cases in which the labral tear may not have healed.

Discussion

Given the total number of shoulder arthroscopies done each year, the occurrence of chondrolysis still appears to be rare.

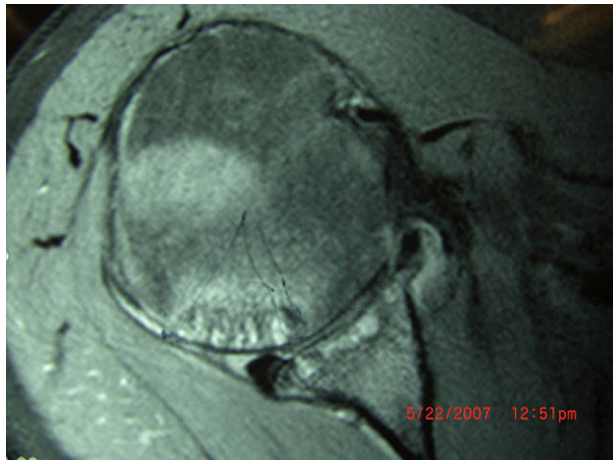

Figure 2 Typical MRI scan showing complete loss of joint space with subchondral cystic changes on both sides of joint, similar in appearance to rheumatoid or other inflammatory arthritis.

Of the 3 commonly used modalities implicated by various authors as potential contributors to chondrolysis (pain pumps, thermal devices, and bioabsorbable tissue anchors), devices used for tissue shrinkage initially had the greatest research support as a potential cause for chondrolysis.[8,12,24] The association for both pain pumps and bioabsorbable anchors was initially more tenuous.[4,6] Gobezie et al[6] reported on 687 consecutive patients who had received pain pumps postoperatively with no instances of chondrolysis or other physiologic side effects. Other reports in the literature on the use of continuous infusion of local anesthetics for postoperative pain control in the shoulder would seem to indicate that pain pumps are both safe and efficacious.[3,9,17,18] Conversely, 2 recent animal studies suggest that direct perfusion of articular cartilage with bupivacaine may have deleterious effects on cartilage metabolism.[4,7] More recently, 0.5% bupivacaine was shown to be significantly more toxic to human chondrocytes than ropivacaine.[20] Whereas the degradation products of bioabsorbable devices have been shown to be chondrotoxic, chondrolysis associated with the use of these devices may more likely be the result of mechanical factors (dislodgement and fragmentation) than a biochemical sequela.[21]

As noted earlier, the available literature on the pathophysiology of chondrolysis after arthroscopic shoulder surgery is sparse. Whereas other authors have correlated the occurrence of chondrolysis with modalities such as pain pumps, bioabsorbable anchors, and thermal devices, the actual etiology would appear to be much more complex and multifactorial. The demographic data of the patients in this series do little to clarify potential etiologies, because they are a fairly representative patient sampling of a typical orthopaedic practice. We were unable to identify a single specific modality that we could implicate in the initiation of postoperative chondrolysis. More likely, we believe that chondrolysis is an unfortunate convergence of multiple

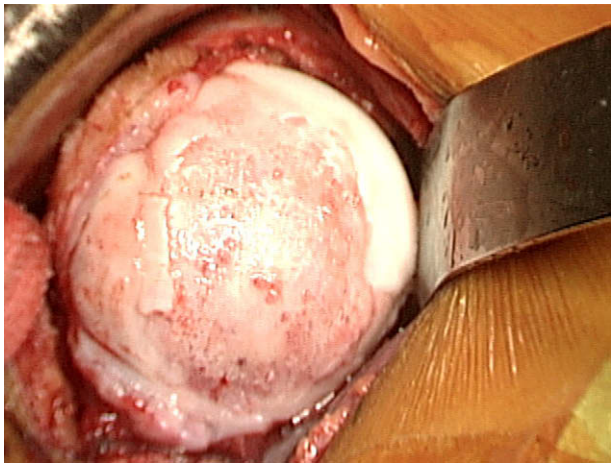

Figure 3 Intraoperative photograph of humeral head with appearance of ''dissolved'' articular cartilage.

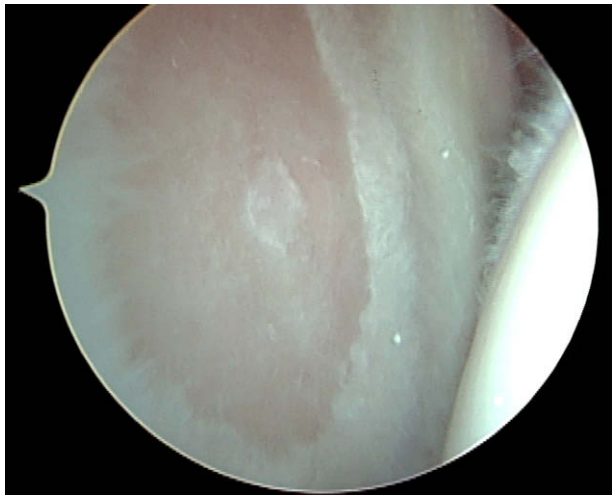

Figure 4 Glenoid with nearly complete loss of articular cartilage 9 months after suture capsulorrhaphy and use of an intra-articular pain pump in a 17-year-old female athlete. This shoulder had normal articular cartilage at the index surgery.

factors that may initiate rapid articular cartilage dissolution and degenerative changes. Realistically, these may include not only the modalities mentioned previously but such factors as genetic predisposition of the patient, irrigation fluids used during the procedure (type, temperature, and pressure), the surgical procedure itself, and any medications the patient has or is taking. These factors remain to be defined. Certainly, with the addition of recent laboratory evidence of chondrocyte toxicity of local anesthetics,[4,7,20] caution should be used in considering the use of indwelling pain catheters near hyaline cartilage.

In our series, we identified some common presenting factors that may aid in making the diagnosis of chondrolysis. Most of our patients had surgery elsewhere and presented with advanced disease, that is, the process of chondrolysis was already mature, and extensive damage to the joint surfaces had already occurred. Upon interviewing the patients, we found that most had initially done well after their procedure, with many indicating nearly complete recovery. However, all noted that they had a sudden change in symptoms, with a rapid increase in their pain that was characterized as different than their original complaints. Most suggested that it began around 8 to 12 months after their original surgery and became severe over a few months' time. This was true for our cases as well, in whom a more defined timeline could be determined. The pain was initially described as a deep, dull ache but progressed to intense pain, particularly in the evening and after activity. Few patients had mechanical symptoms, such as catching, locking, or clicking. Unfortunately, because of the lack of suspicion, very few had early radiographs or MRI scans obtained, and they were often told that they were having pain from overactivity too soon after their procedure. This was particularly true for those who maintained nearly normal range of motion and function. A high index of suspicion should be maintained for those with these symptoms who also had intra-articular exposure to high-volume pain pumps, bioabsorbable anchors or tacks, and/or thermal devices.

Because the findings on plain radiographs were consistently abnormal, we strongly suggest that anyone with an unexplained change in pain have a standard radiographic evaluation of the shoulder. A true anteroposterior view of the glenoid and axillary views are most diagnostic, even if the joint space narrowing is minimal. Comparisons should be made to the original preoperative films to ensure accurate determination of the degree of joint changes. MRI scans were helpful in making the diagnosis, because more extensive damage was more apparent, given that the degree of articular cartilage loss and cystic changes were obvious. In addition, MRI may aid in making treatment decisions because cases with loose bodies or cartilage flaps may be best treated with arthroscopy whereas those without fragmentation might not require arthroscopy. We did not find nuclear imaging studies helpful, and blood work findings were not abnormal. However, if infection is suspected, these 2 tests should be performed, in conjunction with arthroscopic lavage.

Unfortunately, because of the rarity of this condition, the treatment regimen for postarthroscopy chondrolysis of the shoulder is not defined. Our initial approach to treatment has been conservative/palliative, using intra-articular and oral corticosteroids and nonsteroidal anti-inflammatories. Of the 23 patients in this report, 9 subsequently underwent arthroplasty because of loss of function after failure of conservative management. The remainder responded well to debridement with and without intra-articular injections of hyaluronic acid. Long-term follow-up will be necessary to determine the success of the treatment in this series. A trend seemed to exist in short-term follow-up that suggests that those with severe loss of motion and capsular thickening do not rapidly respond to any form of treatment.

Therefore, we would recommend arthroscopic debridement/capsular release and aggressive rehabilitation before performing arthroplasty, even when the joint space appears to be completely lost.

In conclusion, chondrolysis is fortunately a rare sequela of arthroscopic shoulder surgery. However, its long-term consequences can be particularly disabling, especially in the young patient. It is difficult to implicate a single factor as the etiology of this condition. Rather, we believe that this condition results from an unfortunate convergence of multiple factors,. These factors are not adequately defined but probably include genetic, traumatic, biomechanical, and biochemical elements. Likewise, treatment options are poorly defined. Whereas some patients have responded favorably to conservative management, arthroplasty has been required to restore function in others. Clearly, more research is indicated to identify the initiating factors in this pathology. A high index of suspicion is needed to make an early diagnosis, and patients with any change in symptoms after arthroscopy of the shoulder should be encouraged to return for prompt evaluation and followed up closely over time.

References

1. Alford JW, Lewis P, Kang RW, Cole BJ. Case report: rapid progression of chondral disease in the lateral compartment of the knee following meniscectomy. Arthroscopy 2005;21:1505-9.
2. Athwal GS, Shridharani SM, O'Driscoll SW. Osteolysis and arthropathy of the shoulder after use of bioabsorbable knotless suture anchors: a report of four cases. J Bone Joint Surg Am 2006;88:1840-5.
3. Chao D, Young S, Cawley P. Postoperative pain management for arthroscopic shoulder surgery: interscalene block versus patient-controlled infusion of 0.25% bupivicaine. Am J Orthop 2006;35: 231-4.
4. Chu CR, Izzo NJ, Papas NE, Fu FH. In vitro exposure to 0.5% bupivacaine is cytotoxic to bovine articular chondrocytes. Arthroscopy 2006;22:693-9.
5. Daluga DJ, Millar EA. Idiopathic chondrolysis of the hip. J Pediatr Orthop 1989;9:405-11.
6. Gobezie R, Krastins B, Lavery K, Warner JP, Millett PJ. Complications associated with the use of pain control infusion pumps (PCIPs) after arthroscopic shoulder surgery [poster 9]. Presented at the American Orthopaedic Society for Sports Medicine annual meeting; 2006 Jun 30; Hershey, PA.
7. Gomoll AH, Kang RW, Williams JM, Bach BR, Cole BJ. Chondrolysis after continuous intra-articular bupivacaine infusion: an experimental model investigating chondrotoxicity in the rabbit shoulder. Arthroscopy 2006;22:813-9.
8. Grood CR, Shindle MK, Kelly BT, Wanich T, Warren RF. Glenohumeral chondrolysis after shoulder arthroscopy with thermal capsulorrhaphy. Arthroscopy 2007;23:797.e1-5.
9. Harvey GP, Chelly JE, Al Samsam T, Coupe K. Patient-controlled ropivacaine analgesia after arthroscopic subacromial decompression. Arthroscopy 2004;20:451-5.
10. Hogan CJ, Diduch DR. Progressive articular cartilage loss following radiofrequency treatment of a partial-thickness lesion. Arthroscopy 2001;17:E24.
11. Jay GD, Elsaid KA, Chichester CO. Early damage to the articular cartilage matrix occurs following traumatic knee injuries without fracture [abstract]. Acad Emerg Med 2003.
12. Lane JG, Amiel ME, Greenfield R, Amiel D. Matrix assessment of the articular cartilage surface after chondroplasty with the holmium: yttrium-aluminum-garnet laser. A long-term study. Am J Sports Med 2001;29:704-8.
13. Levine WN, Clark AM Jr, D'Alessandro DE, Yamaguchi K. Chondrolysis following thermal capsulorrhaphy to treat shoulder instability. A report of two cases. J Bone Joint Surg Am 2005;87:616-21.
14. Levy JC, Virani NA, Frankle MA, Cuff D, Pupello DR, Hamelin JA. Young patients with shoulder chondrolysis following arthroscopic shoulder surgery treated with total shoulder arthroplasty. J Shoulder Elbow Surg 2008;17:380-8.
15. Lu Y, Edwards RB II, Cole BJ, Markel MD. Thermal chondroplasty with radiofrequency energy: an in vitro comparison of bipolar and monopolar radiofrequency devices. Am J Sports Med 2001;29:42-9.
16. Lubicky JP. Chondrolysis and avascular necrosis: complications of slipped capital femoral epiphysis. J Pediatr Orthop 1996;5:162-7.
17. Mallon WJ, Thomas CW. Patient-controlled lidocaine analgesia for acromioplasty surgery. J Shoulder Elbow Surg 2000;9:85-8.
18. Park JY, Lee GW, Kim Y, Yoo MJ. The efficacy of continuous intrabursal infusion with morphine and bupivacaine for postoperative analgesia after subacromial arthroscopy. Reg Anesth Pain Med 2002; 27:145-9.
19. Petty DH, Jazrawi LM, Estrada LS, Andrews JR. Glenohumeral chondrolysis after shoulder arthroscopy: case reports and review of the literature. Am J Sports Med 2004;32:509-15.
20. Piper SL, Kim HT. Comparison of ropivacaine and bupivacaine toxicity in human articular chondrocytes. J Bone Joint Surg Am 2008; 90:986-91.
21. Sassmannshause G, Sukay M, Mair SD. Broken or dislodged poly-L-lactic acid bioabsorbable tacks in patients after SLAP lesion surgery. Arthroscopy 2006;22:615-9.
22. Tamai K, Higashi A, Cho S, Yamaguchi T. Chondrolysis following a ''color test'' assisted rotator cuff repair—a report of two cases. Acta Orthop Scand 1997;68:401-2.
23. Taylor MD, Daniels AU, Adriano KP, Heller J. Six bioabsorbable polymers: in vitro acute toxicity of accumulated degradation products. J Appl Biomater 1994;5:151-7.
24. Vangsness CT Jr. Radiofrequency use on articular cartilage lesions. Orthop Clin North Am 2005;36:427-31.
25. Yang CY, Cheng SC, Shen CL. Effect of irrigation fluids on the articular cartilage: a scanning electron microscope study. Arthroscopy 1993;9:425-30.