Update on Chondrolysis: Etiology and Implications Related to the Use of Intra-articular Local Anesthetic

Introduction

A devastating condition, chondrolysis is characterized by the disappearance of the joint's articular cartilage. Usually occurring 12 months to 18 months after some insult, such as surgery, this condition most commonly follows after joint arthroscopy.[1-6] The potential impact of chondrolysis is underscored by the roughly 3 million arthroscopic procedures performed annually in the United States, including 1.6 million knee and 230,000 shoulder procedures.[2]

Accompanied by increased stiffness and indicated radiographically by progressive loss of joint space and subchondral cystic changes, chondrolysis has been documented in the hip, knee, ankle, and most notably the shoulder. As the articular surfaces degrade, a concurrent inflammatory response manifests as arthrofibrosis, as early as six months post-operatively. This leads to progressive, and refractory loss of shoulder function.

Multifactorial in nature, post-arthroscopic glenohumeral chondrolysis (PAGCL) has been reported after relatively minor shoulder surgeries and commonly involves other factors such as intra-articular pain pumps (IAPP), radiofrequency energy devices, arthroscopy, suture anchors, methyl methacrylate, gentian violet, holmium:YAG, and infection.[4,5,7-11] While an exact incidence has not been defined, Wiater et al retrospectively looked at 375 patients that had undergone shoulder arthroscopy and found that 13% developed chondrolysis.[5]

Chondrolysis differs from the more common joint disorder, osteoarthritis, primarily in the time it takes to develop. Osteoarthritis may take years to become symptomatic and affects an older patient population, while chondrolysis presents within months of an initial insult and typically affects a younger patient population.[2] In addition, the term "chondrolysis" has been broadly and often incorrectly applied, potentially limiting our ability to prevent or effectively treat it.

Etiology

The exact mechanism of postoperative chondrolysis is still a mystery, but the existing body of clinical and scientific literature organizes the possible contributors into 3 broad categories: patient factors, surgical factors (preoperative and intraoperative), and postoperative factors.[2] These factors may act concurrently or independently from the intra-articular environment.

However, the most commonly cited factors are direct surgical insults to cartilage, use

of thermal and radiofrequency devices, suture anchors or implants/knots that violate the articular surface, and exposure to irrigation solutions or local anesthetics.

Basic science and clinical studies have noted potential causal pathways, including mechanical, thermal or chemical events that cause primary and secondary injuries. The result is an ensuing inflammatory cellular response that culminates with chondrocyte death. Cellular metabolism disturbance results in loss of gliding surface, congruity, and synovial fluid, leading to accelerated wear and friction that presents as symptomatic chondrolysis.

If an inciting injury to the cartilage is localized, minor, or superficial, cartilage can self-stabilize and prevent degradation through homeostatic mechanisms; however, if additional insults compound an existing disturbance in chondrocyte metabolism by inhibiting extracellular matrix production, apoptosis can propagate.

Orthopedic surgeons still need a consistent set of diagnostic criteria for joint chondrolysis. Provencher et al observed a “pooling effect,” whereby focal and diffuse cartilage injury as well as rapid and chronic timing of symptom onset were erroneously combined, leading to misclassification in 7% to 48% of chondrolysis cases.[1] A succinct set of standardized diagnostic criteria will avoid “pooling,” and provide refined treatment recommendations.

A recent review defined attributes of chondrolysis to provide more adequate guidance in identifying optimal treatment pathways and preventing the disease.[1] “Chondrolysis” should be applied to findings typical of acute articular cartilage demise, in which a patient presents within 12 months after a surgical intervention or an insult. The patient has pain, stiffness, limited range of motion, and severe diffuse articular cartilage loss, which are evidenced by radiographs, magnetic resonance imaging, or arthroscopic evaluation.

Patient Factors

Pre-existing patient factors can contribute to the development of chondrolysis. Solomon et al assessed 88 patients identified with chondrolysis in case reports to discover that the majority of patients were male (55%), with the most frequent diagnosis being instability (32%) and SLAP lesions (23%).[2] Other factors that were relevant during history and physical examination included family history of arthritis, collagen disorders, and synovial-based inflammatory processes that reduced hyaline cartilage.

Trauma in the form of instability and recurrent dislocation, as often seen in Hill-Sachs lesions, Bankart lesions, or glenolabral articular disruption,[1,2] may contribute to chondrolysis. Reduced physical activity after surgery with improper rehabilitation due to poor patient compliance and unmet life-style modifications may also compromise

recovery and accelerate the diffuse loss in cartilage.

Prior factors in a patient's make-up, such as pre-existing cartilage degeneration from osteoarthritis or past multiple recurrences of instability, could engender chondrolysis development, as well. In addition, age-related changes to the chondral matrix and the presence of fewer chondrocytes may contribute to cartilage degradation and a more rapid progression to chondrolysis.[3] Although pre-existing chondral damage does not directly correlate with chondrolysis, the existing degradation may contribute to the patient's susceptibility to further chondrolysis.

Surgical Factors

Direct mechanical injury to cartilage has been noted in chondrolysis development. Thus, clinicians must avoid iatrogenic damage to articular surfaces during arthroscopy. In glenohumeral procedures, the trajectory of trocar and cannula must be controlled to avoid chondral scuffing. Proudly placed suture anchors may cause cartilage damage by inducing mechanical trauma with repetitive scuffing of the cartilage surface.[10] In published cases reporting PAGCL, a review of current literature demonstrated no significant difference between the complication rates of non-absorbable suture anchors to bioabsorbable suture anchors.[10]

A significant number of published studies have focused on radiofrequency probes and their association with PAGCL. Case reports aggregated in a systematic review indicated 45% of 88 patients with chondrolysis were exposed to radiofrequency devices during surgery.[2] Basic science and clinical studies also demonstrate long-standing irreversible chondral damage due to thermal injury from direct or indirect sources such as radiofrequency probes or electrocautery devices.[8,9,12]

Fluids utilized during arthroscopy may adversely affect chondrocyte viability. Hyperosmolar solutions provide a protective-response while hypo-osmolar solutions, namely lactated Ringer or normal saline solution, can lead to decreased chondrocyte viability.[11] Other substances such as Gentian violet, used to identify rotator cuff tears, and chlorhexidine have been associated with PAGCL development, as well.[4,5]

Intraarticular Injections: Intraoperative/Postoperative

Peri-operative intra-articular administration of local anesthetics for short-term and long-term pain relief has been a common practice. The dose is delivered as a one-time injection or on a continuous basis with the use of a pain pump. Experts previously considered these intra-articular injections safe, with the commercialization of anesthetics such as bupivacaine and lidocaine. However, with an observed growing incidence of glenohumeral chondrolysis, investigators have focused their studies on chondrotoxicity, the effects of the concentration, and time-dependent phenomena on chondrocyte viability within controlled laboratory settings.

Intra-articular bupivicaine was studied two decades ago with reportedly no adverse

effects. But in 2006, histopathologic changes to in-vitro cartilage were noted in an in-vitro bovine articular cartilage model.[13,14] Further multiple in-vitro studies showed that 0.25% and 0.5% bupivacaine affected cartilage viability along with histology, even after brief exposure.[15] An in-vivo rabbit study showed loss of chondrocyte function in the glenohumeral joint three months after a 48 hour infusion of 0.25% bupivacaine and 0.25% bupivacaine with epinephrine.

In addition, studies indicate an up-regulation of cartilage metabolism, suggesting that in this model, articular cartilage had the ability to recover after the chondrotoxic effects of bupivacaine infusion.[14] A recent in-vivo study on rats showed significant reduction in chondrocyte density after a single intra-articular injection of 0.5% bupivacaine compared to saline negative control and monoiodoacetate positive control. Signs of toxicity due to 0.5% bupivacaine were subtle and would be difficult to detect clinically and may take time to develop.[11] These findings suggest that limiting the use of intra-articular bupivacaine and lidocaine, although no specific dosage recommendations exist.

Postoperative

For post-operative factors, studies have focused on pain management through the use of intra-articular pain pumps (IAPP) placed for the administration of local anesthetics. This is of particular concern in the glenohumeral joint with one case report reporting chondrolysis of the knee.[6] Development of PAGCL with IAPP has been a recently debated topic in which case reports have indicated linked pain pumps containing bupivacaine or lidocaine to PAGCL. Sixty seven percent of patients in a recent review across multiple studies developed PAGCL developed after receiving an IAPP.[2]

A retrospective study in 2011 examined factors associated with PAGCL development. All documented cases were associated with intra-articular post-arthroscopic infusion of a local anesthetic. In an analysis of arthroscopic procedures with local anesthetic infusions, the risk of chondrolysis was greater in patients with one or more suture anchors placed in the glenoid and those who had surgery near the end of the study.[5]

In general, a consistent correlation exists between PAGCL and increased duration of exposure to a high concentration of bupivacaine and lidocaine when administered to the glenohumeral joint, but not the subacromial joint, with the role of epinephrine still undefined.

Treatment

Treatment decisions are based on a definitive clinical reasoning pathway. Initial review of past medical history should determine the rate of loss or previous surgery to separate those afflicted with a systemic arthritis or slowly progressing loss of cartilage. If the patient symptoms fit the expected time course, then clinicians should investigate risk factor exposure: intra-articular implants and intra-articular pain pumps, history of

meniscectomy or the presence of intra-articular hardware.

Follow with a thorough physical exam; eliciting disproportionate pain, noting global motion loss or an acute onset of stiffness (< 12 month). Pain at extremes of motion or uni-planar motion loss may signal more of a focal chondral defect rather than chondrolysis.

A possible confounding but necessary decision would be imaging: diffuse cartilage loss with minimal osteophytes are non-specific but other key radiographic indications such as bipolar osteophytes, focal damage, or avascular necrosis may point away from the diagnosis. Surgical findings may confirm complete or near complete cartilage loss.

Non-operative treatment options consist of altering shoulder mobility, injections of intra-articular steroids, or intra-articular hyaluronic acid injections (off-label usage) to improve range of motion, decrease inflammation, and decrease friction across articular surfaces to slow chondral wear.

Unfortunately, none of these interventions has been documented in studies to be successful in restoring shoulder function and reducing pain. Shoulder resurfacing arthroplasty or hemiarthroplasty, with or without glenoid biologic resurfacing, or total shoulder arthroplasty are some interventions that have been utilized but neither improves patient prognosis.[2,4]

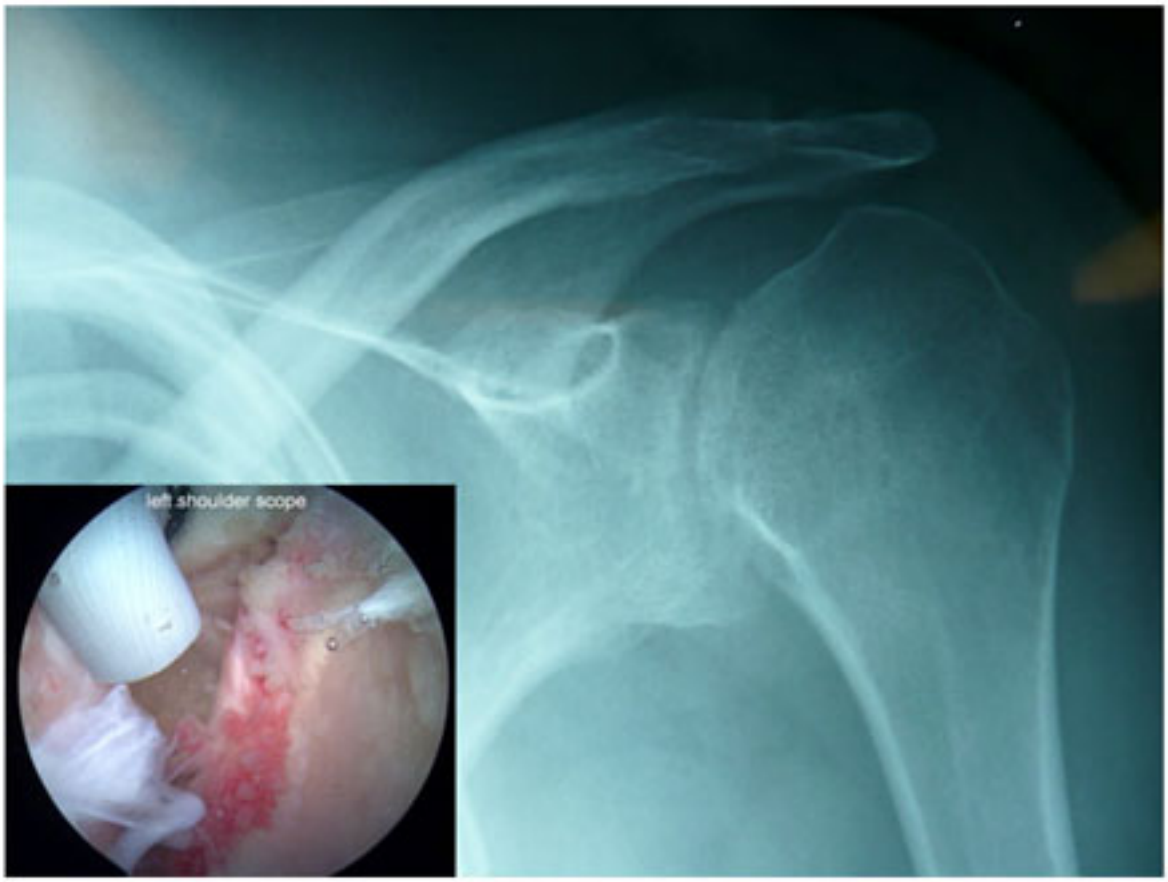
Conclusion

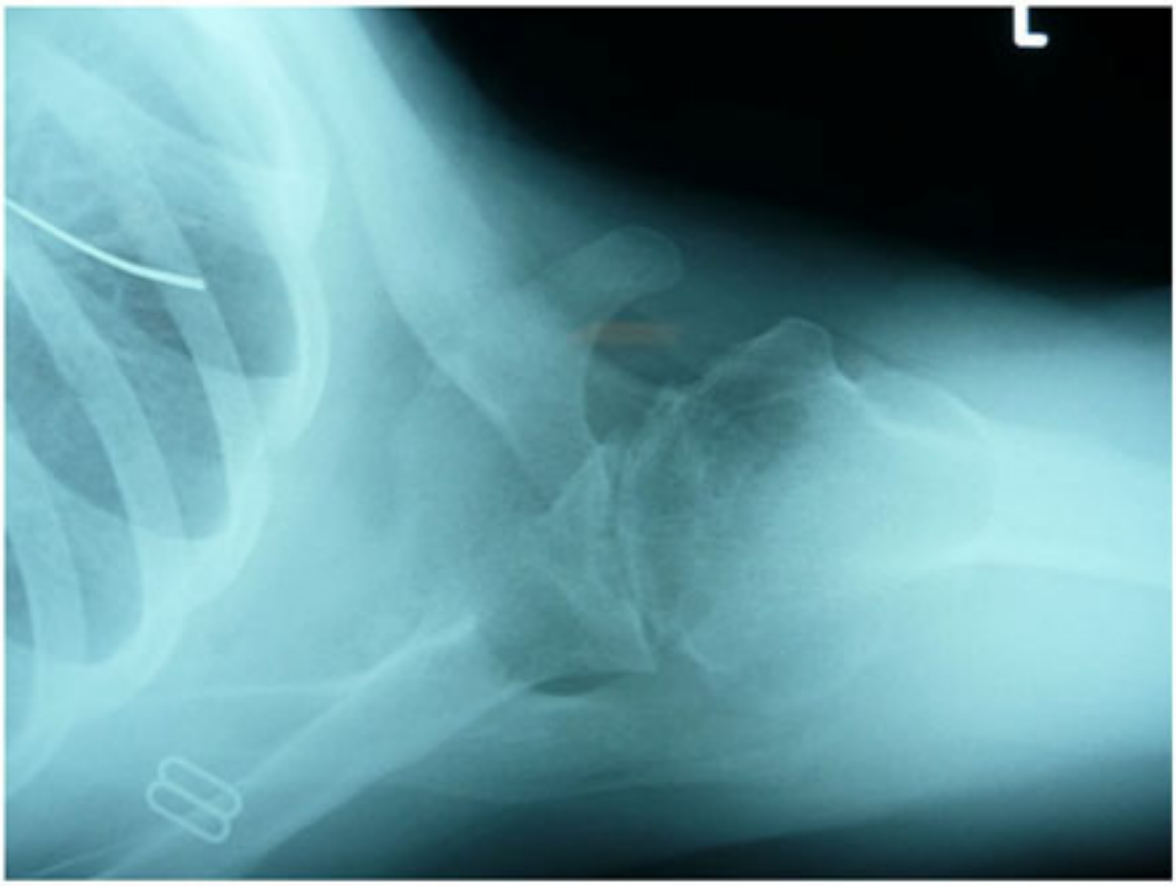
Surgeons must establish guidelines to avoid PAGCL. The minimally effective anesthetic dose or concentration for intra-articular administration of lidocaine and bupivacaine has not been demonstrated. Thus, physicians should exercise caution when administering doses of bupivacaine and lidocaine, as data has shown its potentially chondrotoxic effect; however, the lack of strength in the contemporary evidence does not allow for definite standard-of-care recommendations.

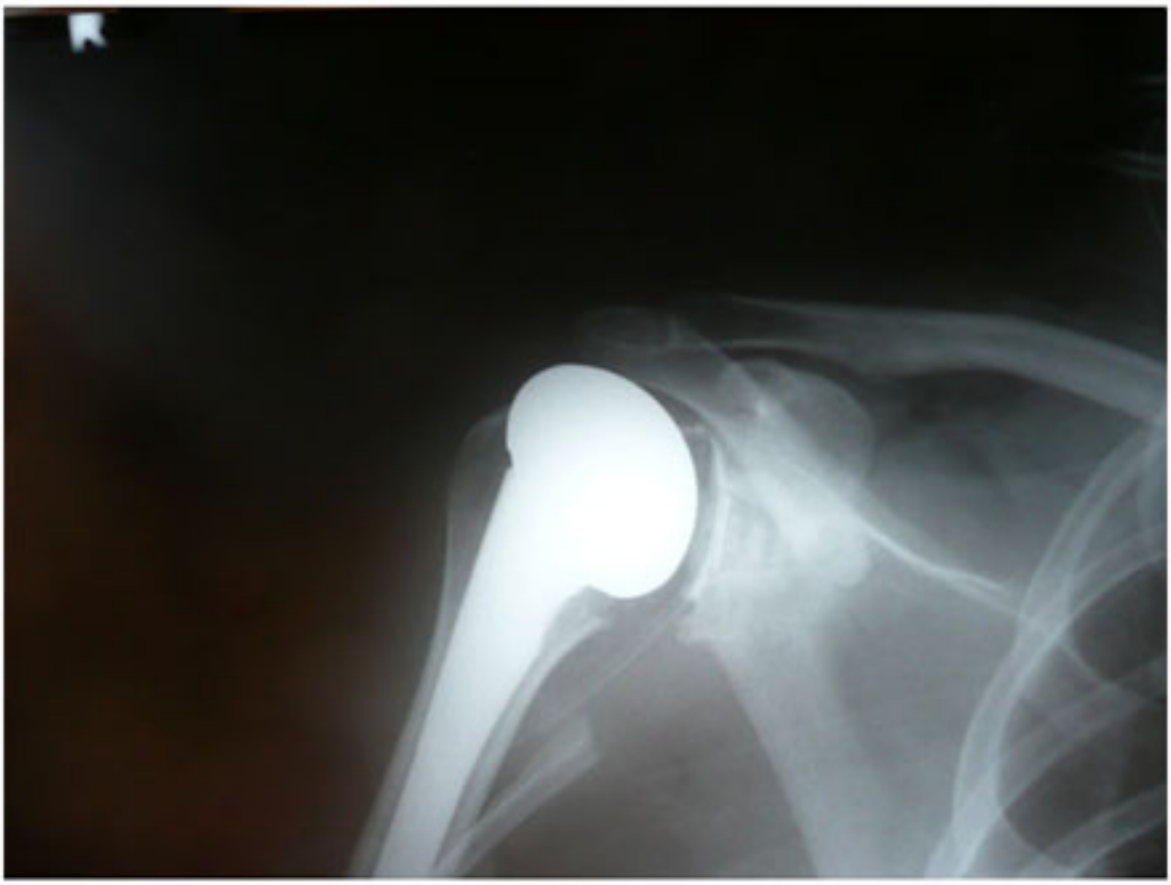
Surgeons should closely monitor the anesthetic administration, capsule integrity, and rate/volume of infusion.[16] Questions also surround the effects of adjuvants, such as epinephrine.

Identifying patients with an increased risk for chondrolysis may also be a challenging task. Wiater et al found that 13% of 375 arthroscopic shoulder procedures led to the development of chondrolysis. A postoperative intra-articular infusion of either Marcaine or lidocaine had been used in each case that developed chondrolysis.[5] Analysis of the arthroscopic procedures that were followed by local anesthetic infusion, showed that the risk of chondrolysis was greater for patients with one or more suture anchors placed into the glenoid. The authors suggest that avoiding postoperative infusion of local anesthetic may reduce the risk of chondrolysis.[5]

Contemporary studies lack explicit definitional criteria as significant variations in clinical criteria leads to difficulty in formulating structured algorithms. The most common definitional criteria utilized to diagnose chondrolysis were patient age, time to onset after potential etiologic exposure, magnitude of cartilage loss (focal versus diffuse), and severity or depth of cartilage injury. To diminish the chance of misdiagnosis, experts must perform basic, clinical, and epidemiological studies to define an evidence-based algorithm that will provide a practical solution to this complex problem.







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