Time-sensitive ambulatory orthopaedic soft-tissue surgery paradigms during the COVID-19 pandemic

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Abstract

Purpose Timing of surgery for orthopaedic injuries continues to evolve, as an improved understanding of biology, healing, and technological advances continues to challenge historical norms. With the growing COVID-19 pandemic stretching limited healthcare resources, postponing surgery becomes an inevitable and unenviable task for most orthopaedic surgeons, and a shift in outpatient paradigms is required to mitigate poor outcomes in patients.

Methods A scoping review of five databases on surgical timing and orthopaedic soft-tissue injuries was performed. All randomized controlled trials, longitudinal cohort studies, retrospective case series, systematic reviews, meta-analyses, and expert opinions were included for review, with 65 studies meeting the inclusion criteria.

Results Better outcomes appear to be associated with early surgery for subluxations (< 1 week), recurrent dislocations (> 2 episodes), ligamentous and tendinous injuries (< 2 weeks), and bony avulsion injuries (< 3 weeks). Spinal conditions with neurological compromise should be operated on within 24 hours and spinal instability within 72 hours to reduce the risk of complications and poor outcomes.

Conclusion Most soft-tissue orthopaedic injuries can be managed with outpatient ambulatory surgery in a semi-elective setting. As the paradigm for outpatient surgery shifts due to technological advances and the COVID-19 pandemic, it is critical for surgeons to time their surgery appropriately to maintain the high standards of orthopaedic practice.

Keywords COVID-19 · Pandemic · Orthopaedics · Surgery · Delayed surgery

Introduction

Acute musculoskeletal conditions account for 87% of all healthcare visits for traumatic injuries [1]. Timely surgery for the repair, reduction, or reconstruction of critical structures has the potential to improve outcomes and overall quality of life for patients. As the COVID-19 pandemic continues to wreak havoc on healthcare systems and limit facilities for surgically necessary procedures, it is essential that orthopaedic surgeons are still able to schedule timely surgery and advice patients based on the current literature.

Lankester et al. [2] categorized orthopaedic conditions requiring emergency surgery into three groups depending on the need for (1) urgent operative intervention, (2) early surgery during the next available semi-elective list with necessary sub-specialty expertise, or (3) conditions that rarely come to harm if operated on after a few days. While most fractures, mangled limbs, neurovascular injuries, compartment syndromes, and severe infections will still require urgent surgery, more procedures may now be performed in a delayed ambulatory setting without compromising patient care due to advances in technology and improved understanding of biology. Massey et al. recommended that most fracture fixations should be performed within two weeks of index injury [3], while DePhillipo recommended a list of acute surgically necessary soft-tissue injuries that should be operated on as elective-urgent procedures in the outpatient setting without guidance on critical timings [4]. As recommendations for time to surgery for sub-acute orthopaedic soft-tissue conditions are currently guided by expert opinions and historical perspectives, this paper aims to further assist surgeons by outlining surgical timings based on a review of the literature as summarized in Table 1.

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Evidence review

We performed a search of electronic databases (Pubmed, Embase, Scopus, Web of Science, Google Scholar) using the keywords “time to surgery,” “early surgery,” and “delayed surgery,” which were subsequently matched to search terms “orthopaedic injury,” “joint dislocation,” “tendon rupture,” “ligament rupture,” “spinal injury,” and “unstable arthroplasty.” Published articles between January 2000 and March 2020 were retrieved, and their titles, abstracts, and full texts were reviewed for appropriateness. Inclusion criteria comprised of (1) randomized controlled trials, longitudinal cohort, and retrospective studies; (2) systematic reviews and meta-analyses; (3) expert opinions; (4) availability of full text; and (5) manuscript availability in English language. We excluded articles if they had (1) majority of study population under 21 years old, (2) studies conducted outside the time frame, and (3) long bone and peri-articular fractures.

| Condition                                      | Recommended time to surgery | Level of evidence |
|------------------------------------------------|-----------------------------|-------------------|
| Shoulder                                       |                             |                   |
| Unstable gleno-humeral joints following dislocation | > 2 dislocations | II               |
| Acute types III, IV, V, and VI Acromioclavicular joint dislocations | < 3 weeks | IV               |
| Acute/severe rotator cuff tears                | < 3 weeks                   | IV               |
| Elbow                                          |                             |                   |
| Unstable elbow subluxations or dislocations    | < 2 weeks                   | III              |
| Locked osteochondral defects of the elbow      | < 2 weeks                   | V                |
| Distal biceps tendon tears                     | < 3 weeks                   | III              |
| Triceps tendon tears                           | < 12 weeks                  | III              |
| Hand and wrist                                 |                             |                   |
| Acute flexor tendon tears                      | < 3 days                    | III              |
| Unstable carpal dislocations/fracture dislocations | < 1 week                   | III              |
| Unstable phalangeal subluxations or dislocations | < 4 weeks                  | IV               |
| Foot and ankle                                 |                             |                   |
| Ankle fracture dislocation or subluxation with syndesmosis disruption | < 1 day                     | V                |
| Acute Achilles tendon rupture                  | < 2 days                    | III              |
| Acute ligament tears with ankle instability    | < 2 weeks                   | II               |
| Knee                                           |                             |                   |
| Acute tendon ruptures (patellar or quadriceps) | < 1 week                    | III              |
| Dislodged osteochondral fractures              | < 2 weeks                   | II               |
| Multi-ligament knee injury                     | 2–4 weeks                   | II               |
| Anterior/posterior cruciate ligament avulsion injuries | < 3 weeks (≤2 weeks for tendinous avulsion) | II |
| Meniscus tears                                 | ≤12 weeks                   | V                |
| Manipulations after total knee replacement     | ≤12 weeks                   | IV               |
| Hip                                            |                             |                   |
| Hip subluxation or dislocation that is not reducible or is unstable post-reduction | ≤6 h | V                |
| Dislocated/unstable arthroplasties             | ≥2 dislocations             | V                |
| Acute proximal hamstring ruptures             | ≤4 weeks                    | IV               |
| Locked hip secondary to intraarticular loose bodies or an incarcerated labrum | ≤6 months | II |
| Spine                                          |                             |                   |
| Neurological deficit or impending deficit that can be prevented by decompression | ≤24 h | II            |
| Spinal fractures with instability              | ≤3 days                     | III              |

Table 1 Recommended time to surgery for conditions requiring time-sensitive orthopaedic ambulatory surgery

Shoulder conditions

Unstable gleno-humeral joints following dislocation

An increasing number of dislocations and duration of dislocation have been shown to be associated with an increasing severity of soft-tissue pathology [5], glenoid or humeral head bony lesions [6], and gleno-humeral arthritis [7]. While surgical repair for first and second time dislocations remains controversial, those with > two dislocations during initial immobilization or functional rehabilitation should be counseled for surgical stabilization of the shoulder due to the risk of progressive damage to the capsulolabral complex [5].

Acute types III, IV, V, and VI acromioclavicular joint dislocations

A review published by Song et al. [8] previously concluded that there was not enough high-quality evidence to perform a proper systematic review. For Rockwood III injuries, a Cochrane review...
by Tamaoki et al. [9] concluded that the evidence for operating on such conditions remains controversial and is currently guided by patient demographic, activity level, occupation, and handedness. Early surgical treatment, within three weeks of acute injury, is associated with better functional outcomes and satisfactory reduction when compared with the delayed procedures (> 3 weeks) [8]. Biological augmentation with a tendon graft or anatomical reconstructive techniques are recommended for surgical repair after three weeks [10, 11].

**Acute/severe rotator cuff tears**

A biomechanical study showed that acute repairs within the first three weeks had better post-surgical viscoelastic properties, as tendons would stiffen if repair was delayed by > three weeks. The delay in repair was also associated with decreasing greater tuberosity bone density, which may contribute to poor healing [12]. A systematic review by Mukovozov et al. showed a trend suggesting that surgeries performed within three months of an acute rotator cuff tear were linked to better post-operative range of motion and Constant scores [13]. The authors did conclude that their findings should be interpreted with caution due to the limitations and bias inherent in case series as 11 of the 15 studies were retrospective, and there was not randomized controlled trials available for analysis.

**Elbow conditions**

**Unstable elbow subluxations or dislocations**

Unstable elbow dislocations are commonly associated with lateral collateral ligament injuries, capsular ruptures, and fractures of the radial head and coronoid. While the evidence for early surgery for recurrent simple elbow dislocations is lacking, emergency (< 24 hours) or early (4–14 days) surgery was associated with better range of motion, Mayo Elbow Performance Scores (MEPS), and reduced elbow stiffness than delayed surgery (> 14 days) for terrible triad of the elbow [14].

**Locked osteochondral defects of the elbow**

Osteochondral defects of the elbow may result in mechanical blocks to motion if not removed expeditiously. The elbow itself is very sensitive to developing stiffness due to fibrosis of the anterior joint capsule. Surgery should be performed within two weeks of the injury to allow early active mobilization and prevent complications of stiffness. Elbow capsular release can be considered if an elbow contracture of more than 30 degrees persists after six months of therapy [15].

**Distal biceps tendon tears**

Delayed biceps tendon repair (> 3 weeks) is associated with a higher rate of initial complications (neuropatia, stiffness, re-rupture, heterotopic ossification, infection) when compared with early repair (< 3 weeks). Despite the higher rate of initial complications, follow-up scores of functional outcomes using the American Shoulder and Elbow Surgeons (ASES) elbow questionnaire and Disabilities of the Arm, Shoulder, and Hand (DASH) score were not statistically significant during long-term follow-up of two to four years [16].

**Triceps tendon tears**

Triceps tendon tears are commonly associated with renal disease and delays in initial diagnosis [17]. In a review of 184 triceps tendon repairs, there was no difference in eventual discharge from medical care when comparing early (< 3 weeks) or delayed (3–12 weeks) surgery. Triceps tendon could be directly repaired in all patients when surgery was performed within the first 12 weeks of injury [18].

**Hand/wrist conditions**

**Acute flexor tendon tears**

Intra-synovial flexor tendon ruptures do not heal satisfactorily without surgical interventions. Early surgery allows for early mobilization to prevent adhesions, prevents scar hypertrophy, and improves gliding function between tendon and sheath [19]. Surgery should ideally be performed within 3 days of injury, as delays to surgery lasting between three to seven days are associated with increased risk of major complications (stiffness, re-rupture) [20, 21].

**Unstable carpal dislocations/fracture dislocations**

Early (< 1 week) concentric reduction of unstable peri-lunate dislocations and fracture dislocations was associated with better clinical and radiological outcomes when compared with dislocations treated between seven and 45 days after injury. While timing of surgery affected outcomes, meticulous appraisal and appropriate fixation of both osseous and ligamentous pathology were more crucial in attaining better outcomes [22, 23].

**Unstable phalangeal subluxations or dislocations**

Acute injuries to finger joints result in joint distention via inflammation and haemarthrosis. Scarring and fibrosis will eventually form if the joint is allowed to remain in its resting flexed position and may cause adhesions along the tendons and soft tissue. Evidence suggests that outcomes are
significantly improved when intervention for injuries in these joints is instituted within four weeks of injury, regardless of treatment modality. While patients rarely regain full range of motion, early concentric reduction to facilitate early motion exercises diminishes complications [24].

Foot/ankle conditions

Ankle fracture dislocation or subluxation with syndesmosis disruption

Early fixation, on the day or day after injury, is recommended for patients under 60 years old if the mortise is unstable or remains malreduced on manipulation and casting. External fixation devices can be used to maintain reduction in the event of soft-tissue compromise, and definitive fixation can be performed in one to two weeks after the soft tissue has settled [25].

Acute Achilles tendon rupture

Patients with acute Achilles tendon rupture who underwent surgery within 48 hours after the injury had better outcomes (Achilles Tendon Total Rupture Score) and a reduced number of adverse events (re-rupture, deep vein thrombosis) when compared with patients undergoing surgery after 72 hours and can be used as a guideline for optimizing Achilles tendon rupture treatment protocols [26].

Acute ligament tears with ankle instability

Surgery for lateral ankle ligamentous instability is warranted for extensive grade III lesions of all three lateral ankle ligaments and in high-level athletes [27]. Acute repairs (< 2 weeks) are associated with better scores on the American Orthopaedic Foot and Ankle Society (AOFAS) clinical rating scale when compared with those who underwent late reconstruction (mean of 4.4 years) [28]. Persistently symptomatic patients who experience recurrent sprains and persistent pain for greater than six months should be considered for operative treatment [29].

Knee conditions

Acute tendon ruptures (patellar or quadriceps)

Acute quadriceps and patella tendon ruptures require prompt diagnosis and surgery within the first week of injury to achieve primary direct repair and prevent complications. Patients with such injuries to the functional extensor mechanism are usually diabetic with inherent poor tissue quality, and any non-functional and diseased tendons should be debrided back to a healthy edge to allow optimal healing [30].

Dislodged osteochondral fractures

While the only limiting factor for primary fixation of dislodged osteochondral fragments in adolescents appears to be the integrity of the fragment itself [31, 32], primary fixation in adults after two weeks appears to be associated with poorer outcomes and is classically excised. As with most articular surfaces, fibrocartilage starts to form within ten days after the injury such that reduction of the osteochondral fragment becomes difficult or even impossible [33, 34].

Multi-ligament knee injury

The timing of surgical intervention for multi-ligamentous knee injury remains a contentious topic in current literature. Early surgery is less technically challenging due to the ease of identification of anatomic landmarks and planes with the potential for direct repair. Early surgery is however associated with increased risks of arthrofibrosis and compartment syndrome from fluid extravasation through capsular injuries. Delaying surgery to two to four weeks after injury allows time for reduction in swelling and interval capsular healing while still allowing for direct repair of bony avulsions or mid-substance collateral ligament ruptures [35]. Differences between early (< 2 weeks) and late (> 6 months) surgery were small in the early phases of recovery but were ultimately not statistically significant at long-term follow-up of two to eight years [36, 37].

Anterior/posterior cruciate ligament avulsion injuries

Cruciate ligament avulsion fracture reduction and fixation are associated with excellent outcomes if treated early and adequately, both in children and adults [38]. Reduction of the fracture fragment does not occur with manipulation in hyperextension, as the fracture fragment is usually displaced and lies in an empty non-articulating area of the joint [39, 40]. Arthroscopic anterior cruciate ligament (ACL) avulsion fixation within 72 hours was not associated with statistically significant improvement in Lysholm and International Knee Documentation Committee (IKDC) scores [41]. Current reviews of posterior cruciate ligament (PCL) avulsion injuries recommend fixation of bony fragments within three weeks of injury and tendinous repair within two weeks of injury [42-45].

Meniscus tears

Meniscal injuries can cause debilitating pain, instability, locking, and stiffness in patients when occurring in isolation.
or together with other knee pathologies. Early repair (< 3 months) for traumatic meniscal injuries was associated with reduced pain, locking, catching symptoms, and need for subsequent surgical procedures [46, 47].

**Manipulations after total knee replacement**

Knee replacement surgeries may be complicated by persistent stiffness due to pain, poor rehabilitation, or prolonged immobilization. Early manipulation under anaesthesia (< 12 weeks) is associated with greater flexion gains, final range of motion, and higher knee society scores compared with those performed after 12 weeks [48]. While there may still be a benefit from manipulation up to 26 weeks, open arthrolysis may be needed in the event of any further surgical delays [49].

**Hip conditions**

### Hip subluxation or dislocation that is not reducible or is unstable post-reduction

Hip dislocations usually occur during high-energy trauma and may remain subluxed or dislocated due to bony and soft-tissue injuries. The primary concern for surgeons would be the risk of chondral injury and subsequent avascular necrosis, which has been found to be correlated with the degree of initial trauma and the time during which the hip remains dislocated [50, 51]. Concentric reduction within six hours of injury substantially decreases the incidence of such complications, and prompt reduction has become a universally accepted mandate in all cases of hip dislocations or persistent dislocating [15].

### Dislocated/unstable arthroplasties

Closed reduction of unstable arthroplasties should be accompanied by 24 hours of rest followed by supervised therapy. For non-compliant patients and recurrent dislocations, bracing for six weeks and avoidance of adduction and internal rotation for three months for posterior approaches to the hip are recommended followed by strengthening of the pelvicrural muscles [52]. Any surgery for hip dislocations should be sufficiently worked up to identify the cause of dislocation (infection, massive haematoma, implant malposition), and open reduction is mandatory within hours in the event of neurological compromise. Otherwise, surgery for recurrent dislocations should be reserved for patients with > two dislocations [53].

### Acute proximal hamstring ruptures

In young, active patients, surgical treatment is usually warranted to allow early return to activity and improved quality of life [54]. Complete 3-tendon tears and 2-tendon tears/avulsions with > 2-cm retraction should undergo surgical repair within the first four weeks of injury. Surgery performed after four weeks poses a technical challenge due to increased scarring, difficulty of sciatic nerve neurolysis, and mobilization of the retracted tendons [55, 56].

**Locked hip secondary to intraarticular loose bodies or an incarcerated labrum**

Conservative therapy for hip labral tears, femoro-acetabular impingement, and chondral damage in symptomatic patients should be limited to a maximal period of six months, as patients who underwent surgery after six months had significantly poorer results (Harris Hip Score) and an increased need for revision surgery [57]. To the author’s knowledge, there is no current literature on the effects of delayed surgery in patients with an acute locked hip, but any intervention should be performed at an even earlier date to prevent further cartilaginous injury, stiffness, and complications of immobility.

**Spine conditions**

### Neurological deficit or impending deficit that can be prevented by decompression

Early (< 24 hours) and ultra-early surgery (< 8–12 hours) for acute spinal cord injury are associated with improved neurological recovery and shorter hospitalizations [58, 59]. No significant differences were reported in the rate of complications (mortality, neurologic deterioration, pneumonia, or pressure ulcers) between early (< 24 hours) and late (> 24 hours) decompression groups [60]. While various thresholds exist in the literature, pre-clinical and clinical evidences show a clear trend of clinically and statistically meaningful improvement in motor scores when surgery is performed within 24 hours of injury, especially in patients with cervical cord injury and traumatic central cord syndrome [59, 61].

### Spinal fractures with instability

Unstable cervical or thoracolumbar spinal fractures may lead to neurological compromise and permanent dysfunction without early intervention. Care of such patients is also complicated by bulky orthoses and increased manpower for daily tasks due to the need to maintain spinal nursing. The National Trauma Data Bank found that the majority of patients with spinal fractures underwent operative fixation within three days, with these patients having less complications (skin breakdown, acute respiratory distress syndrome, venous thromboembolism, progression of neurological insult, pneumonia, urinary tract infection) and requiring less resources [62–64]. These findings were replicated in patients who
sustained polytrauma [65] and should be prioritized before the management of other long bone and peri-articular fractures in these patients. Various spinal colleges throughout the world have different guidelines for timing of surgery, and a universally accepted algorithm remains elusive for the time being. While surgical timings remain controversial, the recommendation seems to be for hospitalization of the patient for expedited surgery and to proceed when surgical expertise and an operating list become available.

Conclusion

Orthopaedic surgical practice will continue to evolve with increased sophistication of surgical techniques and technological advances. For acute traumatic injuries in the ambulatory surgery setting, better outcomes appear to be associated with early surgery for subluxations (< 1 week), recurrent dislocations (> 2 episodes), ligamentous and tendinous injuries (< 2 weeks), and bony avulsion injuries (< 3 weeks). Spinal conditions with neurological compromise should be operated on within 24 hours, and spinal instability within 72 hours. These patients should be hospitalized for serial reviews and expedited timing of surgery instead.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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