Successful treatment of early ischemic contracture in the upper arm caused by traumatic haematoma through surgical muscle release and continuous passive motion: Case report

Jiong Yu, MD **, Jingyi Mi, MD, PhD *

Department of Sports Medicine, Wuxi 9th People’s Hospital Affiliated to Soochow University, Wuxi, Jiangsu, 214000, China

ARTICLE INFO

Keywords:
Ischemic contracture
Continuous passive motion
Soft tissue compartment syndrome
Case report

ABSTRACT

Background: Compartment syndrome is a condition that occurs when there is an increase in pressure within a muscle compartment, leading to a decrease in blood flow to the muscles and nerves within that compartment. If left untreated, this can lead to ischemic contracture, which is a late sequelae of compartment syndrome that occurs when there is sustained ischemic damage to the muscles. Timely diagnosis and treatment are critical in reducing the extent of permanent changes within muscle and nerve tissue. No previously published studies have reported on the treatment of early ischemic contracture resulting from traumatic haematoma in the upper arm. We present an exceptional case involving a 17-year-old male who developed this condition following a collision during a basketball game, resulting in a haematoma with severe pain, tightness and restricted range of motion in the affected arm. He was treated through surgical intervention involving surgical muscle release, haematoma evacuation and continuous passive motion (CPM) postoperatively to restore the range of motion and improve overall function with complete recovery at the 27-month follow-up.

The case

- A 17-year-old male patient presented with severe pain, tightness and restricted range of motion in the affected arm following a collision trauma during a basketball game.
- Final diagnosis was determined to be early ischemic contracture attributed to haematoma, as confirmed by evaluation under anaesthesia and intraoperative observations on the passive stretch with a resilient end point and the identification of non-viable brachialis and biceps muscles.
- Surgical muscle release, haematoma evacuation and continuous passive motion (CPM) postoperatively were performed to restore range of motion and improve overall function.
- At the 27-month follow-up, the patient displayed comprehensive restoration of elbow range of motion and commendable functionality of the affected upper limb.

Lessons learnt

- Resilient end point by passive stretch test under anaesthesia could be a strong indicator for early ischemic contracture in upper arm.
- Surgical muscle release, haematoma evacuation and post-operative continuous passive motion (CPM) therapy can effectively restore range of motion and improve overall function in patients with early ischemic contracture of the upper arm following trauma.

Introduction

Compartment syndrome occurs when there is an increase in pressure within a muscle compartment, which can lead to a decrease in blood flow
to the muscles and nerves within that compartment. Intracompartamental pressures of greater than 30 mmHg significantly impair the arterial circulation and are indicative of compartment syndrome [1]. Volkmann ischemic contracture is a late sequela of compartment syndrome that occurs when there is sustained ischemic damage to the muscles [2]. While compartment syndrome is primarily associated with fractures, it can also be triggered by soft tissue injury [3], albeit in rare instances. It can be caused by soft tissue injury and even occurs in upper arm region [4]. Consequently, the timely identification and management of compartment syndrome are of paramount importance, as they can help mitigate irreversible changes in muscle and nerve tissue. It should be noted that even with prompt intervention, permanent disability in the affected limb may occur, necessitating further surgical interventions, including amputation [5].

The current case reported a 17-year-old male patient who was diagnosed with early ischemic contracture in the upper arm and evaluated under anaesthesia. The patient underwent a combination of haematoma drainage, ischemic muscle debridement, vital surgical muscle release techniques and postoperative continuous passive motion (CPM) therapy, which lead to a complete recovery of the involved elbow and upper limb, followed up by 27 months. To our knowledge, no previous studies addressing this specific issue have been reported in the literature.

**The case**

A 17-year-old male patient, who is right-handed, presented to the orthopaedics emergency department with a chief complaint of severe pain in the right upper arm and increasing swelling. The patient reported experiencing a collision during a basketball game approximately one day prior to seeking medical help. Initially, the pain was tolerable immediately following the incident; however, after about 6 h, the discomfort intensified, leading to difficulty sleeping at night. There were no previous medical interventions reported for this collision trauma. The patient denied any history of illicit substance consumption and there was no evidence of any familial predisposition towards such behavior. Furthermore, the patient’s personal records revealed no involvement in any domestic violence incidents. Upon physical examination, ecchymosis was observed around the elbow joint and its proximal areas. Tenderness was localised at the distal third of the upper arm, with no abnormal sensations reported. The patient exhibited limited active flexion-extension and pronation-supination of the elbow and forearm, with an involuntarily flexed position of approximately 110° (Fig. 1). The patient demonstrated intolerance to passive range of motion assessment, with a Visual Analog Scale (VAS) pain score of 8. A plain radiograph of the upper limb yielded no obvious fractures (Fig. 2A–C), leading to the initial diagnosis of a soft tissue contusion. The patient was instructed to adhere to the RICE (rest, ice, compression, elevation) therapy [6] and scheduled for a follow-up appointment in one week. Upon reassessment at the outpatient clinic, there was mild relief in the swelling around the elbow joint, but active elbow flexion and extension remained limited. The patient reported increased pain when attempting to extend the elbow, with a Mayo Elbow Performance Index (MEPI) score of 25. The individual’s prothrombin time, activated partial thromboplastin time and D-dimer levels were all within the normal range. Upon further examination using the hook test [7], there was a mildly positive response from the distal biceps tendon. Taking into account the patient’s medical history, physical examination and this finding, the diagnoses of distal biceps tendon rupture and soft tissue contamination were considered. Consequently, the patient was admitted for further treatment (see Figs. 3 and 4).

A magnetic resonance imaging (MRI) examination was performed in the FAS (elbow flexion, shoulder abduction and forearm supination) position [8]. The MRI revealed a large haematoma measuring approximately 32 mm × 33 mm × 68 mm within the distal upper arm, situated between the brachialis and the biceps brachii muscles. The brachialis and the distal attachment of the biceps tendon appeared intact but showed significant thinning. This finding indicated that the symptoms were likely a result of compression of the brachialis muscle by the haematoma, leading to restriction of elbow extension.

**Surgical technique**

Surgical intervention was recommended to alleviate pain and improve range of motion by evacuating the haematoma 10 days after the collision trauma event. Prior to the surgery, the patient was evaluated under anaesthesia (brachial plexus block). The examination revealed a significant 70° lag of extension by passive motion, with the elbow displaying stiffness and a resilient end point that manifested as the Volkmann contracture examination (Video 1 in Additional Material). The surgical procedure involved making an incision curved along the brachial artery projection. After exposing the biceps muscle, a haematoma was discovered medially between the biceps and brachialis muscles. Muscle viability was assessed based on colour, consistency, contractility and bleeding capacity [9]. The brachialis muscle was found to be completely non-viable, while almost half of the biceps muscle remained viable (Fig. 2B–D). By this moment, the final diagnosis was confirmed as early ischemic contracture in upper arm caused by traumatic haematoma.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.isako.2023.11.003

Approximately 50 ml of uncoagulated blood clot and the non-viable muscle were then removed. Despite these efforts, the pulsation of the brachial artery was not observed after releasing the tourniquet, even with a waiting period of approximately 10 min. Full passive elbow extension could not be achieved. Consequently, a biceps brachii release was performed through longitudinal dissection along the muscle fibres using a haemostat. Following the procedure, full elbow passive extension was achieved with a slightly resilient endpoint. The wound was closed with a drain, and the elbow was immobilised in maximum extension using a volar cast to maintain the desired extension status. A rehabilitation
program, including pain control with nonsteroidal anti-inflammatory drugs (NSAIDs) and ice compress, was initiated. The drainage was removed on the second day post-surgery, and CPM exercises were started, with a recommended minimum of 4 h per day. During the CPM interval, a maximum elbow extension orthosis was worn with compressed dressing. By the third day, the patient was able to achieve active elbow movement ranging from 0° to 120° without the need for CPM.

On the fourth day, with a dry surgical incision, the patient was discharged from the hospital and advised to continue performing strengthening exercises for elbow flexion and extension at home.

Fig. 2. Preoperative imaging of the case. Panels A and B display X-rays of the upper arm and elbow, respectively, with no fractures detected. Panels C and D reveal MRI images captured in a FAS position attempting to identify the distal biceps tendon, but only a large mass within the muscle tissue was found.

Fig. 3. Intraoperative findings. Panel A represents the evaluation under anaesthesia with an elbow 70° lag of extension during passive motion. Panel B demonstrates approximately 50 ml of uncoagulated dark red blood clots observed anterior to the brachialis muscle. Panel C reveals total necrosis of the brachialis muscle and partial necrosis of the biceps brachii muscle. Panel D displays the outcome following the surgical muscle release procedure, resulting in full elbow extension. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)
Outcome

At the 4-week follow-up, the patient's muscle strength for elbow flexion and extension had improved to grade 4. By 12 weeks, muscle strength had fully recovered to grade 5, accompanied by Visual Analog Scale (VAS) and MEPI scores of 0 and 95, respectively. At the 27-month follow-up, the patient's VAS and MEPI scores were 0 and 100, indicating complete absence of pain and excellent overall elbow function (Video 2 in Additional Material). The patient had successfully resumed playing basketball.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.jisako.2023.11.003

Discussion

In this case, the final diagnosis was not clear until the surgical intervention. A plausible explanation for the chronicity of the disease can be traced back to the collision trauma, which likely resulted in a rupture of the brachialis muscle perforator artery. As a consequence, significant bleeding ensued within the anterior compartment of the upper arm, ultimately progressing into a soft tissue compartment syndrome. This explains why the patient experienced progressively severe pain without any accompanying fractures. Following a week-long interval for a second assessment, the patient exhibited limited active and passive range of motion. It was observed on MRI that a massive haematoma was present, with the distal biceps anchor remaining intact and coagulation functionality being within normal limits. At this juncture, systematic coagulation disorders and distal biceps tendon ruptures were excluded as differential diagnoses. In order to alleviate the symptoms of pain and restricted motion, surgical intervention was deemed necessary. Intraoperative findings, including endpoint feeling and muscle necrosis, confirmed the final diagnosis of early ischemic contracture. The time it takes for compartment syndrome to progress to ischemic contracture can vary depending on the severity of the condition and how quickly it is treated. Immediate identification and early surgical treatment of compartment syndrome are mandatory to avoid its devastating consequences. Delay or misdiagnosis of compartment syndrome can cause devastating consequences such as Volkmann's ischemic contracture, permanent nerve damage, amputation and death [10]. It is important for early diagnosis and treatment to prevent the development of ischemic contracture. The diagnosis of compartment syndrome is based on clinical suspicion, physical examination and measurement of compartment pressures. In this case study, a young patient presented with a traumatic injury resulting in complete brachialis necrosis and reversible elbow contracture. Upon reviewing the case, certain indications suggested the potential for an early diagnosis of compartment syndrome. Firstly, the patient exhibited a discrepancy between symptoms and signs, such as minimal localised swelling, the absence of a fracture, significant pain and a considerable reduction in motion. Concurrently, the passive extension of the elbow elicited severe pain during the passive stretch test, which may serve as a strong indicator of compartment syndrome [11]. Nevertheless, diagnosing early ischemic contracture, particularly in cases involving exclusively soft tissue injuries, can prove to be a formidable challenge.

Acute compartment syndrome is predominantly caused by acute fracture trauma, but it may also result from soft tissue crush injuries or vascular complications [3,4,10]. A systematic review published in 2023 [12] investigated the aetiology of traumatic hand compartment syndrome. The review classified the aetiology of traumatic hand compartment syndrome into three groups: soft tissue injury-related, fracture-related and vascular injury-related causes. The most common aetiology of hand compartment was related to soft tissue injuries which constituted 86.8 % of all aetiologies. However, the review did not provide specific information on compartment syndrome caused solely by soft tissue injury. Volkmann's ischemic contracture represents the outcome of a compartment syndrome, not adequately managed during the acute phase. In some cases, Volkmann's ischemic contracture can develop fully after intensive physio- and occupational therapy supported by nerve stimulation and psychological counselling [13]. Neonatal compartment syndrome, also known as congenital Volkmann ischemic contracture, is a rare condition that presents with progressive limb ischemia and tissue necrosis at birth or immediately thereafter [14].
is a rare complication of total knee arthroplasty (TKA) that, if left untreated, can result in irreversible neurologic deficits and muscle damage, ultimately causing loss of lower limb function, organ failure and rarely death [15].

The treatment of ischemic contracture depends on the severity of the condition and the underlying cause [16,17]. Mild ischemic contracture can be treated with splinting and hand therapy, while moderate ischemic contracture can be treated with surgical techniques such as flexor tendons lengthening or tendons transfer. Severe ischemic contracture requires surgery, which can be graded according to the severity of the deformity. Buck-Gramcko et al. [18] presented the results of long-term follow-up of 66 patients with ischemic contracture of the forearm and hand. Muscle and nerve damage were retrospectively evaluated according to operative notes, and the degree of damage could be classified into four groups. Muscle-slabbing operations were performed, and the results were judged according to twelve separately measured functions. Muscle-slabbing operations resulted in an improved score regardless of ischemic contracture stage. In this study, a case of early Volkman’s contracture was treated through salvage procedures by haematoma drainage and surgical muscle release, performed 10 days following the initial trauma. The brachial artery exhibited occlusion, which was likely induced by the compartment compression effect. It is worth noting that there is limited literature on this subject, primarily due to the importance of timely treatment.

A noteworthy innovation in rehabilitation of the case is the utilisation of CPM, primarily designed to prevent stiffness in the elbow joint following surgical procedures or injuries. Research suggests that CPM may effectively inhibit stiffness if implemented immediately post-surgery and continued until the swelling which restricts joint mobility subsides [19]. Furthermore, CPM exhibits exceptional tolerability, appears to be pain-free and promotes the healing and regeneration of articular tissues. Additionally, it prevents joint stiffness and facilitates the regular recovery of arthroplasty incisions [20]. Although CPM has been predominantly utilised for the prevention of elbow stiffness, we employed this technique to effectively extend muscle and scar tissue, thereby facilitating an enhanced range of motion. This approach provides a considerable advantage in promoting a rapid recovery process according to the rehabilitation process of the patient.

One notable strength of this case report is the meticulous documentation of the patient’s pertinent medical history, providing a solid foundation for comprehensive analysis. However, it is critical to acknowledge and address the inherent limitations present in this case report to ensure accurate interpretation of the findings. The foremost limitation pertains to the absence of a control group, thereby posing challenges to establishing causal relationships between the intervention under study and the observed outcomes. This constraint should be adequately acknowledged and addressed to contextualise the study’s results properly. Another limitation is the inability to generalise the findings to a larger population due to the uniqueness of the patient’s case. Collaborative efforts involving multi-centre studies with larger sample sizes are encouraged to overcome these limitations and provide more robust evidence.

Conclusion

Early detection and appropriate intervention may play a crucial role in managing ischemic contractures caused by haematoma. Surgical muscle release combined with CPM can produce favourable outcomes in terms of pain relief, restoring range of motion and improving long-term function in these cases. Further research is needed to explore optimal surgical techniques and rehabilitation strategies in similar cases of ischemic contracture.

Funding

This study received funding from the Duo-Innovative and Excellent Doctors Project of Wuxi 9th People’s Hospital (2021) (Grant Number: YB202111); “Wuxi Taihu Talent Plan” High-level Talents in Medical and Health (2020).

Declaration of competing interest

The authors have no conflicts of interest or relevant financial activities outside the submitted work.

Acknowledgements

All authors, JY and JYM, contributed to the following tasks: treating the patient, performing the operation, designing the diagnostic and treatment processes, and making the final revision to the article. Additionally, JY conducted the follow-up visits and composed the entire initial manuscript. Both authors have read and approved the final draft.

References