

Research article

Kinetic methods used in the postoperative recovery of a patient diagnosed with a puncture wound and foreign body retention in the middle third of the posterior face of the left forearm

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Abstract: Due to its superficial positioning, the muscle is more frequently exposed to trauma than bone or joint elements. Muscle injuries can occur either as a result of external forces, such as a traumatic agent, or internal forces that affect muscle function.

This paper presents a patient diagnosed with a puncture wound and retention of a foreign body in the middle third of the posterior aspect of the left forearm, with its extraction following three surgical interventions. This type of injury presents an increased risk of affecting daily life activities.

The patient was functionally assessed post-operatively upon inclusion in the rehabilitation program, during the program to observe progress, and at the end of kinetic treatment. The rehabilitation plan must be preceded by an adequate assessment, followed by setting goals according to the patient's needs and test results. Consequently, the patient rigorously followed the initial kinetic exercise plan established by the physiotherapist, leading to an improvement in muscle strength, joint mobility, and motor control. This resulted in an increase in the quality of life and social-professional reintegration.

Keywords: Osteoarthritis, knee, ultrasonography, cartilage, pain.

1. Introduction

Perforation injuries and the retention of foreign bodies in soft tissues represent a common reason for patients to go to the emergency room. These foreign bodies are mainly fragments of metal, plastic, wood, or glass [1]. Long term retention of these foreign fragments in the body can cause severe inflammatory, allergic, and infectious reaction. In the worst-case scenario, this could be a significant factor in tumor formation [2] [3].

Foreign bodies located in the upper limb are considered dangerous due to the anatomical arrangement of blood vessels and components of the nervous system [2], as well as the injuries caused to the musculature. Depending on the size, irregular shape, and positioning of the foreign body, surgical intervention can be challenging and may result in significant musculoskeletal sequelae. In the case of the upper limb, this can impact activities of daily living (ADL) [4]. The process of removing material that has penetrated the tissue is carried out with radiological guidance [5], both before and during the procedure, to ensure the best control and precise intervention, taking into account the difficulty in locating the foreign body and its potential migration [6] along the segment or, in the case of the forearm, its penetration into the interosseous space.

Through this paper, we aim to highlight the importance of a kinetic program after the surgical removal of a foreign body, as well as to present the case of a patient who underwent three surgical procedures for the extraction of the foreign body.

2. Materials and Methods

In this paper, we present the case of a 44-year-old male patient who presented to the Emergency Department on August 17, 2023, with pain and swelling in the middle third of the posterior aspect of the left forearm following a workplace accident involving the deep penetration of a foreign body. Figures 1 and 2 show the appearance of the puncture wound immediately after the accident. The black coloration of the skin results from the reaction between iodine and iron, as iodine was used to disinfect the wound at home immediately after the accident.



Figure 1-2 Aspect of the wound after the accident.

Following the patient's medical history, which involved examining the affected forearm through diagnostic tests, physiological assessments, and monitoring of vital signs, the diagnosis was established as retention of a foreign body in the posterior aspect of the forearm, in the middle third of the forearm, at the depth of the extensor digitorum muscle.

Three surgical interventions were necessary to extract the foreign body, with the first two yielding unfavorable results. The first surgery took place on August 21, 2023, following radiological imaging (Figures 3 and 4) that ruled out a fracture of the forearm bones. However, the surgery was interrupted by the doctor after an hour and a half due to abnormal blood pressure readings during the procedure, with values reaching as high as 208/97 mmHg. After this failed initial intervention, the cause of the sudden rise in blood pressure was investigated, and the conclusion was "white coat syndrome."



Figure 3-4 Forearm X-ray in pronation and pronosupination before the first surgery.

The second surgical intervention occurred two days after the first and lasted three hours and forty minutes, during which 9 local anesthetics were administered. A new series of X-rays was performed (Figures 5 and 6), placing two needles in the skin to provide reference points. During the procedure, it was found that the foreign body was located in an unfavorable position and could not be extracted. The patient was advised to return to the Emergency Department if signs of inflammation or pain occurred.



Figure 5-6 In the left x-ray position between pronosupination and supination , in the right x-ray pronosupination.



Figure 7 Appearance of the wound after the two surgical interventions.

On November 20, 2023, a third intervention was conducted, lasting 20 minutes. After proper preoperative preparation, surgical intervention was carried out under radiological guidance, and the foreign body was extracted. It was located beneath the extensor digitorum muscle tendon, lying on the interosseous membrane. The position of the metallic material can be seen in Figure 8.



Figure 8 Forearm X-ray in a neutral position and pronation.

Post-operatively, another X-ray is performed to ensure that the entire metallic body has been removed and to observe the injury it caused to the muscle (Figures 9-10). Subsequently, the area is immobilized with a radio-cubito-metacarpal orthosis I, including the thumb.



Figure 9 The muscle injury caused by the foreign body.



Figure 10 Appearance of the suture after the third intervention.

In Figure 11, the appearance of the foreign body extracted from the forearm can be seen. Its size is impressive, with irregular and sharp edges.



Figure 11 The foreign body extracted from the forearm.

Upon discharge, the patient received a series of recommendations from the doctor:

- To prevent edema, it is recommended to rest the immobilized segment in a raised position to promote blood venous return.
- To prevent edema, ice should be applied during the first week post-operatively.
- To ensure quick muscle healing, avoid using the supination movement.
- Removal of the sutures 14 days post-operatively.
- Taking off the orthosis once the sutures have been removed.
- Pain relievers as needed.
- Follow up with the scheduled appointment or in case of emergency.

Fourteen days post-operatively, the sutures were removed, the orthosis was taken off, and the patient was advised to begin physiotherapy sessions.

Upon inclusion in the rehabilitation program, a thorough medical history was conducted, focusing on the patient's history and a series of tests such as joint testing, muscle testing, finger extension test, measurement of pain on the visual analog scale (a subjective method based on the patient's assessment), somatoscopy, and somatometry.

The assessment of range of motion primarily focused on the radio-ulnar joint and the radio-carpal joint, both of which were immobilized post-operatively. The tests were also conducted on the unaffected right upper limb to serve as a reference point for developing the treatment plan. It is worth noting that the patient protected the affected upper limb, avoiding its use during the three months following the accident and up until the removal of the sutures.

Based on the results obtained from the medical history, a series of objectives were established with the patient:

- Control of the inflammatory process and reduction of pain.
- Reduction of muscle contractures.
- Recovery of joint mobility and regaining range of motion.
- Restoration of muscle elasticity.
- Regaining muscle coordination characteristic of motor activities.
- Recovery of muscle strength.
- Improvement of the patient's quality of life.
- Reintegration into daily activities.

We worked with the presented patient for three weeks, five times a week. Each session lasted about an hour, and the therapy was individual, not group-based.

The physiotherapy sessions are preceded by a segmental massage of the upper limb, with particular attention to the operated area. Effleurage and gentle friction are the techniques used to warm up and relax the area through hyperemia, with the primary goal of increasing elasticity and mobility, as well as reducing edema and pain, followed by releasing muscle contractures.

The initial therapeutic techniques implemented in the kinetic plan are passive mobilizations, which involve manipulations of the upper limb performed exclusively by the therapist. These techniques aim to regain the range of motion by testing the sensation at the end of the range of motion. They target all joints of the upper limb, starting from the radio-carpal joint, to the elbow joint, and up to the scapulohumeral joint.

During these mobilizations, the therapist performs axial tractions, dislocations, gentle rotations, and pressures to stimulate proprioception. The directions of movement follow anatomical paths, focusing on joint play that respects the biomechanics of each joint.

Gradually, depending on the level of pain, passive-active mobilizations, performed by the therapist together with the patient, are introduced. As the patient's progress continues, simple active mobilizations are performed, followed by the application of external resistance forces applied against the direction of movement. Active movements are performed concentrically and eccentrically, both internally and externally.

Throughout the recovery sessions, all joints of the upper limb are addressed, from the radio-carpal joint to the elbow joint and up to the scapulohumeral joint, targeting all involved joints.

The next phase involves the use of occupational therapy materials, specifically targeting the functional deficit of the extensor muscles of the fingers (*musculus extensor digitorum communis*) to facilitate activities of daily living (ADLs). We used Canadian plates with many types of exercises, progressing from daily activities that use gross motor skills to more complex activities that engage fine motor skills.

To regain gross motor skills, we introduced exercises such as gripping a doorknob and opening the door, opening a window, lifting a glass or bottle from the table, and exercises specific to the patient's profession to expedite reintegration into daily activities.

The activities for regaining fine motor skills were very well selected. We used utensils, buttoning systems, zippers, stringing beads onto a thread, writing exercises, and recommended playing backgammon and chess at home.

Regaining muscle strength was another goal established when the patient was included in the rehabilitation program. This aspect was addressed starting with active mobilizations with resistance and then a plan of exercises was established to increase the muscle strength of the extensor muscles of the fingers, using specific materials such as stress balls, elastic bands, and devices with controllable resistance. Another essential aspect was increasing the muscle strength of the pronator and supinator muscles of the hand, adapting resistance exercises, and progressing from easy to challenging levels.

Each rehabilitation session concludes with stretching exercises to stretch and relax the forearm muscles.

3. Results and discussions

After the three surgical procedures, the patient underwent the removal of the foreign body from the forearm. A long and challenging recovery procedure was required for this. The recovery plan was designed to meet the patient's needs and achieve the goals established during the initial medical history assessment. The therapeutic approach was complex and implemented progressively, with some adjustments made based on evaluations during the sessions.

The final phase of the recovery process involved re-evaluating the functions tested at the patient's inclusion in the recovery program to observe the patient's progress and quantify their improvement. Table 1 presents the values of the joint assessment measured at the beginning and end of the treatment plan. The flexion and extension movement of the wrist were measured, involving the radio-carpal and intercarpal joints in these movements, as well as supination and pronation of the elbow.

Measurements were taken of the affected left upper limb and the unaffected right upper limb. The values obtained from testing the healthy limb served as a guide in the recovery process, and the goals set were closely related to these measurements. The final values showed a satisfactory increase in range of motion, with a considerable approximation to the values of the healthy limb.

Table 1 Joint testing, initial and final evaluation.

Movement	Tested Limb	Normal value	Initial values	Final values
Flexion	Right	70°-80°	76°	78°
	Left	70°-80°	42°	72°
Extention	Right	60°-75°	72°	72°
	Left	60°-75°	34°	63°
Supination	Right	80°-90°	90°	90°
	Left	80°-90°	45°	81°
Pronation	Right	75°-85°	83°	85°
	Left	75°-85°	41°	77°

5. Conclusions

The purpose of this paper was to highlight the importance of a kinetic program in the recovery process of a patient diagnosed with a puncture wound and retention of a foreign body in the middle third of the posterior forearm post-operatively.

Regardless of the nature of the injury, it has a significant impact on the patient's physical and mental health, mainly when it involves conditions of the upper limb that significantly affect daily activities and the patient's professional life. Thus, the patient's active involvement in the recovery process, their desire to heal, positive thinking, and active lifestyle before the injury, combined with an appropriate treatment plan based on a thorough medical history and well-established objectives, lead to achieving of the main goals set.

As the results presented earlier show, by the end of the recovery program, we achieved the patient's socio-professional reintegration, allowing them to resume some of their daily activities while following the physiotherapist's recommendations.

We chose to present this patient's case due to its complexity, arising from the three surgical interventions and the period during which the metal foreign body was not extracted. Consulting the specialized literature, we noticed the lack of approach to this type of case, which simultaneously led to certain limitations of the work, as not many such pathologies accompanied by recovery programs are described by specialists. Therefore, we decided to use classical recovery methods. The lack of exact data in the literature is most likely due to patients who do not undergo kinetic treatment. It is well-known that the frequency of work-related accidents involving the penetration of a foreign body, regardless of location, is high, hence this work could serve as a basis for future research towards new postoperative treatment approaches.

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