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ORIGINAL ARTICLE

Minimally Invasive Surgical Management of Lacertus Syndrome: Short-Term Results

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Abstract

Background: Compression of the median nerve proximally by lacertus fibrosis at the elbow, also referred to as lacertus syndrome (LS), has conventionally been regarded as a vague and uncommon condition to diagnose, primarily because it is rarely identified through electro-physiological studies. This article explores the condition's clinical symptoms, methods for diagnosis, surgical approach, and the outcomes of surgical intervention.

Methods: This study analyzed data collected retrospectively over a two-year period, from February 2021 to February 2023, focusing on patients who underwent lacertus syndrome release. The investigation included available Disability of the Arm, Shoulder, and Hand (DASH) questionnaire scores, along with post-operative outcomes such as Visual Analogue Scale (VAS) ratings for pain and numbness, patient-reported satisfaction with the surgical results, and intra-operative restoration of muscle strength.

Results: A total of 28 lacertus releases were recorded, 20 cases (71.4%) were isolated LR, and 8 patients (28.5%) were associated both LR and carpal tunnel releases.

The most frequently reported symptoms among patients with LS included diminished strength of the hand (96.7%), reduced endurance or hand fatigue (74.4%), and pain in the forearm (36.5%). All individuals with associated LS and CTS experienced numbness in the median nerve distribution of the hand.

The average pre-operative DASH score was 35.5 (range 3.4–85.2), while the activity DASH averaged 54.9 (range 0–100), and the work DASH averaged 35.3 (range 0–100). Post-operatively, the average quick-DASH score significantly decreased to 13.5 (range 0–63.6), mean improvement of 24, with a highly significant statistical difference ($p < 0.001$). Likewise, the activity and work DASH subscores showed significant reductions to 20.6 (range 0–69.8) and, 9.5 (range 0–76) correspondingly ($p < 0.001$). Postoperative VAS scores averaged 1.7 for pain, 1.9 for numbness, and 8.6 for operative outcome satisfaction. Notably, 89% of patients reported good to excellent satisfactory results, while only one individual (3.5%) was dissatisfied and had remaining compression at the superficialis arcade that necessitated a revision. Intraoperative strength recovery was confirmed in 27 patients (96.4%). The one exception involved complete anterior interosseous nerve palsy (affecting the FPL and FDP II), but the patient regained full strength within ten weeks post-surgery.

Conclusion: Lacertus syndrome (LS), is a less frequently occurring condition caused by proximal compression of the median nerve at the elbow, and characterized by diminished hand muscle strength and reduced endurance or fatigue. Minimally invasive surgical management of LS with follow-up periods of at least twelve months has been shown to provide immediate restoration of hand muscle strength, substantial improvements in DASH scores, and favorable outcomes in terms of (VAS) pain, numbness, and patient satisfaction.

Level of evidence: IV retrospective study.

Key Words: Lacertus syndrome, proximal median nerve entrapment, lacertus release.

INTRODUCTION

Proximal median nerve entrapment (PMNE) has become a focal point of interest for hand surgeons in recent years [1]. Originally termed "pronator syndrome" by Henrik Seyffarth in 1951 [2], this condition is characterized by nerve compression occurring between two heads of the pronator teres muscle (the humeral and ulnar), often involving a fibrous tether at the site of compression. However, more recent studies have raised questions about the exact structures responsible for the entrapment and the scope of surgical intervention necessary to achieve symptom relief [3,4]. The lacertus fibrosus (LF), an aponeurotic structure emerging from the bicep's brachialis tendon distal and medial edge, travels medial and distal, often making direct contact with the median nerve in nearly half of all population. It traverses the common flexor musculature and merges with its fascia [5,6]. From a biomechanical point of view, this structure plays a dynamic role in transmitting loads during flexion of the elbow, adapting the lever arm, and restricting supination which in turn can cause its ability to compress the median nerve dynamically[4,5]. Due to the unique anatomy and the transient nature of LF-induced compression—often referred to as lacertus syndrome (LS)—its symptoms can be subtle and frequently overlooked [7,8]. Research on concurrent carpal tunnel syndrome (CTS) and PMNE remains limited, with studies suggesting an incidence of 6–13% [9,10]. The LS underdiagnosis and the suboptimal results following carpal tunnel surgical release in cases of double crush entrapments highlight the need for a deeper understanding of diagnostic strategies and management approaches. We hypothesized that LR would be an effective tool in isolated LS or associated LS and CTS. This study aims to evaluate the clinical features and operative results associated with LS and its median nerve encroachment.

METHODS

This research, involving human subjects, adhered to the ethical guidelines set forth by the Helsinki 1964 agreement and its subsequent appendices. Approval from the IRB (Internal Regulation Bureau) committee and informed consent from participants were obtained. The study was retrospective, using perioperative gathered data from our department registry of patients covering the period from February 2021 to February 2023. Inclusion criteria included, cases who had received operative lacertus release (decompressing the median nerve at the LF), either isolated or associated with other procedures such as CTS release or additional median nerve releases. We excluded patients who had associated peripheral neuropathies or other multiple neurological compressions.

Patient medical records were examined to evaluate preoperative criteria such as gender, age, profession, the dominant side, symptoms as reported by the patients, the type of surgical intervention, and improvements in strength intraoperatively. Data from pre- and post-intervention assessments, including the Disability of the Arm, Shoulder, and Hand (Quick-DASH) questionnaire with subscores for activities and work, as well as post-surgical pain levels measured by the VAS (Visual Analog Scale), numbness, patient satisfaction with the operative results, and intraoperative strength recovery, were also reviewed. The LS diagnostic features were established by a detailed case history and clinical evaluation, which included triad of clinical characteristics: muscle manual tests of the upper limb showing weakness in the FCR (flexor carpi radialis), FPL (flexor pollicis longus), and the FDP II (index finger flexor digitorum profundus); like the SCT (scratch collapse test) as sensory provocative test; and existence of pain with or without a positivity of Tinel's test at the site of nerve compression [4]. In cases of LS, pain occurs at the location of the median nerve beneath the LF. Concurrent carpal tunnel syndrome (CTS) was diagnosed when a Tinel's test and provocative tests were positive. LS is a type of dynamic nerve entrapment often categorized as a Sunderland grade "zero." This means there is no damage to the axon, but instead, there are alterations in the blood flow at the perineurial level and its axonal conveyance [11], which leads to low specificity in EMG (electromyography) studies [8] so EMG was not used to diagnose LS. Patients showing early LS signs may find relief by a local corticosteroid injection at the proximal margin of the LF. Furthermore, a treatment plan that includes nerve gliding maneuvers, along with an assessment of the workplace ergonomically, plays a crucial role in the conservative management of these patients [1].

Surgical Technique

Lacertus release (LR) procedure for decompressing the median nerve at the level of the LF was done under WALANT (wide awake, local anesthesia, without the use of a tourniquet whenever possible)

[12, 13]. A key benefit of performing the surgery with the patient awakened and compliant is the ability to monitor the return of muscle strength during the procedure. If necessary, additional release can be performed right away.To accurately place the incision, the "tripod grip" technique is used to locate the LF using surface landmarks. For proper alignment, the surgeon's hand should be on the same side as the patient's arm, which means usage of the right hand is used to identify the LF on the patient's right elbow (and similarly for the left). By positioning the thumb on the patient's medial epicondyle and the middle finger on the patient's biceps tendon, the surgeon's index finger will simply fall in a tripod shape, pointing directly to the LF location. Once the surgical incision site is marked, a local anesthesia solution is prepared by mixing 20-30 mL (10 mg/mL) of lidocaine 1% with epinephrine (5 µg/mL) and buffering it with 2-3 mL(50 mg/mL) of sodium bicarbonate. This mixture is then injected subcutaneously with a 27 G needle, starting at the medial elbow crease and extending obliquely over the LF area, which is typically located about 4 cm distal and central to the elbow crease. A transverse 2-3 cm skin incision is made either directly in the slightly distal to volar elbow medial crease for optimal cosmetic results. During the dissection, care is taken to identify and protect the medial antebrachial cutaneous nerve, and the procedure proceeds carefully under the subcutaneous layer until the PT (pronator teres) fascia is reached. The (PT fascia) is then opened, allowing the LF to be identified central and lateral within the wound. At this stage, the proximal margin of the LF is raised to prevent injury to the underlying neurovascular structures while the LF is fully divided. Attention must be given to any perforator vessel within the LF that could cause hematomas postoperatively if damaged. Below the split LF, the median nerve can usually be recognized, and in uncommon instances, within the PT muscle belly itself. After achieving adequate hemostasis, wound closure is commenced and a small sterile dressing is utilized. **Figure (1)** illustrates the surgical technique. Early post-surgery mobilization is encouraged. Patients who do not engage in manual labor can typically return to work within 1 to 2 days after surgery, though they are advised to refrain from lifting heavy objects over 1-2 kg. Gradual resumption of more strenuous tasks, including heavier lifts, is permitted after 4 weeks. Outcome data were gathered in a retrospective manner, which included preoperative, intraoperative, and twelve months after surgery records. The main measures included the quick DASH (preoperative and postoperative) scores, with separate subscores for activity and work. The DASH inquiry is a well-established instrument for evaluating the functional impact of upper limb musculoskeletal conditions and injury. It uses a scale from 0 to 100, with higher scores reflecting more severe symptoms [14,15]. Secondary measures included the postoperative Visual Analog Scale (VAS) for pain, individual satisfaction with the operation and numbness, (rated 0-10) [4], and finally, the restoration of strength during the procedure was included.

Statistical Analysis

The results were reported as mean values, median values, ranges, and interquartile ranges. Preoperative and postoperative measures were coded and assessed using a Student's t-test (paired two-tailed), with a p-value of less than 0.05 considered significant statistically. Statistical analysis was carried out using SPSS version 19 (IBM SPSS Inc., Chicago, IL).

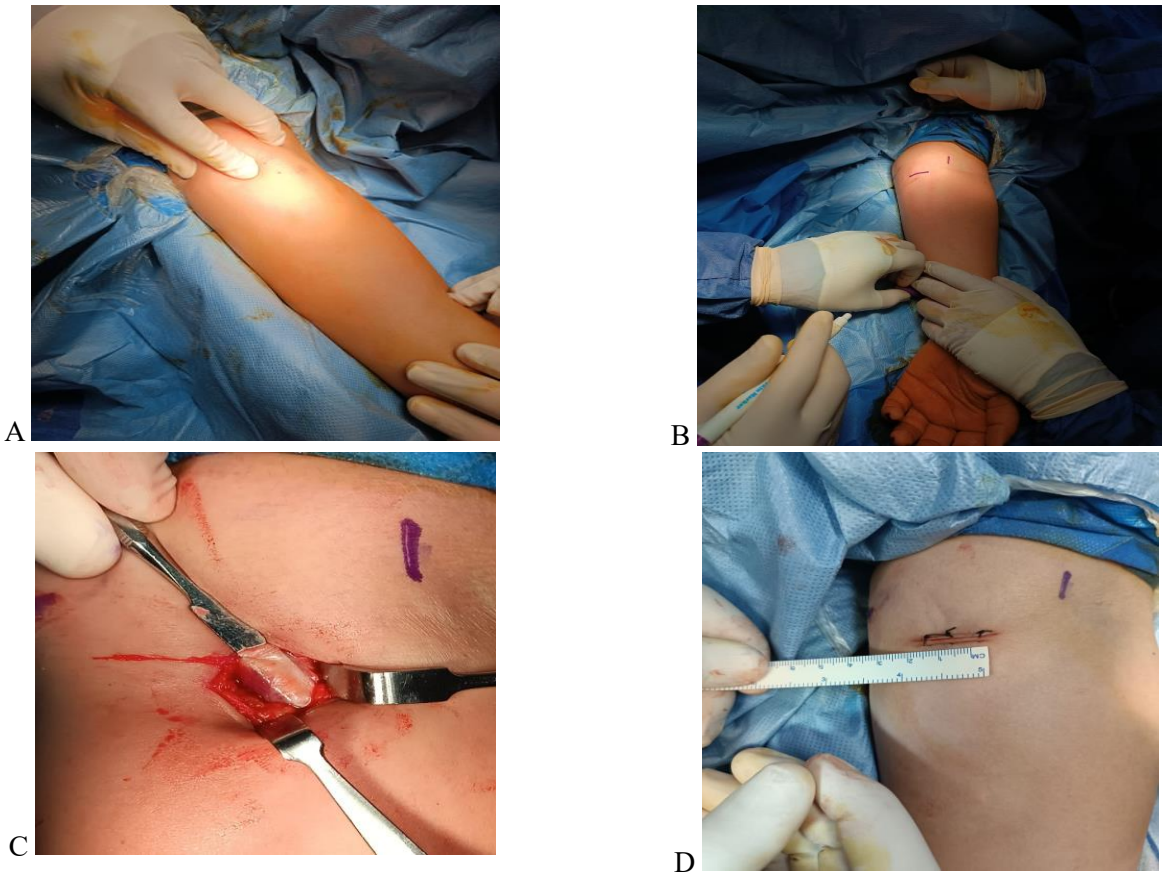
RESULTS

Over a two-year period, a total of 28 lacertus releases were recorded. After excluding patients who had undergone simultaneous decompression of other nerves (radial or ulnar nerve decompression). Among these, 20 cases (71.4%) were isolated LR, and 8 patients (28.5%) were associated both LR and carpal tunnel releases. Study demographic criteria are detailed in **Table 1.** The most frequently reported symptoms among patients with LS included diminished strength of the hand (96.7%), reduced endurance or hand fatigue (74.4%), and pain of the forearm (36.5%). All individuals with associated LS and CTS experienced numbness in the median nerve distribution of the hand. However, numbness was observed in only 11.3% of patients with isolated LS, primarily localized to the median cutaneous palmar branch distribution or tips of the radial three fingers. **Figure (2)** shows symptoms distribution. Preoperative DASH scores, including activity and work subscores, were collected from 28 patients. The average pre-operative DASH score was 35.5 (range 3.4–85.2), while the activity DASH averaged 54.9 (range 0–100), and the work DASH averaged 35.3 (range 0–100). Post-operatively, the average quick-DASH score significantly decreased to 13.5 (range 0–63.6), mean improvement of 24, with a highly significant statistical difference ($p < 0.001$).

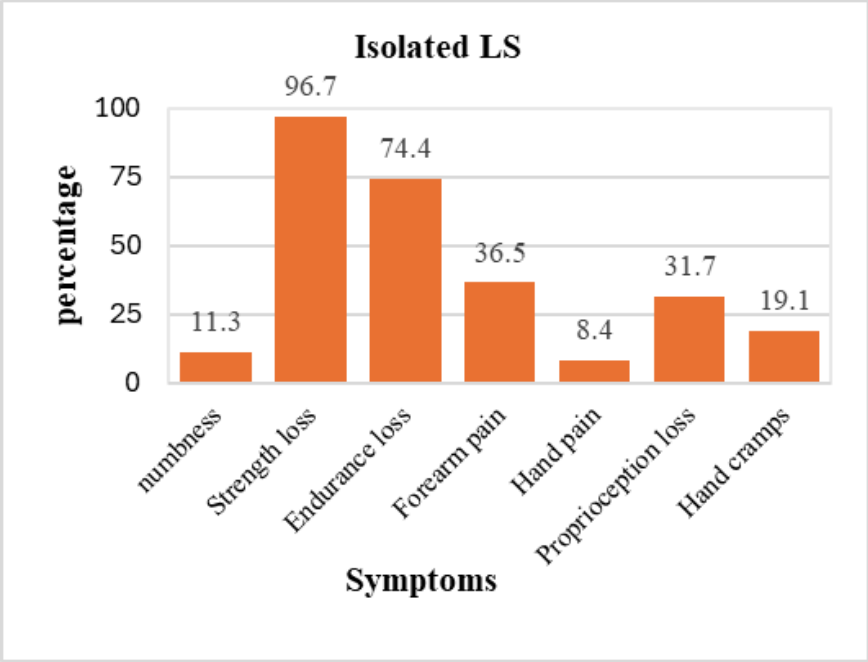
Likewise, the activity and work DASH subscores showed significant reductions to 20.6 (range 0–69.8) and, 9.5 (range 0–76) correspondingly ($p < 0.001$). **Figure (3)** shows Quick DASH and subscores. Postoperative VAS scores averaged 1.7 for pain, 1.9 for numbness, and 8.6 for operative outcome satisfaction. Notably, 89% of patients reported good to excellent satisfactory results, while only one individual (3.5%) was dissatisfied. Subsequent evaluation revealed that the unsatisfied patient had additional remaining compression of the median nerve at the superficialis arcade that necessitated a revision. A total of 28 procedures were performed using WALANT (wide awake, local anesthesia, without the use of a tourniquet whenever possible), which allowed for the immediate intraoperative assessment of strength restoration in the FDP II FCR, and FPL muscles after LR. Intraoperative strength recovery was confirmed in 27 patients (96.4%). The one exception involved complete anterior interosseous nerve palsy (affecting the FPL and FDP II), but the patient regained full strength within ten weeks post-surgery.

Table (1) Demographic criteria

Variables data	*Number and percentages*	
Age (years), mean (range)	48 (35-69)	
Gender	Males 13 (46.4%)	Females 15 (53.6%)
Side affected	Dominant 22 (78.6%)	Non dominant 6 (21.4%)
Manual labour	23 (82.1%)	
Pronation labour	19 (67.9%)	



Figure(1) A: Tripod grip to define anatomical structures, **B:** landmarks drawn, **C:**Lacertus fibrosus elevated, **D:** closure.



A

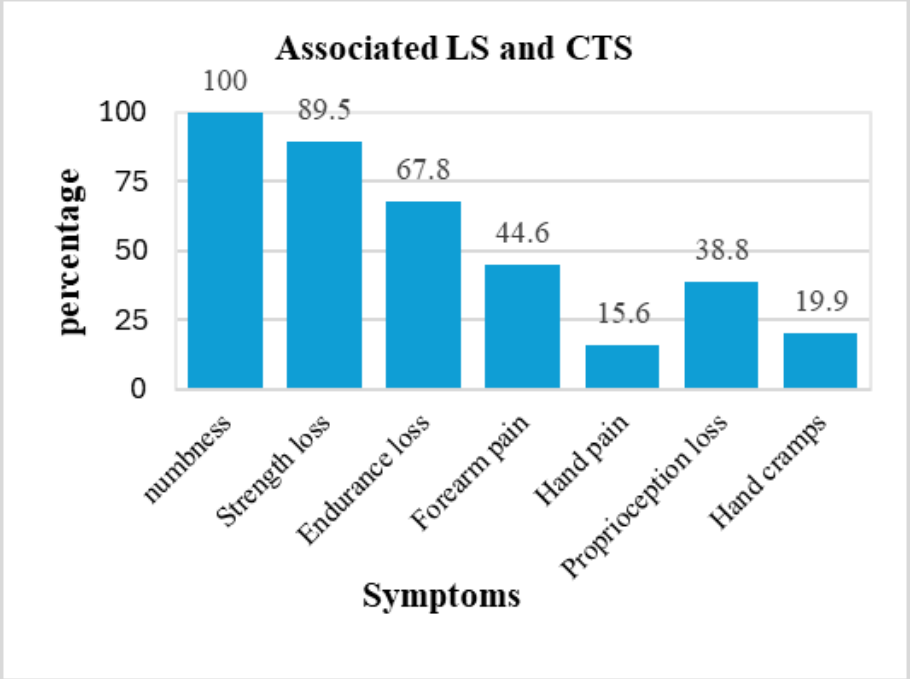


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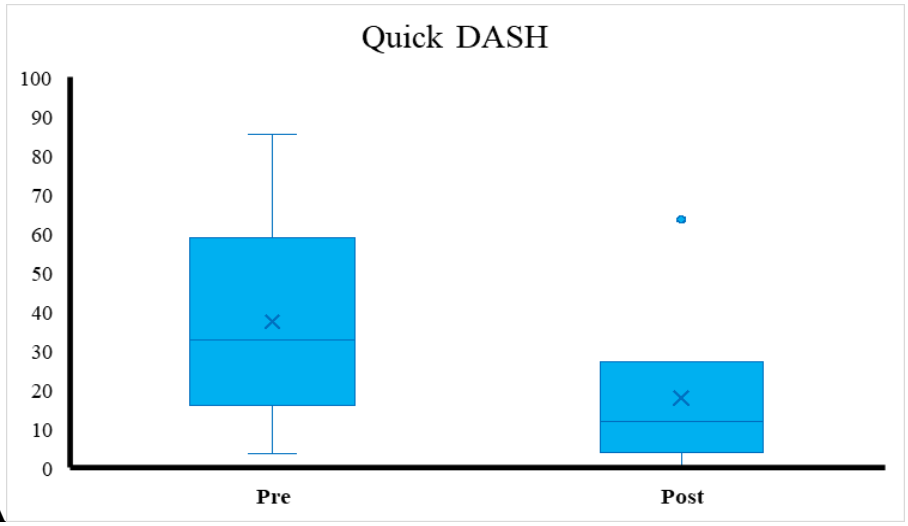
Figure (2): A:presenting symptoms in isolated LS **B:** Associated LS and CTS.



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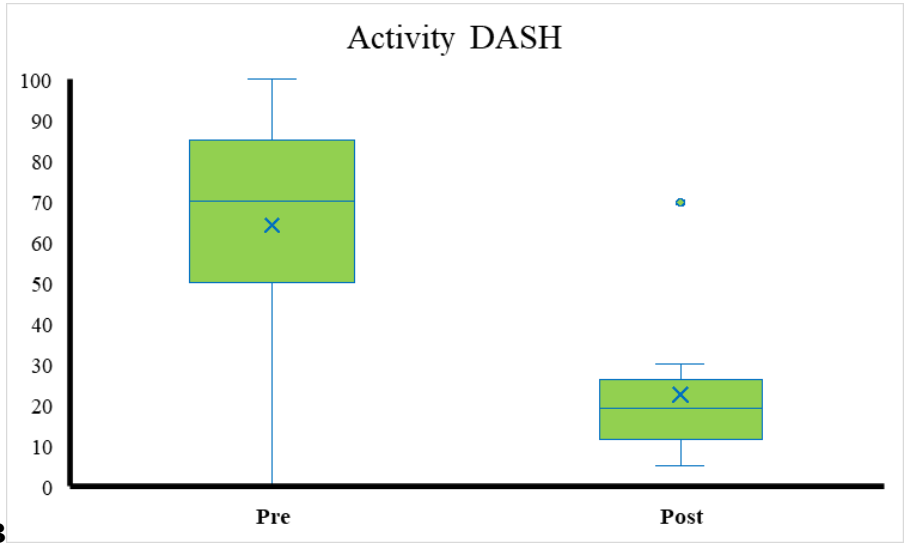

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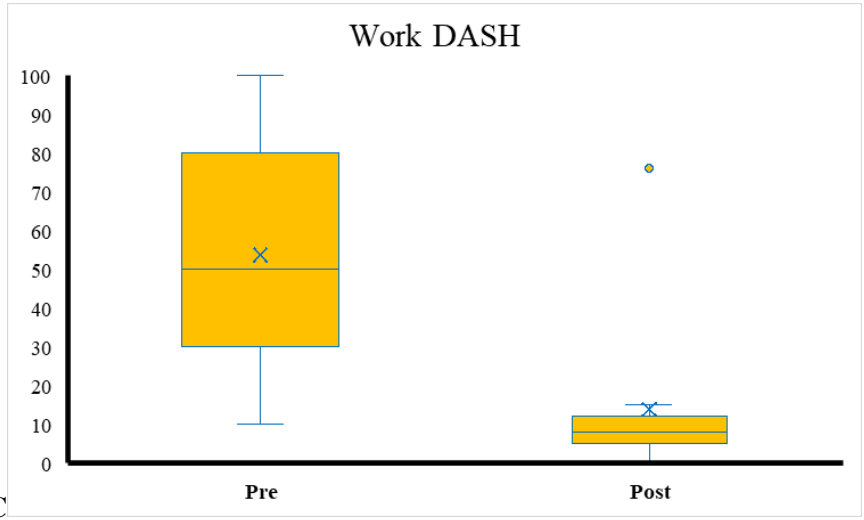

C

Figure (3): Box and whisker plots showing pre and post-operative **A:** quick-DASH, **B:** activity DASH scores , **C:**work DASH, ☒ show the average, and dots • show the outliers.

DISCUSSION

The study's key outcomes reveal that median nerve compression at the lacertus fibrosus (LF) is not an uncommon entrapment disorder. Releasing the lacertus fibrosus leads to substantial improvement in Quick-DASH scores and its subcategories, as well as reductions in VAS (pain, numbness), and enhanced patient satisfaction with the surgical procedure after a minimum follow-up period of 12 months. Additionally, the strength of the hand is nearly fully restored in 96.4% of patients intraoperatively. A thorough clinical evaluation focusing on strength in cases of entrapments of the peripheral nerve has identified a higher occurrence of dynamic compression that does not exhibit electromyographic changes (classified as Sunderland grade zero neuropathic compression). This highlights the importance of performing such examinations routinely [16–21]. The findings from this study indicate that patients with isolated lacertus syndrome commonly report symptoms of reduced hand strength and diminished hand endurance or fatigue. Additionally, if numbness is observed in the median nerve distribution, it should prompt consideration of associated carpal tunnel syndrome (CTS). Similarly, Binder et al. [16] in a cohort retrospective study involving 26 patients who had pronator syndrome found that 38.5% of them had an additional previous history of carpal tunnel release., so Patients who experience partial symptomatic relief following carpal tunnel release should be evaluated for possible concomitant LS. Likewise, El-Haj et al. [18], in a retrospective review of 27 patients who had PMNE decompression, observed a similar case scenario in 48% of them. The varied prevalence of insufficient symptom relief following CTS release across the literature can be attributed to the absence of a standard diagnostic algorithm. As a result, PMNE motor affection often goes underdiagnosed, and differential diagnoses tend to overlook associated double crush conditions, focusing instead on sensory deficits [10, 22]. Yet our clinical awareness of PMNE and lacertus syndrome was evolving when we started this study, so to avoid multiple factors that can confuse our perception of the condition and the outcomes, we focused on primary cases either isolated LS or associated LS and CTS excluding revision cases or previous unsatisfactory CTS releases. Most literature on PMNE including LS has demonstrated favorable surgical outcomes. Binder et al. observed substantial improvements in DASH scores (from 48.7 ± 15.5 preoperatively to 22.8 ± 18.4 postoperatively, $p < 0.01$) and VAS scores (from 8 ± 1 preoperatively to 0.7 ± 1.4 postoperatively, $p < 0.01$) following PMNE open decompression in a group of 12 patients over an average follow-up of 75 months. In a similar study, Lee et al. [23] reported comparable results after performing endoscopic assisted pronator syndrome decompression in 12 patients, with a mean improvement of 51 points in the DASH score (from 57 preoperatively to 6 postoperatively, $p < 0.05$) at an average follow-up of 22 months. Likewise, Apard et al. [17] conducted a prospective evaluation on 15 patients who underwent ultrasound-assisted percutaneous LR, which resulted in VAS score reduction significantly (from 6.2 preoperatively to 0.6 postoperatively, $p < 0.001$) at 4 weeks post-surgery, along with immediate restoration of muscle strength in all patients. This study demonstrates well-matched outcomes when using a minimally invasive (mini-open LR, achieving improvements that surpass the minimum important clinical difference in the quick DASH score [24, 25]. However, the exact key anatomical structure involved in PMNE remains a point of debate, as there are not enough studies comparing different surgical approaches addressing different anatomical structures. By showing that 96.4% of patients experienced an immediate post-operative return of strength following LF release, our research provides valuable insight into the role of the lacertus fibrosus in PMNE. In the current study's 28 cases, only one patient experienced simultaneous compression at the superficialis arcade, leading to one revision release surgery to the median nerve at such a level. Symptoms of superficialis arcade compression included pain about 3 cm distal to the Lacertus fibrosis, along with weakness in the flexor digitorum superficialis affecting the ring and middle fingers—this weakness was absent when the compression was solely at the LF. While pronator involvement was not clear in this cohort, it is noteworthy that 19 patients (67.9%) reported performing work that involved pronation for at least six hours a day. Theoretically, the explanation is that most PMNE is attributed to the pronation dynamic act rather than the pronator muscle itself, so it should be called pronation syndrome instead of pronator syndrome, yet this needs further evidence to be well established. Ultrasound (US) evaluation of the median nerve prior to surgery could help differentiate between the potentially distinct, yet, rare sites of PMNE compression. US is a proven tool for

diagnosing carpal tunnel syndrome [26], and it has also been suggested as a method for US-assisted median nerve release at both the CTS and the LF [17, 27, 28]. However, there is currently no standard protocol for using US to assess the median nerve above the carpal tunnel. This study does have some limitations. First, the short follow-up period was due to the rapid recovery and improvement of symptoms observed after the surgery, which led to patients not attending subsequent visits. Second, the study was devoid of electromyographic tests. However, as noted by other researchers, electromyography has little value in diagnosing this condition due to the dynamic type of compression of the LS [19–21, 30]. Finally, while strength loss was assessed qualitatively, this was balanced by a comparative intraoperative strength evaluation both before and after the release. Future research should focus on examining the normal and pathological appearance of the median nerve via ultrasound from Struther's arcade at the distal upper arm to the superficialis arcade at mid-forearm, specifically evaluating nerve structure integrity and size. Future research also should focus on the prevalence of this syndrome and the use of dynamic quantitative tests for its diagnosis. Also, prospective randomized controlled studies on one hand, and comparative studies on the other hand with larger sample sizes and standardized diagnostic algorithms are needed to establish solid awareness among surgeons for such underestimated syndrome.

CONCLUSION

Lacertus syndrome (LS), is a less frequently occurring condition caused by proximal compression of the median nerve at the elbow, and characterized by diminished hand muscle strength and reduced endurance or fatigue. Minimally invasive surgical management of LS with follow-up periods of at least twelve months has been shown to provide immediate restoration of hand muscle strength, substantial improvements in DASH scores, and favorable outcomes in terms of (VAS) pain, numbness, and patient satisfaction.

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Citation

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