Journal of Hand Surgery Global Online 5 (2023) 498–502

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Original Research

Lacertus Syndrome: an Outcome Analysis After Lacertus Release

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ARTICLE INFO

Article history:
Received for publication April 29, 2022
Accepted in revised form March 1, 2023
Available online April 7, 2023

Key words:
Lacertus fibrosis
Lacertus syndrome
Median nerve compression
Pronator syndrome
Wide-awake local anesthesia no tourniquet

Purpose: The lacertus fibrosus or bicipital aponeurosis is a sheet of ligamentous tissue just distal to the elbow joint and can be a compression point for the median nerve. Essentially, lacertus syndrome is a subset of pronator syndrome and an uncommon diagnosis by itself. Surgical release of the lacertus consists of a small 2-cm incision that can be performed under local anesthesia. This study aimed to evaluate the outcome of lacertus release in resolving median nerve symptoms.

Methods: This retrospective study was performed at Prince Court Medical Centre, Kuala Lumpur, Malaysia, from January 2020 until June 2021. Ninety-three patients who presented with numbness of fingers, hand, or upper limb; forearm pain; and muscle weakness. They were diagnosed with lacertus syndrome on the basis of local tenderness at the lacertus fibrosus with either weakness of flexor pollicis longus and flexor digitorum profundus of the index finger or paresthesia over the thenar eminence. The patients underwent 3 months of hand therapy, and those with no symptom improvement were offered lacertus release performed by a single surgeon. The surgical technique consists of a surgical incision starting from a point 2 cm distally and 2 cm radially to the medial epicondyle. The incision projects 2 cm distally in an oblique fashion toward the radial styloid. A wide-awake local anesthesia no tourniquet (WALANT) technqiue was utilized and 20 mL of local anesthesic was injected subcutaneously around this region at least 20 minutes before the surgery. Careful dissection was made subcutaneously, and the lacertus fibrosus was identified as a thickened, shiny white structure and released. The Quick Disabilities of the Arm, Shoulder, and Hand (*Quick*DASH) score, grip strength, and pinch strength were tested before and after surgery. At 6 months after surgery, the *Quick*DASH score was again assessed with a WALANT satisfactory questionnaire.

Results: A total of 93 patients were included in the study. The mean age of the patients was 38.7 years, and most were women (77.4%). The mean operating time was 70 minutes. The mean preoperative *Quick*DASH score was 53, which significantly reduced immediately after surgery to 7.8 ($P < .001$) and remained low at 6 months after surgery (10.6). The mean grip strength showed a significant increase from a preoperative mean of 16 kg to a postoperative mean of 24 kg ($P < .001$). Pinch strength also significantly increased from a preoperative mean of 9 kg to 13 kg after surgery ($P < .001$).

Conclusions: Lacertus syndrome remains an underdiagnosed disease that can be treated efficiently with a directed minimal surgical incision under wide-awake local anesthesia. Lacertus release appears to significantly reduce pain and numbness with markedly improved hand grip and pinch strength. The corresponding *Quick*DASH scores also improved significantly after surgery. This study is vital to our understanding of proximal median nerve entrapment and to accurately diagnose it.

Type of study/level of evidence: Therapeutic III.

Pronator syndrome is a condition where the upper part of the median nerve can be compressed at various points. The lacertus is one of these points and consists of a sheet of ligamentous tissue (lacertus fibrosus [LF] or bicipital aponeurosis) just distal to the elbow joint.[1] Essentially, lacertus syndrome (LS)

Declaration of interests: No benefits in any form have been received or will be received related directly to this article.

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https://doi.org/10.1016/j.jhsg.2023.03.001

Table 1
Comparison Between Carpal Tunnel Syndrome, LS, and Pronator Syndrome

	Carpal Tunnel Syndrome	Lacertus Syndrome	Pronator Syndrome
Numbness	Tips of the fingers	Fingers and palms, including thenar eminence	Fingers and palms, including thenar eminence
Pain		Forearm ache	Forearm ache
Weakness	Abductor pollicis brevis and opponens pollicis	Flexor pollicis longus and flexor digitorum profundus of index finger	Flexor pollicis longus and flexor digitorum profundus of index finger
Tenderness on palpation		Over the lacertus fibrosus	Over the pronator region or FDS arch
Compression eliciting numbness or worsening numbness	Over the carpal tunnel (Durkan compression test)	Over the lacertus fibrosus	Over the pronator region or FDS arch
Other symptoms		May be associated with shoulder or neck pain	
Other possible tests		Resisted elbow flexion with forearm supination	Resisted forearm pronation with elbow extended resisted contraction of FDS of middle finger

is a subset of pronator syndrome and an uncommon and controversial diagnosis.

Lacertus syndrome is a proximal median nerve entrapment (PMNE) at the level of the elbow. It has been considered an elusive and rare diagnosis, and the prevalence of LS is unclear.[2] It relies on clinical symptoms and physical examination as it is hard to detect using electrodiagnostic techniques, such as electroneuromyography and nerve conduction studies, to establish diagnosis.[3] The LF, as the only compressing structure on the median nerve, has been mentioned in various studies on pronator syndrome.[1,2,4–8]

Hagert[2] reported on 44 patients with median nerve compression by only the LF. The author performed lacertus release with significant recovery. The phrase “lacertus syndrome” was used on the basis of the following clinical manifestations: (1) weakness in muscles innervated by the median nerve distal to the LF, ie, in flexor pollicis longus (FPL); (2) flexor digitorum profundus (FDL)-II, and flexor carpi radialis (FCR); (3) pain on pressure over the median nerve at the level of the LF, and (4) a positive scratch collapse test.[2] It is essential to distinguish it from carpal tunnel syndrome because it often has similar clinical manifestations; carpal tunnel syndrome will not have tender points over the lacertus or pronator region, the numbness will be confined to the fingers only without involving the palm, and there will be no weakness of the FPL, FDP-II, or FCR. The difference between carpal tunnel syndrome, LS, and pronator syndrome is clearly outlined in Table 1. However, the literature review on LS is sparse compared with its distal entrapment and carpal tunnel syndrome.

Lacertus syndrome release can be performed under local anesthesia, namely wide-awake local anesthesia no tourniquet (WALANT), which is a quick surgery under daycare or clinic conditions that is performed with just a 2-cm small incision, has no hospitalization or general anesthetic risk, and allows the surgeon to examine during surgery and determine the immediate outcome.[1,2,8] It is also an efficient option, especially during the COVID-19 pandemic.

Apart from Hagert’s[2] study in 2013, there appears to be limited studies on lacertus release. We hypothesized that releasing the lacertus fibrosis would resolve signs and symptoms of upper median nerve entrapment. The objective of this study was to evaluate patients diagnosed with LS and their outcomes after release.

Materials and Methods

This retrospective study was performed at Prince Court Medical Centre from January 2020 until June 2021. We obtained approval from the ethical committee of the medical center on August 29, 2021 (ECG/PCMC/008). A total of 93 patients who underwent lacertus release by a single surgeon were reviewed. Data collected from medical records included patient demographics and presenting complaints, such as numbness of fingers, hand, or upper limb; forearm pain; and muscle weakness. Inclusion criteria were patients with a diagnosis of LS on the basis of the following criteria during physical examination: (1) local tenderness at the LF, (2) weakness of FPL and FDP of the index finger, (3) paresthesia over the thenar eminence, and (4) pain on resisted elbow flexion in 90° full supination. All patients had positive signs of local tenderness at the LF, weak FPL, and FDP of the index finger. Some patients presented with thenar eminence paresthesia, and a few with pain on resisted elbow flexion in 90° full supination.

The flexor digitorum superficialis (FDS) arch area was also examined, which is located 2 cm distal and 2 cm radial to the LF. Patients with tenderness at the FDS arch were also included, provided the pain at the lacertus region was worse than the FDS arch region. If the pain worsened at the FDS arch, the patient was excluded from the study. A further inclusion criterion included patients who failed hand therapy after 3 months or more.

The exclusion criteria were patients with other differential diagnoses, such as carpal tunnel syndrome, cervical nerve root compression, thoracic outlet syndrome, neuromuscular abnormalities, or those with nerve compression surgery, such as carpal tunnel release. All patients who fulfilled the inclusion criteria were offered lacertus release surgery, and once agreed, consent was obtained from each patient for the study and surgery.

The diagnosis of LS is purely on the basis of history and clinical examination; therefore, there was no requirement for investigations, such as nerve conduction study, electromyography, and ultrasound.

Before surgery, all participants had their grip and pinch strength tested using a dynamometer and pinch meter, respectively. Participants completed the Quick Disabilities of the Arm, Shoulder, and Hand (*Quick*DASH) and visual analogue scores for pain.

Surgical method

The surgery was performed under WALANT and without the tourniquet technique by a single surgeon, (A.A.A.), in a daycare setting. A wide-awake local anesthesia no tourniquet solution comprised of 1% lignocaine mixed with 1:100,000 adrenaline with sodium bicarbonate. The LF was identified by palpating the distal biceps tendon and feeling a dense ligament located in the deep fascia of the forearm (Fig. A). First, we palpated the medial epicondyle. Then, a point that was 2 cm distal and 2 cm radial to the medial epicondyle was marked, which was the starting point of the

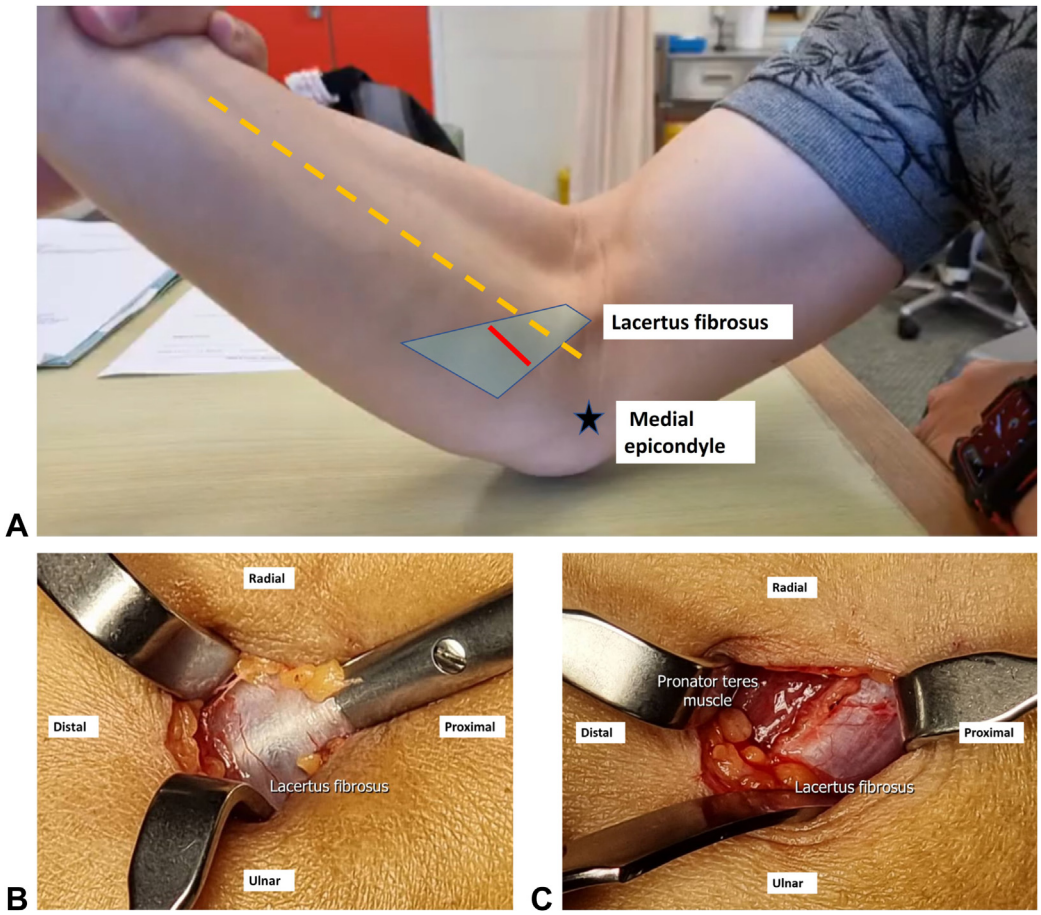

Figure. **A** The surgical incision is located 2 cm distally and 2 cm radially from the medial epicondyle. The surgical incision (red) was 2 cm in length in an oblique direction toward the radial styloid. The LF is a shaded light blue–shaded quadrangle. The median nerve (yellow dotted line) is underneath the LF. **B** A close-up view of the LF before release. **C** After release of LF showing the pronator teres muscle. Note that the median nerve will not be visualized unless the pronator teres muscle is forcefully retracted ulnarly.

incision. The incision projected 2 cm distally in an oblique fashion toward the radial styloid. The WALANT solution was injected subcutaneously around this region at least 20 minutes before the surgery. Careful dissection was made subcutaneously, taking great care to identify and protect branches of the medial antebrachial cutaneous nerve. The LF was identified as a thickened, shiny white structure (Fig. B). On release of the lacertus, the pronator muscle could be visualized (Fig. C). Notably, the median nerve was not visualized unless there was a forceful retraction of the pronator teres muscle ulnarly.

The FPL, FDP-II, and FCR were immediately tested to observe for any increase in muscle power. The patients' grip and pinch strength were also obtained, and patients were asked if they felt any relief from pain or numbness.

After surgery, the patients had a compression bandage for 2 days and allowed the full range of motion as tolerated. Patients were followed up at 6 weeks, 3 months, and 6 months. At 6 months, they completed a *Quick*DASH score and WALANT satisfactory questionnaire.

The *Quick*DASH is a shortened version of the original DASH and consists of an 11-item questionnaire instead of 30 items.[9] It was developed by Beaton et al[10] to produce a short, reliable, and valid measure of hand function and symptoms related to upper limb musculoskeletal disorder. It produces a comparable and efficient result compared with the original DASH score. Moreover, *Quick*-DASH is free for noncommercially related research and nonprofit use, and is available in Bahasa Malaysia.[11]. The permission is available online.[12] Data that were available were analyzed using Wilcoxon signed-rank test and Mann-Whitney U test.

Table 2
Comparisons Between Before Surgery and Immediately and 6 Months After Surgery for DASH Scores and Grip and Pinch Strength

	Before surgery	After surgery (Immediate)	After surgery (6 mo)
	DASH Score	DASH Score	DASH Score
n	*93*	*92*	*45*
Mean	53.1	7.9	10.6
SD	21.9	8.0	13.9
	Grip (kg)	Grip (kg)	
n	*86*	*88*	
Mean	16.41	24.3	
SD	15.77	16.0	
	Pinch (kg)	Pinch (kg)	
n	*87*	*88*	
Mean	9.7	13.4	
SD	4.4	4.7	

Results

A total of 93 patients met the inclusion criteria. The mean age of patients was 38.7 years, and 77.4% were women. The mean DASH score was 53.1 before surgery and reduced to 7.9 immediately after

Table 3
Tests of Normality, Percentiles, and Comparison of Preoperative and Postoperative DASH Scores and Grip and Pinch Strength

	Shapiro-Wilkinson		
	Statistic	df	*P* value
DASH score (before surgery)	0.966	44	.210
DASH score (after surgery)	0.847	44	<.001
DASH score (6 mo after surgery)	0.773	44	<.001
Grip (before surgery)	0.783	44	<.001
Grip (after surgery)	0.829	44	<.001
Pinch (before surgery)	0.952	44	.065
Pinch (after surgery)	0.905	44	.002

		Percentiles		
	N	25th	Median	75th
DASH score (before surgery)	93	36.1	53.3	70.0
DASH score (after surgery)	92	1.1	5.8	11.9
Grip (before surgery)	86	5.0	10.0	20.0
Pinch (before surgery)	87	7.0	10.0	11.0
DASH score (6 mo after surgery)	45	0.0	4.2	13.7
Grip (after surgery)	88	10.5	20.0	30.0
Pinch (after surgery)	88	10.0	12.5	16.0

		Mean	N	SD	Mean Difference	*P* value
Pair 1	DASH score (before surgery)	53.1	92	22.0	45.2	<.001
	DASH score (after surgery)	7.9	92	8.0		
Pair 2	DASH score (before surgery)	48.9	45	22.7	38.3	<.001
	DASH score (6 mo after surgery)	10.6	45	13.9		
Pair 3	DASH score (after surgery)	8.9	45	8.9	1.8	.741
	DASH score (6 mo after surgery)	10.6	45	13.9		
Pair 4	Grip (before surgery)	16.4	86	15.8	7.6	<.001
	Grip (after surgery)	24.0	86	116.0		
Pair 5	Pinch (before surgery)	9.7	87	4.4	3.6	<.001
	Pinch (after surgery)	13.3	87	4.7		

df, degrees of freedom.

surgery. At 6 months, only 45 patients completed the DASH questionnaire, with the DASH score remaining low at 10.6 (Table 2). The grip strength increased from a preoperative mean of 16.4 to a postoperative mean of 24.3, and pinch strength increased from a preoperative mean of 9.7 to 13.4 after surgery (Table 2). We obtained the body mass index in 62 patients and the mean was 27.3 (SD, 6.70).

Comparison of the DASH score between before surgery and immediately after surgery and 6 months after surgery was significant ($P < .001$). Comparison of grip and pinch score between before and after surgery was also significant, with $P < .001$ (Table 3).

For the WALANT satisfactory questionnaire (Table 4), only 44 patients responded. The first question (Q1) revealed that 86% of patients would select WALANT as their choice of anesthesia for subsequent surgery. Compared with a dental procedure in question 2 (Q2), 65% claimed that WALANT was less painful. Most patients felt that the anesthesia lasted for approximately 3–6 hours (52.3%), followed by 6–10 hours (38.6%), and lastly, 1–2 hours (9%). When asked about the overall experience, 81% responded “better than expected” using the WALANT technique. In addition, 86% will recommend WALANT to someone with the same experience (Q5). For question 6 (Q6), regarding residual symptoms after WALANT, 11 patients experienced residual numbness, 4 had pain, and 1 had weakness but all had resolved by 6 months. However, the length of time required for these symptoms to resolve was not mentioned in the responses.

Discussion

In earlier studies, a tight LF was considered part of the pronator syndrome. Of 71 patients in Johnson et al's[4] article, only 2 had a tight lacertus. Hartz et al[5] reported 15 patients with pronator syndrome with a tight lacertus. Swigget and Ruby[6] reported three cases where the lacertus appeared to be the sole cause of the proximal median nerve compression. However, they differ on the basis of symptoms; Hartz et al's[5] patients had numbness in the thumb and index finger with no motor loss compared with Swiggett and Ruby's[6] patients with only motor symptoms but no sensory loss. Swiggett and Ruby[6] suggested that the median nerve anatomy has motor fibers located superficially; therefore, a mild compression will result in only motor loss, whereas the sensory fibers are located deeper in the center; therefore, sensation would not be affected. This theory agreed with Hagert,[2] who proposed a clinical triad to diagnose PMNE at the LF level described as follows: (1) weakness in muscles innervated distal to the LF (FCR, FPL, and FDP-II), (2) pain over the point of compression (lacertus level), (3) and a positive scratch collapse test.[2]

The most common complaints in patients with LS are a loss of key and tip pinch strength, a loss of fine motor skills and sense of clumsiness (dropping objects), and, rarely, transient paresthesias in the median nerve innervated region of the hand (thumb-radial aspect of the ring finger).[2] The area of tenderness is best ascertained by pressing the tip of the thumb under the leading (proximal) edge of the lacertus rather than pressing over it.[1,8] Patients with LS also present with aching forearm pain. Table 1 compares carpal tunnel syndrome, pronator syndrome, and LS.

Furthermore, LS in the elbow of throwing athletes (eg, baseball pitchers) is considered more common than pronator syndrome.[7] However, forearm pain after exertion or throwing items is similar to exertional compartment syndrome. Resting will resolve the pain as time progresses, and the duration of resting required becomes progressively longer.

As described by Mackinnon and Novak,[13] PMNE has traditionally been described as an elusive diagnosis, where all seven possible

Table 4
Wide-Awake Local Anesthesia No Tourniquet Satisfaction Questionnaire

	Question	n	%
1	If you had to have hand surgery again and were given a choice, would you prefer to be	44	
	a) Wide awake	38	86.4
	b) Sedated	3	6.8
	c) Completely asleep	3	6.8
2	How did WALANT compare to having a procedure at a dentist?		
	a) Do not know (never had a dental procedure)	9	20.5
	b) Less pain	29	65.9
	c) Same	4	9.1
	d) More pain	2	4.5
3	How long did the anesthetic last?		
	a) 1–2 hs	4	9.1
	b) 3–6 hs	23	52.3
	c) 6–10 hs	17	38.6
4	How was the overall experience of your hand surgery?		
	a) About what you expected	8	18.2
	b) Better than expected	36	81.8
5	Would you recommend WALANT?*		
	a) Not sure	1	2.3
	b) Probably	5	11.6
	c) Definitely	37	86.0
6	Residual symptoms after surgery†		
	a) None	17	51.5
	b) Numbness	11	33.3
	c) Pain	4	12.1
	d) Weakness	1	3.0

Of 93 patients, 44 responded to the questionnaire.
* Of 44 patients, only 43 patients responded.
† Of 44 patients, only 33 patients responded.

points of nerve compression from the mid-upper arm to the mid-forearm should be released through a large S-shaped incision. The scar length is usually 5–6 cm and can be technically demanding, resulting in a large surgical scar and higher morbidity. Additionally, surgery has to be performed under general anesthesia. In our surgical technique, we believe a 2-cm oblique incision is adequate on the basis of a study by Snoeck et al,[14] which is an anatomical study of 24 cadavers showing a mean superior LF width of 0.9 cm (maximum, 1.6 cm), central LF width of 1.2 cm (maximum, 1.9 cm), and inferior LF width of 1.0 cm (maximum, 2.1). Therefore, a 2-cm oblique skin incision is adequate to release the LF and elicit immediate relief of the patient's symptoms.

A recent article by Tang[8] agrees that LS is commonly missed, as many surgeons focus only on carpal tunnel syndrome. Some are hesitant even to perform a release as this is a pronator release with a large incision. This article emphasizes LF and FDS arch as the main culprit in median nerve compression rather than the pronator muscle, suggesting the term "superficialis-pronator syndrome" rather than the more common pronator syndrome. The only differentiating factor between both syndromes would be the area of tenderness. Sunderland[15] also mentioned that there are likely to be two areas of compression: (1) at the superficialis arcade (superficialis syndrome) level and (2) the lacertus.

Possible surgical complications that might arise from the release are superficial brachial artery and persistent median artery injury, as demonstrated in a study using dissection of the cubital fossa in 75 cadavers.[16] There is also a possibility of "unmasking" other nerve compressions with anecdotal experience where patients after lacertus release begin complaining of carpal tunnel symptoms or cervical symptoms since most of these patients have a double or triple crush phenomenon.

There is no specific postoperative rehabilitation regime for patients after lacertus release, but patients with no manual labor can return to work within 1–2 days after surgery.[1]

In our results, the preoperative *Quick*DASH score was high, with a mean of 53.1; this was for an upper median nerve compression compared with carpal tunnel syndrome, which is a low median nerve compression with less disability. With a significant reduction in the preoperative mean *Quick*DASH score from 53.1 to an immediate postoperative DASH score of 7.9 ($P < .01$), our hypothesis was confirmed that lacertus release would result in a resolution of signs and symptoms of upper median nerve entrapment.

Limitations of this study include a moderately short follow-up of 6 months. There might be a possibility of symptoms recurring 1–2 years later. The surgery was performed by a single surgeon, and although it is good to prevent interobserver/intersurgical bias, it may not be reproducible by other surgeons. Of 93 patients, only 45 agreed to complete the *Quick*DASH score questionnaire. Since the study was performed in a private hospital, we were unable to ascertain whether symptoms recurred and whether patients sought treatment elsewhere due to financial reasons.

Conclusions

Lacertus release remains an underdiagnosed disease that can be treated efficiently with a minimal surgical incision. Lacertus release under wide-awake local anesthesia significantly reduces numbness with markedly improved hand grip and pinch strength. The corresponding *Quick*DASH scores also improved markedly after surgery. This study is vital to our understanding of PMNE and to accurately diagnose it.

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