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Surgical Management of Distal Biceps Tendon Anatomical Reinsertion Complications: Iatrogenic Posterior Interosseous Nerve Palsy

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Data Interpretation D
Manuscript Preparation E
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Background: Although iatrogenic posterior interosseous nerve (PIN) palsy is an uncommon complication of ruptured distal biceps brachii tendon surgical anatomical reinsertion, it is the most severe complication leading to functional limitation. The present study investigated possible types of PIN palsy as a postoperative complication of anatomical distal biceps tendon reinsertion, and aimed to clinically assess patients at 2 years after its surgical treatment.

Material/Methods: The studied sample comprised 7 male patients diagnosed with an iatrogenic PIN palsies after anatomical reinsertion of the distal biceps tendon, who were referred to the reference center for management of a peripheral nervous system injury. The nerve injury was intraoperatively evaluated. The clinical assessment used the Medical Research Council (MRC) System for motor recovery, and the Quick Disability of the Arm, Shoulder, and Hand (Quick DASH) was performed before the surgical treatment of the PIN injuries and at 2 years postoperatively. In all studied cases, electromyography was performed preoperatively and postoperatively.

Results: The comparison of the preoperative (x=1.43±0.53) and postoperative (x=4.71±0.49) results of the motor recovery of the PIN demonstrated a statistically significant improvement ($p<0.001$). Moreover, the results of functional assessments with the use of the Quick DASH questionnaire significantly improved ($p<0.001$) postoperatively (x=6.14±6.86) compared to the preoperative evaluations (x=54.29±12.05).

Conclusions: The PIN palsies as complications of the surgical anatomical reinsertion of ruptured distal biceps brachii resulted from mechanical nerve compression or direct intraoperative damage. The 2-year outcomes justified the clinical use of surgical management for iatrogenic PIN palsy.

MeSH Keywords: Iatrogenic Disease • Nerve Compression Syndromes • Peripheral Nerve Injuries

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Background

Ruptures of the distal biceps brachii tendon are relatively infrequent and occur, on average, in 1.2 cases per 100 000 patients per year [1], which amounts to approximately 3% of all biceps tendon injuries [2]. The ruptures in the vast majority of cases occur in the dominant limb in males in their fourth to fifth decades of life [3] or during an excessive eccentric contraction of the biceps brachii with the flexed and supinated forearm [4]. Distal biceps tendon rupture management options include nonoperative or operative treatment. However, without surgical treatment of the rupture, patients are left with weakness in the forearm flexion and supination; thus, early surgical anatomical reinsertion is the criterion standard for physically active patients [5]. The best surgical approaches involving single and double incision [6], as well as fixation techniques such as suture anchors [7–9], bone tunnels, interference screws [10,11], and cortical buttons [12–14], remain debatable issues [15].

Postoperative complications occur after 16% to 40% cases of ruptured distal biceps brachii tendon reinsertions [16–19]. The main neurological complications involve superficial forearm sensory disturbances as a sign of a lateral antebrachial cutaneous or superficial radial nerve palsy; they are uncomfortable for patients but generally do not affect the functional outcome. In line with the literature, although PIN palsy occurrence is relatively infrequent, affecting 1% to 5% of patients after anatomical distal biceps reinsertion [18–22], it is the most severe neurological complication because it leads to an inability to perform finger and thumb extension [22].

The aim of this study was to investigate the possible types of PIN palsy as a postoperative complication of anatomical distal biceps tendon reinsertion, and to clinically assess patients 2 years after its surgical treatment.

Material and Methods

The present study was carried out in an academic clinical hospital and was performed according to the ethics guidelines and principles of the Declaration of Helsinki. All participants were informed about the goal of the study and the approach to be used. The study was approved by the local bioethics committee (KB – 515/2016), and written informed consent forms were signed by all of the participants.

The studied sample comprised 7 patients who were diagnosed with an iatrogenic PIN palsy following the anatomical reinsertion of a ruptured distal biceps tendon and who had been referred to the academic clinical hospital where the study was carried out as a reference center of peripheral nervous system injuries management in the years 2005–2015. All of the subjects were males. The characteristics of the studied sample in terms of age, operated and dominant limbs, and the time interval between the ruptured distal biceps brachii tendon reinsertion and the surgical treatment of the PIN injury performed in our clinic are presented in Table 1. All 7 patients underwent a surgical treatment of the PIN injury performed by 2 senior surgeons. The indications to the surgical treatment performed in our clinic were: 1) clinical signs of a PIN injury that occurred after anatomical reinsertion of a ruptured distal biceps tendon and persisted for at least 3 months postoperatively, and 2) the PIN injury was confirmed by needle electromyography (EMG). Based on the medical documentation of patients, immediately after the primary surgery, all of the patients complained of an inability to extend their fingers and thumb in the operated limb while maintaining active wrist extension.

The primary surgery: ruptured distal biceps tendon reinsertion

All of the studied patients underwent surgical primary unilateral anatomical reinsertion of the ruptured distal biceps tendon to the radial tuberosity performed in different hospitals outside our clinic. The surgical approaches in 5 patients were single incisions, and in 2 patients double incisions were used (Table 1). The cortical button fixation method was used in 5 cases, whereas the suture anchor method was used in 2 cases (Table 1). All patients were treated acutely, as the mean time between distal biceps tendon rupture and surgical anatomical reinsertion was 3±1.54 days.

The secondary surgery: surgical procedure of the pin injury treatment

The mean time between the anatomical surgical reinsertion of the ruptured distal biceps brachii tendon and the surgical treatment for the PIN palsy was 18.86±4.45 weeks (Table 1). In all studied patients, the PIN exploration was performed through a longitudinal forearm incision across the initial wound. The nerve was visualized, and an intraoperative evaluation of the injury according to Seddon's classification [23] and Sunderland's classification [24] was performed and documented. In case of PIN compression neuropathy (Figure 1), during the secondary surgeries, nerve releasing (neurolysis) was performed (Figures 2, 3). The neurolysis was initiated with the proximal part of the PIN from the elbow joint to the proximal margin of the reinserted tendon. Consecutively, the neurolysis was continued from the distal margin of the reinserted tendon to the supinator muscle and then beneath the reinserted biceps. Electrostimulation was carried out intraoperatively to check for the presence or absence of action potentials to the PIN nerve, and in all 5 cases a positive result was noted.

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Table 1. Descriptives for the studied cases, including details concerning the primary performed ruptured distal biceps tendon surgical anatomical reinsertion.

Patient	Age (years)	Operated limb	Dominant limb	Time between surgeries* (weeks)	Surgical approach	Fixation method
1	38	Right	Right	18	Double-incision	Cortical button
2	43	Right	Left	22	Single-incision	Cortical button
3	52	Right	Right	12	Double-incision	Anchor
4	38	Right	Right	24	Single-incision	Anchor
5	43	Left	Left	20	Single-incision	Cortical button
6	26	Right	Right	22	Single-incision	Cortical button
7	34	Right	Right	14	Single-incision	Cortical button

* The time between the surgical anatomical reinsertion of the ruptured distal biceps brachii tendon, and the surgical treatment of the iatrogenic posterior interosseous nerve palsy.

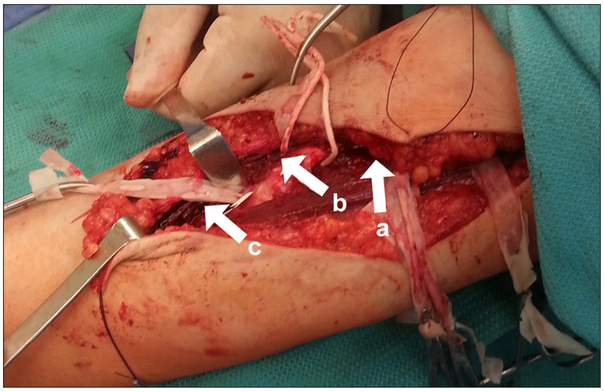

Figure 1. Intraoperative picture showing the entrapment of the posterior interosseous nerve. a – Proximal part of the posterior interosseous nerve; b – biceps brachii muscle; c – distal part of the posterior interosseous nerve.

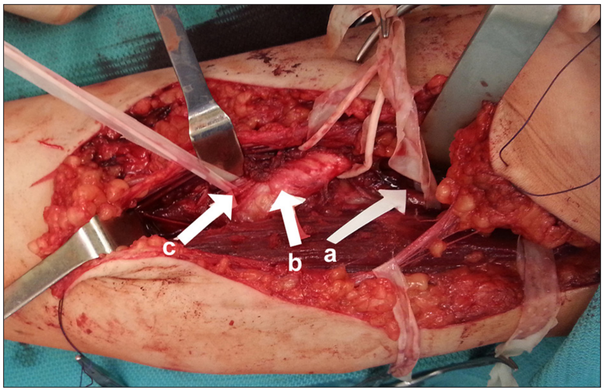

Figure 2. Intraoperative picture showing partial neurolysis of the posterior interosseous nerve entrapment. a – Proximal part of the posterior interosseous nerve; b – biceps brachii muscle; c – distal part of the posterior interosseous nerve.

Neurotmesis was diagnosed in the last 2 cases. The ends of the proximal and distal stumps were sharply cut with a razor blade to identify the individual fascicles or groups of fascicles. Consecutively, mobilization, preparation of the nerve ends, and direct end-to-end repair of the nerve ends were performed.

Postoperative procedure

Postoperatively, splinting the extremity in an appropriate position for 2–3 weeks to take off the tension was recommended. The postoperative procedure was based on physical, occupational, and hand therapy, with the aim of minimizing disability and preparing the patient to return to his previous work environment and recreational activities.

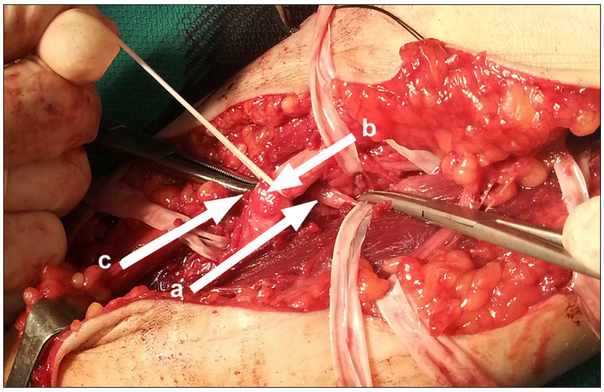

Figure 3. Intraoperative picture showing complete neurolysis of the posterior interosseous nerve. a – Proximal part of the posterior interosseous nerve; b – biceps brachii muscle; c – distal part of the posterior interosseous nerve.

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Table 2. Descriptives for the studied cases in terms of the intraoperative nerve evaluation, including the injury type, the nerve injury classification, and possible aetiology of the injury.

Patient	PIN injury type	Nerve Injury according to Seddon Classification	Nerve Injury according to Sunderland Classification	Possible PIN injury etiology
1	Compression	Neurapraxia	1	Hematoma
2	Rupture	Neurotmesis	5	Drilling
3	Compression	Neurapraxia	1	Hematoma
4	Rupture	Neurotmesis	5	Drilling
5	Compression	Neurapraxia	1	Incarceration
6	Compression	Neurapraxia	1	Incarceration
7	Compression	Neurapraxia	1	Hematoma

PIN – posterior interosseous nerve.

Clinical assessment

The information concerning the primary surgery was based on a detailed analysis of the surgery protocols that were made available by the hospitals where the surgery had taken place and medical documentation. The studied patients underwent a comprehensive preoperative evaluation, including a detailed history and physical examination supported by electrophysiological assessment and diagnostic imaging.

Postoperative assessments were performed in all cases at two years after the surgical treatments the PIN palsy. Because the PIN is a motor branch of the radial nerve, the patients were assessed using the Medical Research Council (MRC) System for motor recovery. The motor recovery was graded as M0 (no contraction), M1 (contraction in muscles proximal to the lesion), M2 (contraction in muscles proximal and to the lesion), M3 (contraction in all important muscles), M4 (contraction in all muscles acting synergistically), or M5 (complete recovery) [25]. The patients were also scored using the Quick Disability of the Arm, Shoulder, and Hand (Quick DASH) questionnaire. The scores were taken only for the operated limb. In the Quick DASH, the final score ranged from 0, indicating no disability, to 100, indicating the greatest possible disability [26].

In all cases, preoperative electrodiagnostics that confirmed the lack of PIN conduction were performed. However, as the patients were referred to our clinic from other hospitals, the evaluations were performed in different centers and by using different devices; thus, it was impossible to compare them by statistical analysis. Postoperative electromyography was performed in our clinic and revealed the PIN conduction in all studied patients.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics 20 software. The arithmetic mean (x) and standard deviation (SD) of the patients' ages, the time between the primary and secondary surgeries, the MRC System scores, and the Quick DASH scores were calculated for the studied group. The data distributions of MRC System and Quick DASH values were tested for normality using the Shapiro-Wilk test. For the intra-group comparison of the MRC System and Quick DASH scores between the preoperative and postoperative examination, the Wilcoxon test was used. Differences were considered significant if $p<0.05$.

Results

Intraoperative nerve injury evaluation

The PIN compression neuropathies were diagnosed in 5 studied patients (Table 2). The nerves were injured, but in continuity. In 3 cases, the compressions were a result of fibrotic hematomas, whereas in the remaining 2 patients the reason for the nerve palsies were the entrapment by the biceps brachii muscle (Table 2). The injuries were classified as neuropraxias according to Seddon (1943) [23], and the injury type 1 according to Sunderland (1951) [24].

The neurotmesis was diagnosed in the last 2 cases (Table 2). The complete transaction of the PIN with the scar formation resulting in neuroma was observed. The possible etiology was considered to be drilling, as the nerve ends were jagged, and the observed nerve damage seemed larger than it might have been in the case of an intersection.

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Table 3. The comparison of the clinical assessment results obtained before and two years after the surgical treatment of an iatrogenic PIN injury.

Results of clinical assessment before and after the surgical treatment of the PIN injury				
		Before the surgery	Two years after the surgery	*p*
MRC System (n)	x	1.43	4.71	<0.001
	SD	0.53	0.49	
Quick DASH (n)	x	54.29	6.14	<0.001
	SD	12.05	6.86	

MRC System – Medical Research Council (MRC) System for motor recovery; *n* – number of points; *p* – level of significance; Quick DASH – Quick Disability of the Arm, Shoulder, and Hand questionnaire; SD – standard deviation; x – arithmetic mean.

Clinical evaluation

All patients had a complete lack of finger and thumb extension at the visit before surgical treatment of PIN palsy. A comparison of the preoperative and postoperative results of motor recovery of the PIN revealed a statistically significant improvement that resulted in complete recovery (M5) in 5 of the studied patients and contraction in all muscles acting synergistically (M4) in 2 studied patients (Table 3). Moreover, the results of functional assessment with the use of the Quick DASH questionnaire significantly improved postoperatively compared to the preoperative evaluation (Table 3).

Discussion

In most studied cases, the PIN palsy was a result of mechanical nerve compression, first by the hematoma fibrotic changes and, second, by the biceps brachii. The second reason for the PIN injury was direct intraoperative damage during the anatomical reinsertion of the ruptured distal biceps brachii tendon. The patient assessments, which were conducted 2 years after iatrogenic PIN palsy management, revealed very good results and justified the use of surgical treatment for the studied complication of a surgical anatomical reinsertion of a ruptured distal biceps brachii. The outcomes that were reported to be very good may be crucial information to be discussed with the patients when such a complication occurs.

When it is not detected early or treated according to general principles, iatrogenic nerve injury can result in severe disability. Iatrogenic nerve injury is estimated to be the cause of 17–20% of all operated traumatic nerve lesions in nerve centers that treat injuries requiring surgical repair [27,28]. However, the estimation would be different if nonoperatively-treated nerve lesions were considered. Orthopedic surgery is one of the specialties with the highest incidences of iatrogenic nerve injuries [29].

The anatomy of the PIN

The PIN is a motor branch of the radial nerve that arises at the level of the elbow and supplies the posterior musculature of the forearm (Figures 4, 5). The PIN gives off small branches to the supinator muscle and has 2 main terminal branches: the medial (recurrent) branch and the lateral (descending) branch. The superficial musculature of the forearm, which consists of the extensor digitorum communis, extensor digiti minimi, and extensor carpi ulnaris, is supplied by the medial branch, whereas the lateral branch supplies the deep extensors: the abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, and extensor indicis proprius. The extensor carpi radialis brevis can also be supplied by the PIN [30].

Complications after surgical treatment of distal biceps brachii tendon rupture

Panagopoulos et al. (2016) divided the complications after cortical button distal biceps repair into major ones such as posterior interosseous nerve palsy, rerupture, reoperation, and symptomatic heterotopic ossification (Figure 6), and minor ones such as temporary paresthesia (lateral antebrachial cutaneous nerve, and superficial radial nerve), superficial infection, problems with wound healing, and irritation from the cortical button [31]. Single-incision distal biceps rupture repair using the EndoButton fixation method was first introduced by Bain et al. (2000) [32]. The advantage of cortical button fixation is the significantly superior load to failure compared to other fixation methods described in biomechanical studies [33,34], although its superiority has not been proven clinically [35,36]. The single-incision approach is less invasive than the double-incision approach and results in a lower incidence of heterotopic ossification. However, a disadvantage of this approach is the risk of PIN lesions [37]. The risk of complications occurrence appears to increase when the surgical repair of a ruptured distal biceps tendon is delayed [19].

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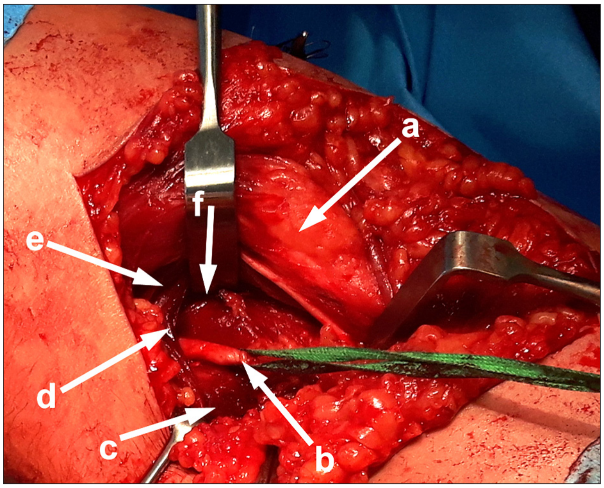

Figure 4. Intraoperative picture of the posterior interosseous nerve (part I). a – Biceps brachii muscle; b – posterior interosseous nerve; c – extensor carpi radialis brevis muscle; d – Arcade of Frohse; e – supinator muscle; f – pronator teres muscle.

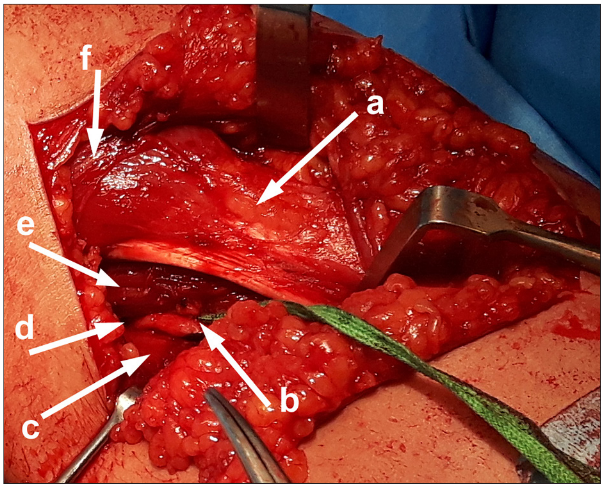

Figure 5. Intraoperative picture of the posterior interosseous nerve (part II). a – Biceps brachii muscle; b – posterior interosseous nerve; c – extensor carpi radialis brevis muscle; d – Arcade of Frohse; e – supinator muscle; f – pronator teres muscle.

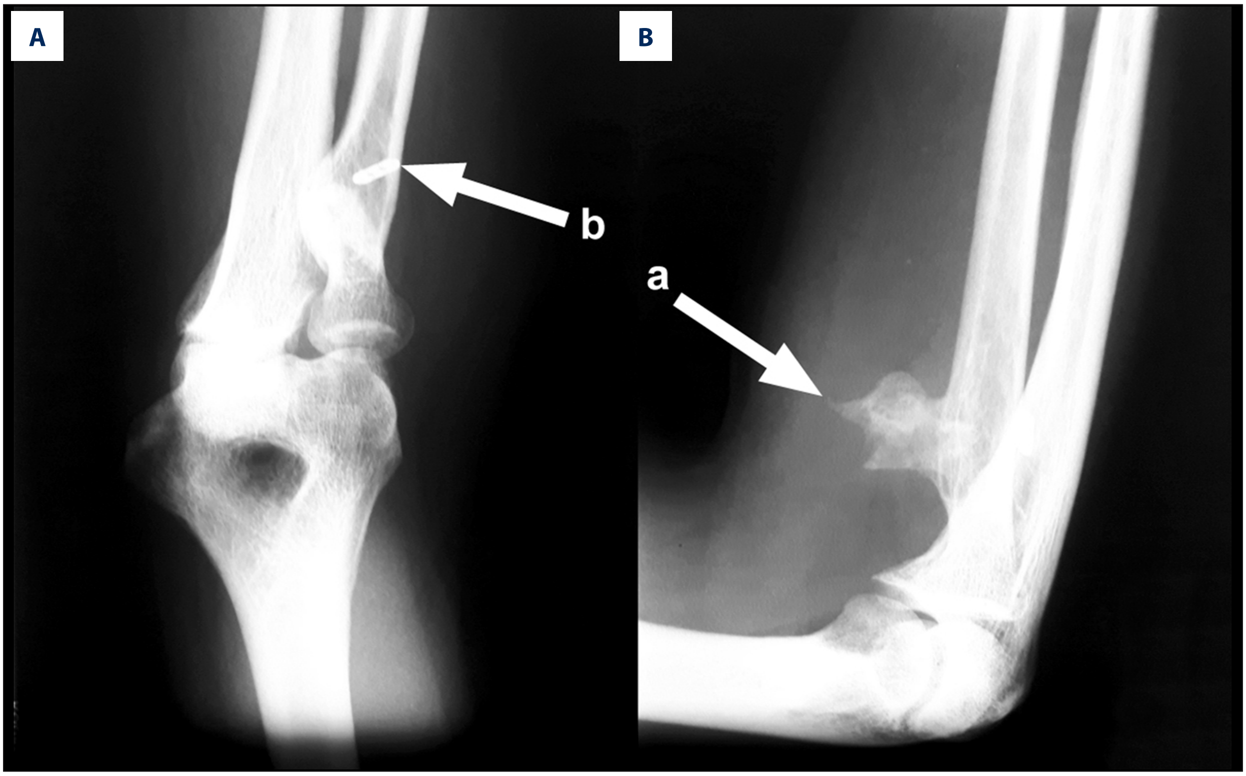

Figure 6. Antero-posterior (**A**) and lateral (**B**) radiographs of the elbow joint and proximal forearm after the surgical anatomical reinsertion of a ruptured distal biceps brachii tendon. The radiographs show heterotopic ossification, which is characterized by the formation of mature lamellar bone in no osseous location.

Prognosis for PIN palsy recovery

There is little available information on the incidence and recovery period of PIN palsy after anatomical ruptured distal biceps brachii tendon reinsertion, and there are no valid standard protocols for its treatment. PIN injury is the most dreaded neurological complication of distal biceps tendon surgical management, although it is estimated to occur in only

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1–5% of patients after anatomical distal biceps tendon reinsertion [18–22]. It had been reported to occur in up to 5% of cases of repairs when using the single-incision approach. Thus, in 1961, Boyd and Anderson designed a double-incision approach technique with the elevation of the supinator origin from posterior to anterior to expose the radial tuberosity, aiming to protect the nerve [38]. Then, the technique was modified with a dissection through the extensor muscle mass [5]. Studies reporting on PIN palsy following the 2-incision technique are rare [39]. It is worth noting that although the double-incision approach decreased the number of PIN injuries observed for the single-incision approach, it did not completely eliminate such injuries. The time of transient PIN palsy resolution varies in the literature, from a few weeks to 1 year postoperatively [18–21]. Most PIN injuries after ruptured distal biceps tendon repairs are classified as neuropraxias that ultimately recover. However, permanent deficits have also been reported, even including patients who are operated on using the 2-incision technique [40]. Nigro et al. (2013) noted that the time until the complete resolution of PIN palsy lasted, on average, 12 weeks [22]. According to Cohen and Katolic (2003), stretch PIN injuries generally recover in less than 8 weeks, and the use of a dynamic digital extension splint during this period is recommended [41]. A favorable prognostic sign for nerve recovery is the presence of motor unit action potentials in the muscles of the dorsal forearm. The same authors noted that an absence of recovery for 2–3 months is an indication for nerve exploration with nerve repair or nerve transfers to restore the active extension of digits and thumbs [41]. In line with the literature, the surgical treatment of PIN palsy was performed, on average, after 19 weeks to ensure that the palsy did not resolve spontaneously. Until that time, the patients were treated with dynamic extension splinting and occupational therapy. It is worth noting that even a temporary loss of finger and thumb extension, leading to a limitation of hand function, may lead to secondary stiffness and a passive range of motion reduction [22].

The etiology of PIN injury and minimizing its occurrence

Generally, iatrogenic nerve injury mechanisms can be divided into nonsurgical and surgical causes [42]. Nonsurgical causes include injection injury, compressive hematoma, tourniquet palsy, irradiation, pharmaceuticals, and chemotherapy [42]. Malpositioning, direct lesions during surgery, and en bloc removal of unrecognized nerve sheath tumors are examples of the causes of surgical nerve lesions [42].

In the present study, PIN palsy was a result of mechanical nerve compression by hematoma fibrotic changes. In general, iatrogenic hematoma, as an effect of trauma, surgery, angiography, or injection, can result in external mechanical compression to the nerve and produce a compartment syndrome that leads to ischemia. The characteristics of the anatomical region that is affected by hematoma strongly affects the potential functional deficit. In cases of neurological deficits and/or pain, early surgical decompression is recommended because the progressive growth of the hematoma can induce neurological deterioration due to clot contraction and fibrotic changes [42].

The causes of surgical iatrogenic nerve injury can be divided into intraoperative positioning damage and direct intraoperative damage [42]. The second reason for nerve compression in the present study was its entrapment by the biceps brachii, and it might have occurred due to incorrect forearm positioning during the primary surgery. To avoid PIN neuropraxia, deep dissection to the radial tuberosity should be performed with the forearm placed in full supination [41].

Causes of intraoperative direct nerve lesion include squeezing; drilling; wounding by screws; grabbing and squeezing together with the bone being repositioned; compressing the nerve by plates or retractors; tearing with surgical instruments; stretching or pinching with repositioning instruments; piercing by Kirschner wires or screws; contusing by a sudden repositioning manoeuvre or the application of excessively strong forces; coagulating with Bovie cautery or bipolar forces; transecting; burning; cementing; excising altogether with the target pathology; being injured directly or indirectly by wire cerclage; being sutured and ligated; and being stretched to non-functionality [27]. Intraoperative nerve transection occurs mainly because the nerve was not appropriately visualized, was incorrectly identified, or was mistaken for vessels.

The other main reason for PIN injury was the direct intraoperative damage, which might have occurred due to the inappropriate visualization and incorrect identification of the nerve during the anatomical reinsertion of the ruptured distal biceps brachii tendon.

The cadaver studies performed by Lo et al. (2011) revealed that even though a perpendicular orientation of the guidewire during the anatomical distal biceps brachii tendon reinsertion allowed for an average distance of 11.2 mm from the PIN, the distal orientation of the guidewire created an average distance of 2 mm from the nerve and made direct contact in 30% of the specimens [43]. The authors recommended drilling across the radius at 90° to its longitudinal axis and aiming for 0° to 30° ulnarly, with the patient's forearm in full supination to provide an increased margin of safety and thereby prevent injury to the PIN compared with drilling radially or distally [43]. According to Nigro et al. (2013), PIN palsy most likely results from a traction injury caused by retraction on the radial soft tissues; thus, Mighell modified the technique to include a direct-pull retractor radially [22].

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Limitations of the study

One of the main limitations of the present study is its small sample, but it is worth noting that ruptures of distal biceps brachii tendon are generally uncommon injuries. Among neurological postoperative complications, PIN palsy is the least common, but it is the most severe. The other limitation of the study is the lack of electrodiagnostic data because we were not able to statistically analyze the results obtained in different clinics that used different devices. As the studied sample comprised patients who had been referred to the clinic where the study was carried out as a reference center of peripheral nervous system injuries management, we failed to provide the incidence of iatrogenic PIN palsy for each surgical procedure, i.e., single or double incision. Also, the fact that few different initial techniques were used and different type of revision surgeries were performed is also a limitation; however, with such rare iatrogenic injuries, even initial reports are interesting and of important clinical relevance.

Conclusions

The PIN palsies as complications of the surgical anatomical reinsertion of ruptured distal biceps brachii tendon resulted from mechanical nerve compression by hematoma fibrotic changes or by the biceps brachii. The second reason for the PIN injury was the direct intraoperative damage during the anatomical reinsertion of the ruptured distal biceps brachii tendon. Data for 2 years of outcomes justify the clinical use of surgical management for iatrogenic posterior interosseous nerve injury as a complication of surgical anatomical reinsertion of a ruptured distal biceps brachii.

Conflict of interests

None.

References:

1. Safran MR, Graham SM: Distal biceps tendon ruptures: Incidence, demographics, and the effect of smoking. Clin Orthop Relat Res, 2002; (404): 275–83
2. Sarda P, Qaddori A, Nauschutz F et al: Distal biceps tendon rupture: Current concepts. Injury, 2013; 44(4): 417–20
3. D'Alessandro DF, Shields CL Jr., Tibone JE, Chandler RW: Repair of distal biceps tendon ruptures in athletes. Am J Sports Med, 1993; 21(1): 114–19
4. Schmidt CC, Jarrett CD, Brown BT: The distal biceps tendon. J Hand Surg Am, 2013; 38(4): 811–21; quiz 821
5. Morrey BF, Askew LJ, An KN, Dobyns JH: Rupture of the distal tendon of the biceps brachii. A biomechanical study. J Bone Joint Surg Am, 1985; 67(3): 418–21
6. Kodde IF, van den Bekerom MP, Eygendaal D: Best approach for the repair of distal biceps tendon ruptures. World J Orthop, 2013; 4(2): 98–99
7. Citak M, Backhaus M, Seybold D et al: Surgical repair of the distal biceps brachii tendon: A comparative study of three surgical fixation techniques. Knee Surg Sports Traumatol Arthrosc, 2011; 19(11): 1936–41
8. Balabaud L, Ruiz C, Nonnenmacher J et al: Repair of distal biceps tendon ruptures using a suture anchor and an anterior approach. J Hand Surg Br, 2004; 29(2): 178–82
9. Gregory T, Roure P, Fontes D: Repair of distal biceps tendon rupture using a suture anchor: description of a new endoscopic procedure. Am J Sports Med, 2009; 37(3): 506–11
10. Khan W, Agarwal M, Funk L: Repair of distal biceps tendon rupture with the Biotenodesis screw. Arch Orthop Trauma Surg, 2004; 124(3): 206–8
11. Heinzelmann AD, Savoie FH 3rd, Ramsey JR et al: A combined technique for distal biceps repair using a soft tissue button and biotenodesis interference screw. Am J Sports Med, 2009; 37(5): 989–94
12. Recordon JAF, Misur PN, Isaksson F, Poon PC: Endobutton versus transosseous suture repair of distal biceps rupture using the two-incision technique: A comparison series. J Shoulder Elbow Surg, 2015; 24(6): 928–33
13. Ranelle RG: Use of the Endobutton in repair of the distal biceps brachii tendon. Proc (Bayl Univ Med Cent), 2007; 20(3): 235–36
14. Siebenlist S, Elser F, Sandmann GH et al: The double intramedullary cortical button fixation for distal biceps tendon repair. Knee Surg Sports Traumatol Arthrosc, 2011; 19(11): 1925–29
15. Miyamoto RG, Elser F, Millett PJ: Distal biceps tendon injuries. J Bone Joint Surg Am, 2010; 92(11): 2128–38
16. Bisson L, Moyer M, Lanighan K, Marzo J: Complications associated with repair of a distal biceps rupture using the modified two-incision technique. J Shoulder Elbow Surg, 2008; 17(1 Suppl.): 67s–71s
17. Chavan PR, Duquin TR, Bisson LJ: Repair of the ruptured distal biceps tendon: A systematic review. Am J Sports Med, 2008; 36(8): 1618–24
18. Gallinet D, Dietsch E, Barbier-Brion B et al: Suture anchor reinsertion of distal biceps rupture: Clinical results and radiological assessment of tendon healing. Orthop Traumatol Surg Res, 2011; 97(3): 252–59
19. Kelly EW, Morrey BF, O'Driscoll SW: Complications of repair of the distal biceps tendon with the modified two-incision technique. J Bone Joint Surg Am, 2000; 82-a(11): 1575–81
20. Chillemi C, Marinelli M, De Cupis V: Rupture of the distal biceps brachii tendon: Conservative treatment versus anatomic reinsertion – clinical and radiological evaluation after 2 years. Arch Orthop Trauma Surg, 2007; 127(8): 705–8
21. Hetsroni I, Pilz-Burstein R, Nyska M et al: Avulsion of the distal biceps brachii tendon in middle-aged population: is surgical repair advisable? A comparative study of 22 patients treated with either nonoperative management or early anatomical repair. Injury, 2008; 39(7): 753–60
22. Nigro PT, Cain R, Mighell MA: Prognosis for recovery of posterior interosseous nerve palsy after distal biceps repair. J Shoulder Elbow Surg, 2013; 22(1): 70–73
23. Seddon HJ: Three types of nerve injury. Brain, 1943; 66(4): 237–88
24. Sunderland S: A classification of peripheral nerve injuries producing loss of function. Brain, 1951; 74(4): 491–516
25. Seddon H: Results of repair of the nerves. Surgical disorders of peripheral nerves. Edinburgh: Churchill Livingstone, 1975; 303–14
26. Longo UG, Franceschi F, Loppini M et al: Rating systems for evaluation of the elbow. Br Med Bull, 2008; 87: 131–61
27. Birch R: Iatrogenous injuries. In: Birch R (ed.), Surgical disorders of the peripheral nerves. London: Springer-Verlag, 2011; 483–525
28. Kretschmer T, Heinen CW, Antoniadis G et al: Iatrogenic Nerve Injuries. Neurosurg Clin N Am, 2009; 20(1): 73–90, vii
29. Welch MB, Brummett CM, Welch TD et al: Perioperative peripheral nerve injuries: A retrospective study of 380,680 cases during a 10-year period at a single institution. Anesthesiology, 2009; 111(3): 490–97
30. Dang AC, Rodner CM: Unusual compression neuropathies of the forearm, part I: Radial nerve. J Hand Surg Am, 2009; 34(10): 1906–14
31. Panagopoulos A, Tatani I, Tsoumpos P et al: Clinical outcomes and complications of cortical button distal biceps repair: A systematic review of the literature. J Sports Med, 2016; 2016: 11
32. Bain GI, Prem H, Heptinstall RJ et al: Repair of distal biceps tendon rupture: A new technique using the Endobutton. J Shoulder Elbow Surg, 2000; 9(2): 120–26

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33. Greenberg JA, Fernandez JJ, Wang T, Turner C: EndoButton-assisted repair of distal biceps tendon ruptures. J Shoulder Elbow Surg, 2003; 12(5): 484–90
34. Mazzocca AD, Burton KJ, Romeo AA et al: Biomechanical evaluation of 4 techniques of distal biceps brachii tendon repair. Am J Sports Med, 2007; 35(2): 252–58
35. Fox JA, Fernandez JJ: Single incision technique for distal biceps tendon repair: Using the endobutton. Operative Techniques in Sports Medicine, 2003; 11(1): 42–46
36. Kettler M, Tingart MJ, Lunger J, Kuhn V: Reattachment of the distal tendon of biceps: Factors affecting the failure strength of the repair. J Bone Joint Surg Br, 2008; 90(1): 103–6
37. Van den Bogaerde J, Shin E: Posterior interosseous nerve incarceration with endobutton repair of distal biceps. Orthopedics, 2015; 38(1): e68–71
38. Boyd H, Anderson M: A method for reinsertion of the distal biceps brachii tendon. 1961
39. Karunakar MA, Cha P, Stern PJ: Distal biceps ruptures. A followup of Boyd and Anderson repair. Clin Orthop Relat Res, 1999; (363): 100–7
40. Stearns KL, Sarris I, Sotereanos DG: Permanent posterior interosseous nerve palsy following a two-incision distal biceps tendon repair. Orthopedics, 2004; 27(8): 867–68
41. Cohen MS, Katolic L: Complications of distal biceps tendon repairs. Operative Techniques in Sports Medicine, 2003; 11(1): 60–66
42. Kretschmer T, Heinen C: Chapter 36 – iatrogenic injuries of the nerves A2 – Tubbs, R. Shane. In: Rizk E, Shoja MM, Loukas M et al. (eds.), Nerves and Nerve Injuries. San Diego: Academic Press, 2015; 557–85
43. Lo EY, Li CS, Van den Bogaerde JM: The effect of drill trajectory on proximity to the posterior interosseous nerve during cortical button distal biceps repair. Arthroscopy, 2011; 27(8): 1048–54

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]