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ORIGINAL ARTICLES

Ulnar Nerve Entrapment at Elbow, a Retrospective Clinical Observational Study.

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Abstract

Importance: Ulnar neuropathy at the elbow is the second most frequent entrapment neuropathy, affecting 6% of the population. Surgical criteria are based on a general agreement but remain controversial about which procedure is associated with the best results and the fewest complications. This data can help evaluate the effectiveness of operative techniques in symptomatic cure.

Material and Methods: The study analysis included 26 out of 35 patients with 'Ulnar neuropathy at elbow' diagnosis, treated between January 2017- March 2022 at the Department of Neurosciences, University Service of Neurosurgery, University Hospital Center "Mother Theresa", Tirana, Albania.

9 patients from the time period January-June 2018 were excluded from this study analysis due to lack of access to data. Data sources such as medical records and documentation copies of instrumental examinations were extracted from archives of Statistics Service and Hospital Registers, University Hospital Center "Mother Theresa", Tirana, Albania. Phone follow-up was applied as well.

Results: We report 26 patients analyzed retrospectively (female: male ratio 1:2.71). 29 operated extremities were studied: 26 with Cubital Tunnel Syndrome, of which 2 presented with ipsilateral Carpal Tunnel Syndrome and 1 bilateral; 2 with contralateral Carpal Tunnel Syndrome. There were 11 patients gr. II McGowan and 15 patients gr. III McGowan.

There are no positive elbow flexion-extension test cases, indicative of the transposition technique. All p atients were c linically evaluated at a distance of 1-3 years post-operatively and 19% presented objective symptoms. Long-term follow-up shows the motor and sensory improvement for gr. II McGowan patients, while gr. III McGowan patients show only sensory and grip improvement, with the persistence of muscular atrophy.

The most frequent cause of compression was determined fibrosis and hypertrophy around the Osborne ligament (13/26).

Conclusions: Clinical stage of neuropathy is the decisive factor influencing prognosis. Simple decompression in situ is sufficient in most cases. Dynamic intraoperative testing of sulcus competence, to assess (sub)luxation of the ulnar after decompression, determines the final operative technique.

Keywords: ulnar neuropathy, decompression, Gr. McGowan, dynamic test, clinical stage, operative technique.

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Introduction:

Entrapment neuropathy is a peripheral nerve disorder characterized by pain and/or loss of function (motor and/or sensory), resulting from chronic compression; if left untreated, it can progress to significant disability. [1] Ulnar nerve entrapment at elbow is the second most common entrapment neuropathy after Carpal Tunnel Syndrome (CTS) and the most common entrapment at elbow. It has an incidence of 20.9 cases per 100'000 person-years; estimated to be 1/13 of CTS. [2, 3]

Affect 6% of population with a male: female ratio results 3:1 due to the smaller size of procesus coronoid ulnae and subcutaneous adipose tissue not as abundant as in women. [4]There are bilateral manifestations in 18.6-38.8% of cases. [5]

Prevalence within at-risk populations ranges: 2.8% in assembly line workers, packers and cashiers; 8% in floor cleaners and 42.5% in vibratory tool operators. [6]

Traumatic neuropathy can be caused by local injuries such as dislocations; while the non- traumatic compressive one is usually associated with (idiopathic) arthritis. Pressure causes motoric damage, loss and deficit with/without sensory loss. [7, 8]The most common compression's sites along the ulnar trajectory are: Cubital tunnel the most frequent; Arcadae Struthers and Pronator Flexor Profundus Aponeurosis. While less common, according to

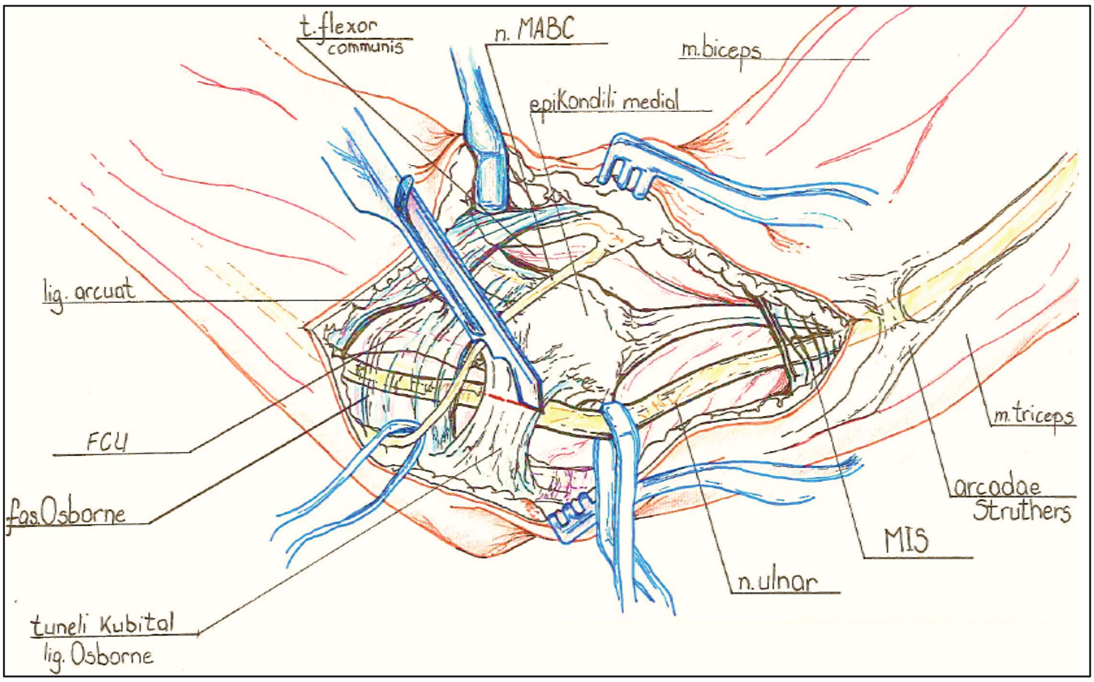

Figure 1. *Simple in-situ decompression, phase 1: lig. Osborne decompression. Original sketch by Aurora Muça(-in colors-)*

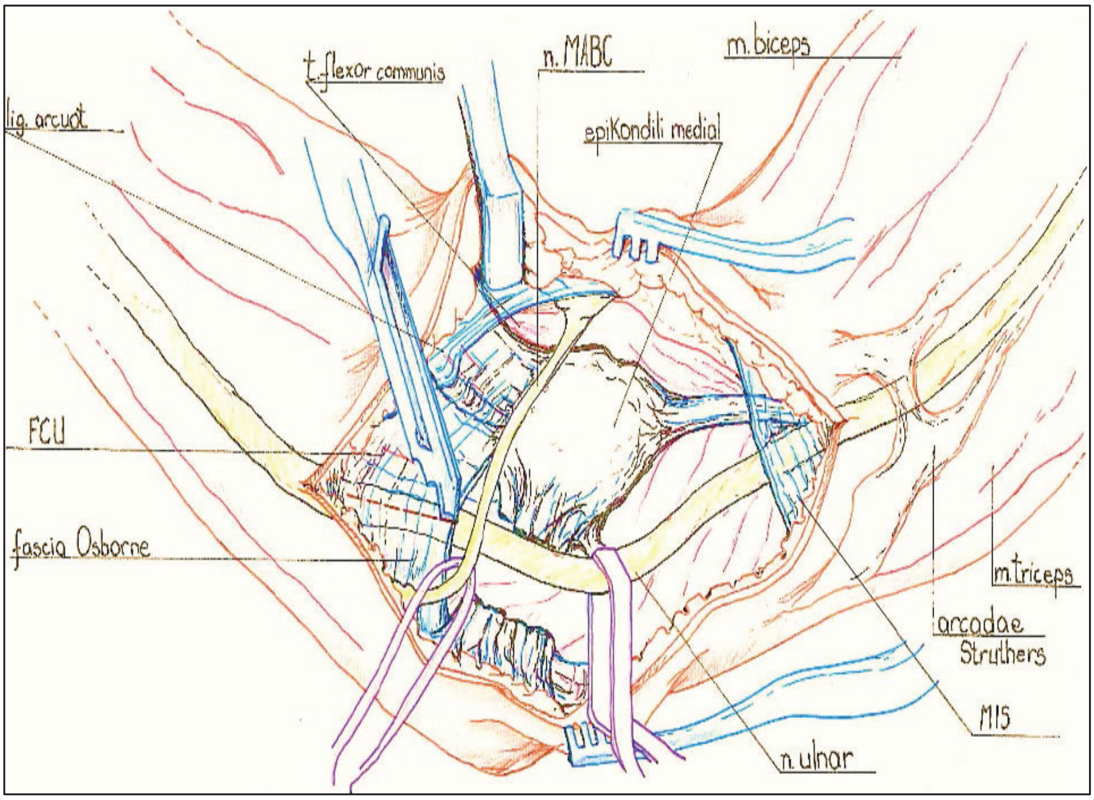

Figure 2. *Simple in-situ decompression, phase 2: fascia Osborne decompression. Original sketch by Aurora Muça(-in colors-)*

the frequency are: Intermuscular medialis septum (MIS); Epicondylus medialis; hypertrophy of caput medialis m. triceps; Flexor Carpi Ulnaris

(FCU) fascial band; m. accessory epitrochlear anconeus (found in 3-23% of population) and flexor digitalis superficialis aponeurosis. [5, 15]

Pathogenic factors that promote compression are: Vascular (Diabetes Mellitus - DM), microcirculatory disease); Inflammatory (Synovitis, Rheumatoid Arthritis); Traumatic (Supracondylar humerus fracture, dislocation); Anatomical (Muscular abnormality, vascular plexus, fascial bands); Metabolic (Pregnancy, hypothyroidism); Iatrogenic (Injections, hematoma) and Neoformations (Ganglion, lipoma, sarcoma). [9]

Associated conditions are considered: Medial epicondylitis; Varus / valgus cubital deformities; Burns and Elbow Release Contractures. Risk factors include repetitive work and obesity. [5]

Physical examination should include determination of motion range, crepitus, ligamentous stability; deformities,

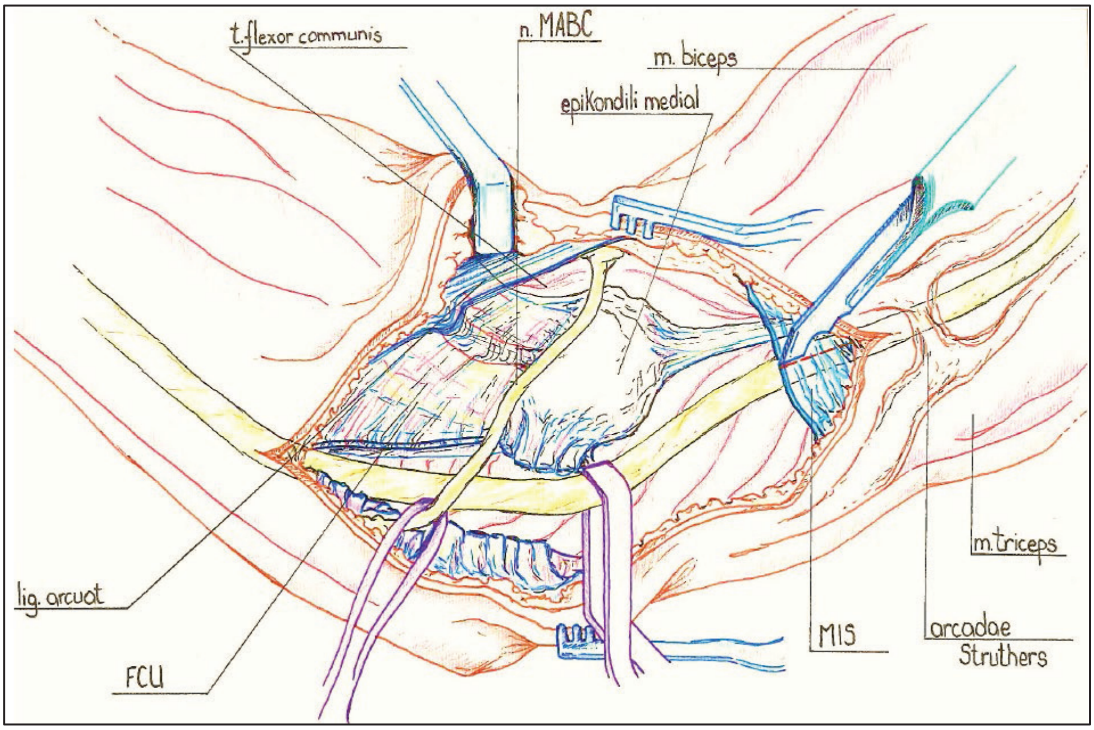

Figure 3. *Simple in-situ decompression, phase 3: MIS decompression. Original sketch by Aurora Muça(-in colors-)*

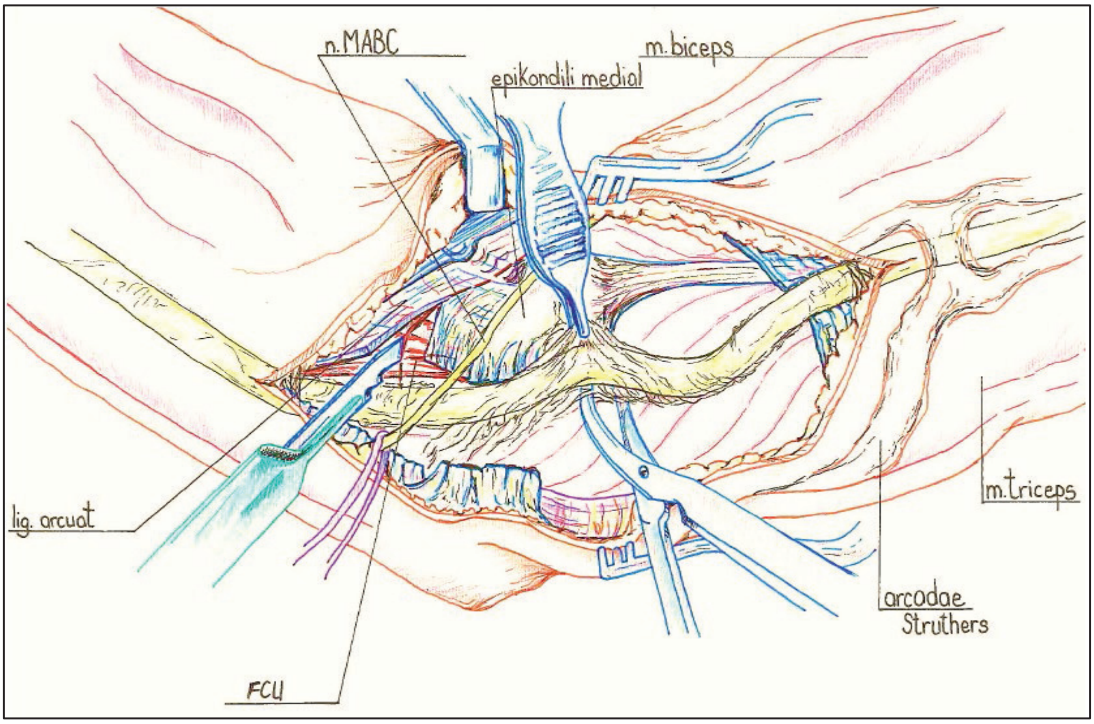

Figure 4. *Simple in-situ decompression, phase 4: lig. arcuat decompression and neurolysis. Original sketch by Aurora Muça.(-in colors-)*

McGowan grade and evaluation of medial epicondyle. [1, 9]

Diagnosis is clinical with confirmation by provocative tests, during physical examination; electrodiagnostic with 75% sensitivity and CT-RMI imaging with 97% sensitivity. Electrodiagnostic studies remain the standard criteria for objective neuropathic assessment, but are highly operator-dependent and results do not always correlate with symptom' severity. [2, 6, 10, 11]

Cubital Tunnel Syndrome (CuTS) treatment depends on etiology and severity. In minimally symptomatic cases and in absence of intrinsic muscles atrophy, a conservative approach is attempted, which consists in modified activity such as avoiding elbow flexion, medial elbow support on hard surfaces; nocturnal splinting; overnight fixation in 45° extension; physiotherapy, especially nerve gliding exercises. [3]

Operative approach is indicated when conservative therapy fails. The general principle of operative intervention is nerve decompression in areas of compression, preventing subluxation over the medial epicondyle and traction/tension with elbow movement. In most cases, surgeon preference and expertise influence the selection of operative procedure. [5, 7, 12]

Surgical treatment options for CuTS are: Simple in-situ decompression, Medial epicondylectomy, Anterior subcutaneous transposition, Intramuscular anterior transposition and Anterior submuscular transposition. [6]

Material and Methods

This is an observational, retrospective cohort clinical study. The study analysis included 26 out of 35 patients with *'Ulnar neuropathy at elbow'* diagnosis, treated between January 2017- March 2022 at the *Department of Neurosciences, University Service of Neurosurgery, UHC "Mother Theresa", Tirana, Albania*. 9 patients from time-period January-June 2018 were excluded from this study analysis due to lack of access to data. Data sources as medical records and documentation copy of instrumental examinations were extracted from archives of *Statistics Service and Hospital Registers, UHC "Mother Theresa", Tirana, Albania.* Phone follow-up was applied as well.

Data selected for analysis included: gender, age, profession, residence, local traumatic episodes, duration and typology of symptoms and signs from the beginning of complaints, comorbidities, localization of neuropathy and sites of compression, diagnostic tools, pre- and post-operative McGowan grade, type of anesthesia, surgical intervention and intraoperative techniques, post-surgical complications and post-operative treatment.

Data extracted was analyzed with *Microsoft Excel Off ce 2016.*

Results

Our 6-year study demonstrates clinically applicable surgical techniques and examination instruments. In total, 26 out of 35 patients who underwent surgery were analyzed during the study period. 29 operated

extremities (26 with CuTS, of which 2 associated with ipsilateral and 1 bilateral CTS, and 2 with contralateral CTS, with an average operative time difference of 1 month) were studied.

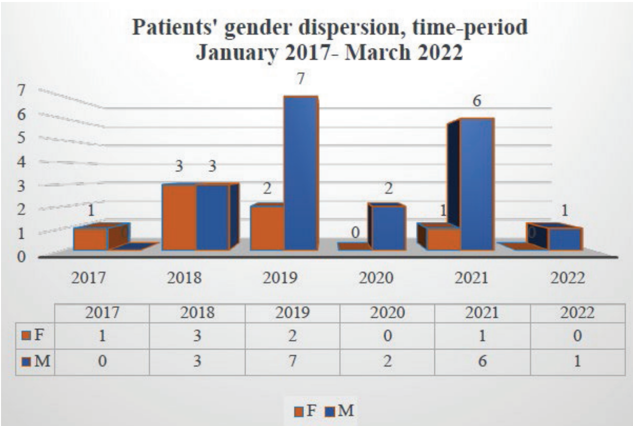

Table 1. *Patients'gender dispersion, time period January 2017-March 2022*

Throughout the study, 19 (73%) were male, median (SD) age was 55.05 (11.69) years; and 7 female (27%), median age (SD) 46.14 years (10.97). Male: Female ratio resulted 2.71:1. Age dispersion size (SD) resulted [32;75] (11.75), while study group median age (SD) 52.65 years (11.75). The predominant age interval was [40:50] (35%) and the least represented interval [70:80] (8%). 18 patients (69.23%) were exposed to heavy arm work, with active-working age (SD) at a mean of 47.94 years (11.56), within age range [32:68] years, and 11 of them (61%) presented with grade III McGowan.

Age-group	F	M	TOTAL	%
30-40	3	1	4	15.38%
40-50	3	6	9	34.62%
50-60	0	7	7	26.92%
60-70	0	4	4	15.38%
70-80	1	1	2	7.69%
Totali	7	19	26	100.00%

Table 2. *Patients' age-group dispersion*

Only 3 patients (12%) were exposed to a pre-operative history of local trauma, of which 2 males and 1 female, at 25.33 years (19.86) mean age of trauma (SD). Trauma-operation time period was calculated at the average (SD) of 22.33 years (28.3). In this exposure group, it cannot be concluded that trauma is the main cause of ulnar nerve entrapment at elbow, based on low presentation percentage (12%). However, it is reported that men were exposed to trauma twice as women; ENG was the most significant diagnostic test; NSAIDs were necessary for associated post-operative pain and simple decompression was the choice technique for both grades: II and III. This operative technique stops further nerve paralysis by preventing aggravation, evidenced in 1-year post-operative follow-up interval. These patients expressed deterioration cessation over a period of 2-3 years with symptoms relief but no change in McGowan grade.

In 13 patients (50%), which constitute the majority, lig. Osborne was the compression level, meanwhile the rarest case at a male patient was double-level compression in fasc. Osborne and FCU. 14 patients (54%) were specified with CuTS Dexter, 71% of which gr. III McGowan, 64% were labor force and only 3 of them were female. 10 patients (38%) were specified with CuTS Sinister, 40% of which were gr. III McGowan, 80% were workforce and 4 of them female. 2 patients were specified with Bilateral CuTS, 50% specified gr. III McGowan.

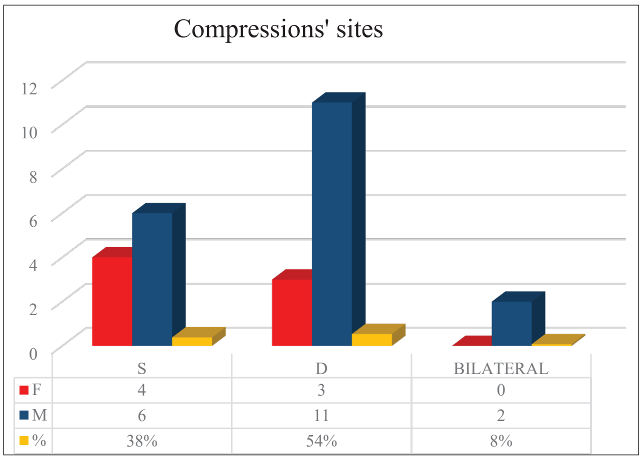

***Table 3.** Compressions' sites dispersion in study group*

Patients have been symptomatic pre-operatively for a mean time period (SD) of 20.17 years (24.69). The majority, 15%, turned out to have shown symptoms for 6 months -1-year period. The fewest cases evidenced were of 5 years symptoms duration; while employees make up 73% of the patients. Gr. II McGowan is dominant in every time-frame except 6 months-1 year. Patients with pre- operative trauma history showed 3 years symptoms duration. Selected diagnostic tools were: RMI and ENG.

In the study group, 20 patients (77%) had comorbidities, of which 5 women (25%) and 15 men (75%). CTS was the most frequent comorbidity, encountered in 6 patients (23%); followed by: other neuropathies-5 patients (19%), SARS COVID-19 and cardiopathy- each by 3 patients (12% and 12%), DM-2 patients (8%) and 1 patient with nephropathy (4%). DM, cardiopathies and nephropathies were categorized in pathogenic factors group that increase risk for CuTS, through vascular alterations and favoring infectious conditions. SARS COVID-19 inflammatory effect was not seen to have a correlation with ulnar nerve entrapment at elbow, but it is thought to have played a role in reducing the rate of diagnosis and treatment due to pandemic emergency. Cases studied before the pandemic made up 62% of total cases and the subsequent 3 years of the study from January 2020-March 2022 made up 38% of total cases, obviously with a slight downward trend, but not determining causality.

Instrumental examinations used in the study were: ENG, EMG and RMI. ENG is used in all cases to confirm diagnosis, even though you not reported in medical records. McGowan grade and neuropathy clinical stage relevance are in proportion. This is also seen in intraoperative findings of ulnar nerve interest degree at the site of compression. ENG was used in 13 (50%) patients; as the only instrumental examination tool in 9 patients (35%) and accompanied by EMG and/or RMI in 4 patients (15%).

We report that in 26 patients, from time-period January 2017-March 2022, 11 patients (42%) were categorized gr. II McGowan and 15 patients (58%) gr. III McGowan. Male gender was predominant in both grades: 64% in gr. II McGowan group and 80% in gr.III McGowan group. McGowan grade III patients reported more post-operative pain, had a younger mean age and made up a larger cohort of workforce (11/18 employed).

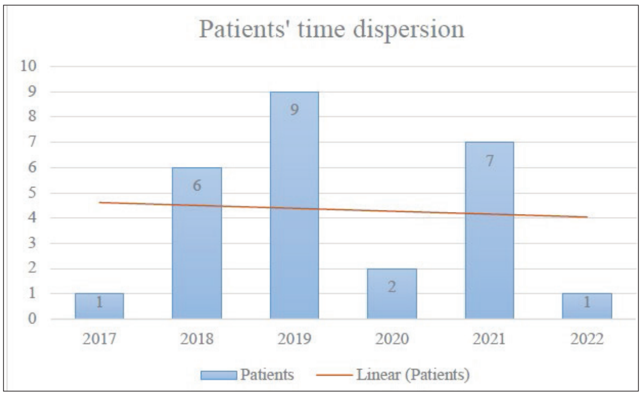

***Table 4.** Patients' time dispersion*

Simple open decompression was performed in 22 patients (85%) as a sufficient operative technique; in which 17 patients (77%) were male and 11 patients (50%) were

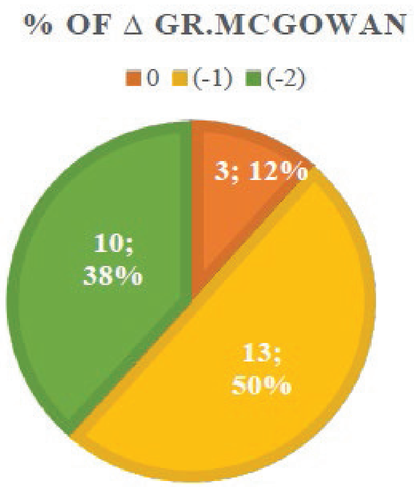

***Table 5.** Percentage of difference in McGowan grade in pre- and post-operatory evaluation*

evaluated grade III McGowan pre-operatively. Additional intraoperative procedures consisted of: Hemostasis (23%) and Fasciectomy (4%). 23 patients (88%) were administered local anesthesia, 2% lidocaine, with 0% anesthetic side effects encountered in the peri- and post-operative period.

Overall, 88% of patients have improved with surgery; all forms of open in situ decompression were sufficient without additional transposition procedures need.

No gr. III McGowan patient in our study is reported to have fully recovered, while 3 gr. II McGowan patients are considered fully recovered without any complaint or reference symptom. It is established that 6 out of 11 pre-operative McGowan gr. II patients and 7 out of 15 pre-operative gr. III McGowan patients show improvement and post-operative categorization of gr. I McGowan, accompanied only by mild subjective symptoms.

During follow-up, 19% of patients showed post-operative symptoms with recurrence potential; 38% of patients were observed to have a pronounced improvement with a two gr. McGowan difference, of which 70% resulted gr. III McGowan in preoperatory evaluation.

The majority, with 50% dominance, resulted improved with one gr. McGowan difference, of which 54% resulted gr. III McGowan in pre-operative assessment. Overall open decompression in situ resulted a safe operation without motor/sensory side effects, either psychological or aesthetic complications in the study timeframe.

Rare Intraoperative Findings

In this section, 4 cases of rare intra-operative findings are presented, which are attributed to Prof. Asc. Dr. Ridvan Alimehmeti, during operative practice in the surgical room. Intra-operative photos are presented with the permission of author and accompanied by specific description of the case.

CASE 1. Case of ulnar nerve pressing in sulcus with bony callus that is drilled.

Asc. Prof. Dr. Ridvan Alimehmeti, MD, Ph.D. Courtesy. (-in colors-)

Photo 1. Post-operative scar. (1-epicondylus medialis; 2 olecranion)

A 32-year-old male patient case with previous history of trauma and surgery in the left cubital region, as evidenced through the post-operative scar in between epicondylus medialis and proc. olecranion *(photo 1)*. During physical examination there was no sign of 'ulnar claw' hand, but initial intrinsic hand muscles atrophy evidenced, Positive Froment Sign, and gr. II McGowan pre-operative grading (photo 2). The ulnar motor branches were identified and preserved *(photo 3)*. After that bony callus, that pressed ulnar nerve in sulcus, was drilled *(photo 4, 5)*. Pulsatile arterial compression was evidenced distal to medial epicondyle *(photo 6)*. It is subjected to the operative technique of simple in- situ decompression, based on the negative intraoperative dynamic elbow flexion-extension test *(photo 7, 8)*, determining no further need of anterior transposition technique. It is accompanied by neurolysis *(photo 9)* and hemostasis *(photo 7, 8)*.

Photo 2. No 'ulnar claw' hand evidenced, nor intrinsic muscles atrophy.

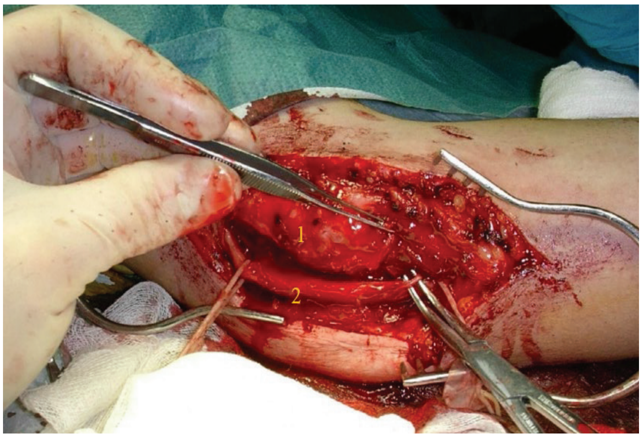

Photo 3. Ulnar motor branches and ulnar nerve pressing in sulcus evidence. (1- epicondylus medialis, 2- ulnar nerve)

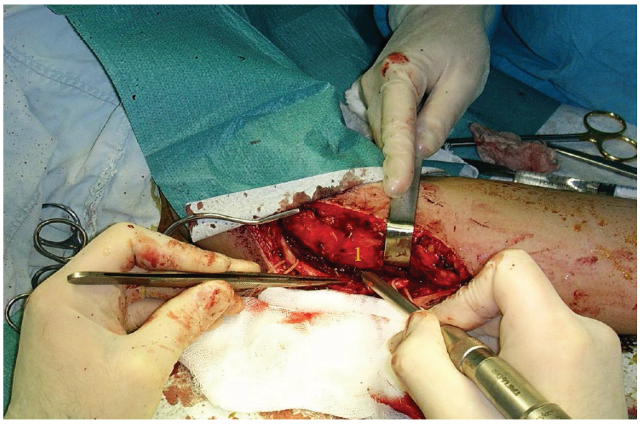

Photo 4. Bony callus starting to drill. (1- epicondylus medialis)

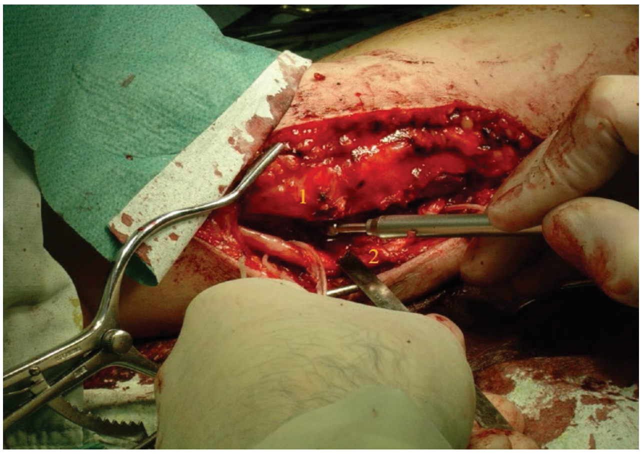

Photo 5. Bony callus drilling. (1- epicondylus medialis, 2- ulnar nerve)

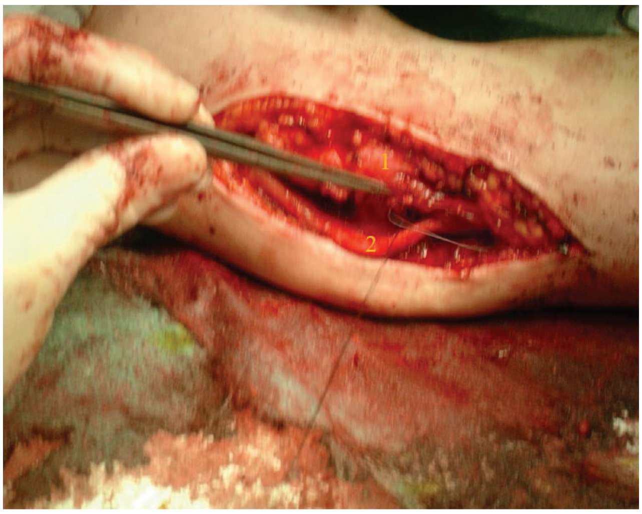

Photo 6. Reconstruction of periosteum of the ulnar sulcus. (1- medial epicondyle, 2- ulnar nerve).

Photo 7. Negative intraoperative dynamic elbow flexion-extension test. (1- epicondylus medialis, 2- ulnar nerve, 3- proc. olecranius)

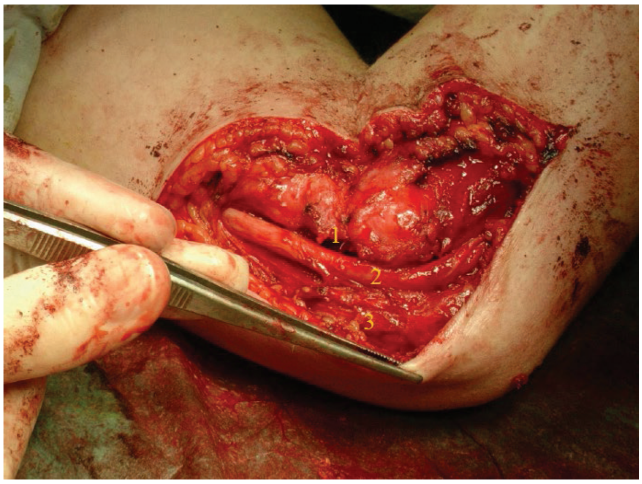

Photo 8. Simple in-situ decompression, with negative intraoperative dynamic elbow flexion-extension test. (1- epicondylus medialis, 2- ulnar nerve, 3- proc. olecranius)

Photo 9. Neurolysis.

CASE 2. *Case of Neuro-vascular conflict.*
Asc. Prof. *Dr. Ridvan Alimehmeti, MD, Ph.D. Courtesy. (-in colors-)*

Photo 10. Claw hand

Case of a neuro-vascular conflict *(photo 11)* at the CuT in a 37-year-old male patient, without prior local trauma history at elbow. Hypotrophy phase of intrinsic muscles and 'ulnar claw' hand appearance, were evidenced during objective examination *(photo 10)*. Intraoperatively n. MABC was evidenced and preserved during simple in-situ decompression operative technique *(photo 12)*.

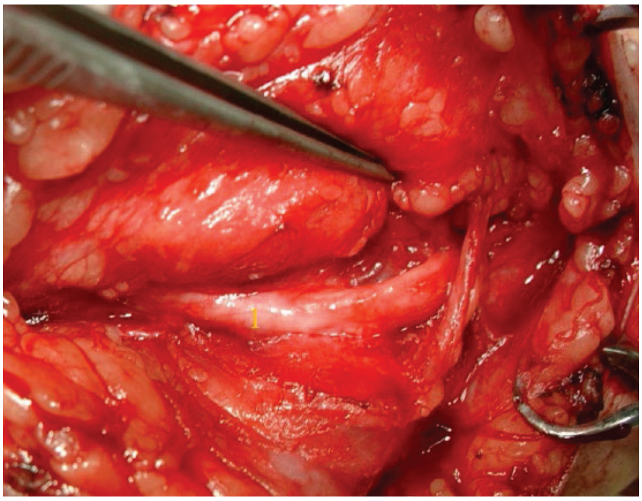

Photo 11. Neuro-vascular conflict. (1- small vessels over the ulnar).
In video is clearly shown the pulsation versus ulnar nerve. The vessels were dissected and partially coagulated until they could not cause a compressing pulsation versus the ulnar.

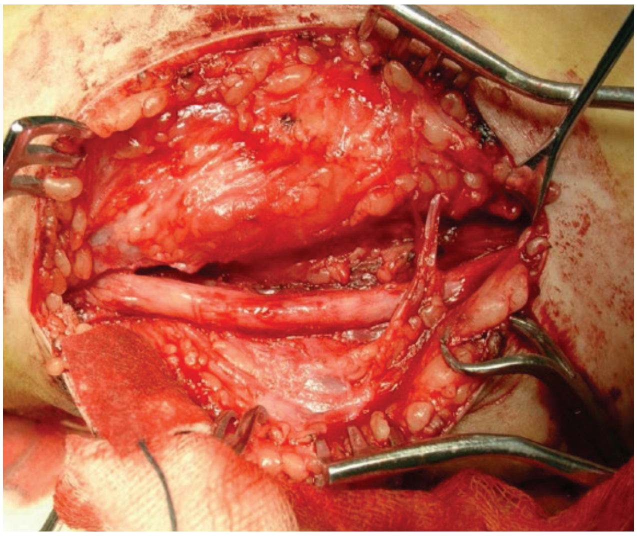

Photo 12. Decompressed ulnar nerve and n.MABC.

CASE 3. Late ulnar neuropathy due to compression from traumatic synovial cyst.
Asc. Prof. Dr. Ridvan Alimehmeti, MD, Ph.D. Courtesy. (-in colors-)

Case of a late ulnar neuropathy due to compression from traumatic synovial cyst, in a 22-year- old female patient, with a distortion history at the age of 5. This patient had been showing an onset of right ulnar hand deficiency symptoms for about 2 weeks *(photo 13)* with intrinsic hand muscles atrophy evidenced pre-operatively. During surgery a synovial cyst was evidenced *(photo 14, 15)*. It was caused by prior local trauma, causing late ulnar neuropathy due to compression. It was ruptured and drained *(photo 16, 17)*. In this patient was performed simple decompression followed by fascial wrapping also known as 'flapping'. Ulnar nerve was fixed through immobilization, anterior transposition and wrapping under the FCU's fascial band Z-cut *(photo 18, 19)*. Hemostasis and drainage system installation, followed *(photo 20)*. [13]

Photo 13. Onset of right ulnar hand deficit.

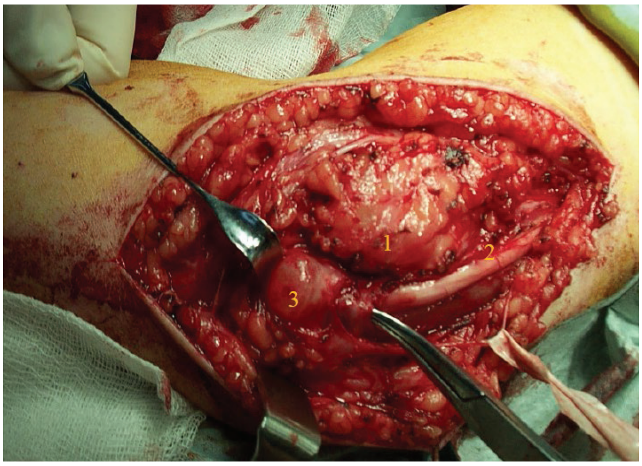

Photo 14. Post-traumatic synovial cyst.
(1- epicondylus medialis, 2- ulnar nerve, 3- synovial cyst)

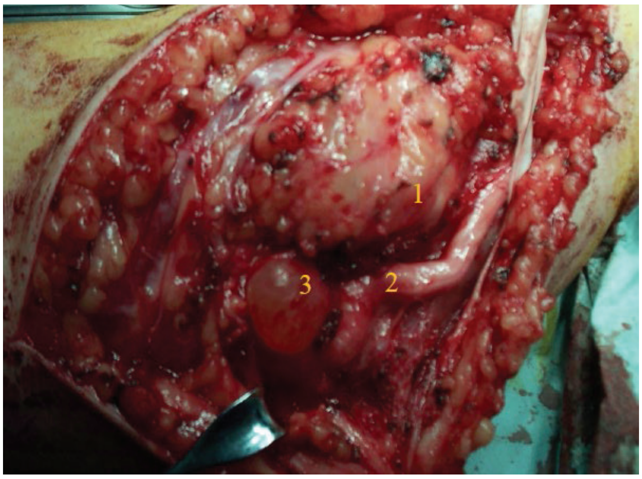

Photo 15. Post-traumatic synovial cyst.
(1- epicondylus medialis, 2- ulnar nerve, 3- synovial cyst)

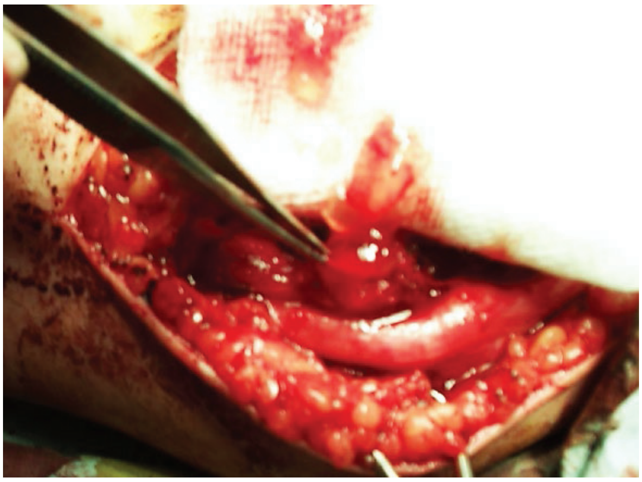

Photo 16. Rupture and drainage of the synovial cyst evidenced. (1- epicondylus medialis, 2- ulnar nerve, 3- synovial cyst)

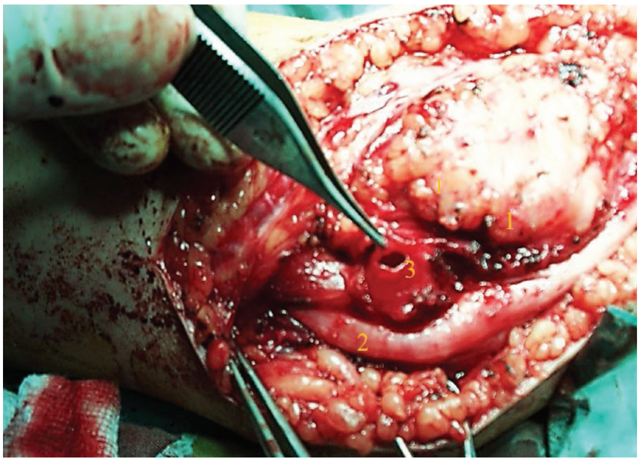

Photo 17. Synovial cyst ruptured and drained.
(1- epicondylus medialis, 2- ulnar nerve, 3- synovial cyst)

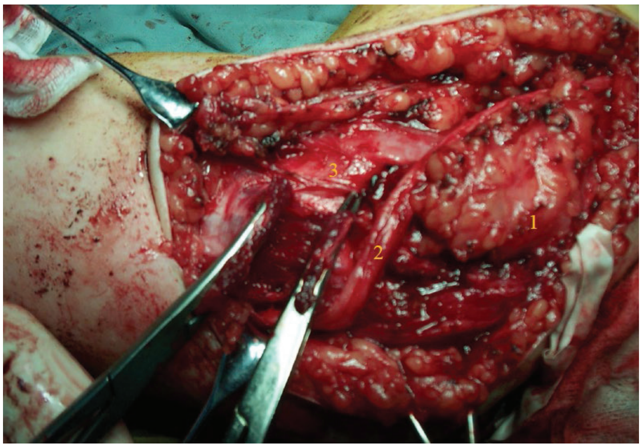

Photo 18. FCU's fascial band Z-cut. Ulnar nerve immobilization and anterior transposition. (1- epicondylus medialis, 2- ulnar nerve, 3- FCU'S fascial band)

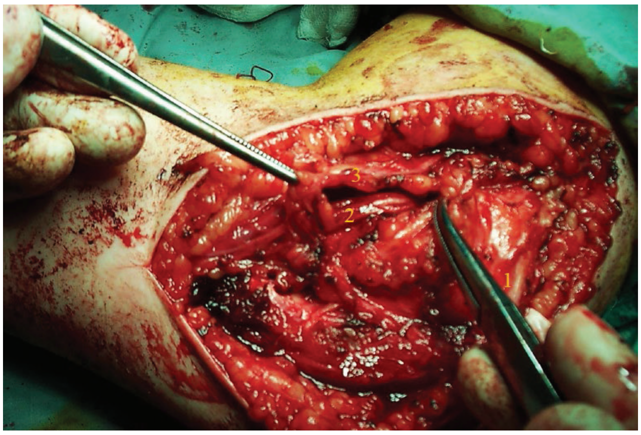

Photo 19. Flapping of ulnar nerve under FCU'S fascial band cuts. (1- epicondylus medialis, 2- ulnar nerve, 3- FCU'S fascial band)

Photo 20. Drainage system installation

Photo 21. Photo 1 year after surgery. No sign of muscle atrophy. Recovery noticeable.

Published at "Late ulnar neuropathy due to compression from traumatic synovial cyst: Case report and review." Chirurgia 24.4 (2011): 213-4. [13]

CASE 4. *Case with evidence of neuroma and m. anconeus present.*
Asc. Prof. Dr. Ridvan Alimehmeti, MD, Ph.D. Courtesy. (-in colors-)

A 52-year-old male patient with a prior history of distortion at elbow in childhood, presented in clinic without significant muscle atrophy signs *(photo 21)*. Specified gr. III McGowan pre- operatively with atrophy stage of intrinsic hand muscles evidence. During surgery was observed a nerve formation tissue mass with abnormal growth *(photo 23, 24)*. Simple in-situ decompression was performed in this patient, without any further need of transposition *(photo 23)*, followed by epineurotomy to assist neuroma proximally to local nerve compression *(photo 25, 26)*. M. anconeus presence, a rare finding, was evidenced, afterwards dissected to release nerve from compression *(photo 22, 23)*. During 1-year follow-up this patient referred hand-grip improvement, slight intrinsic muscles recovery and increased force of first clench.

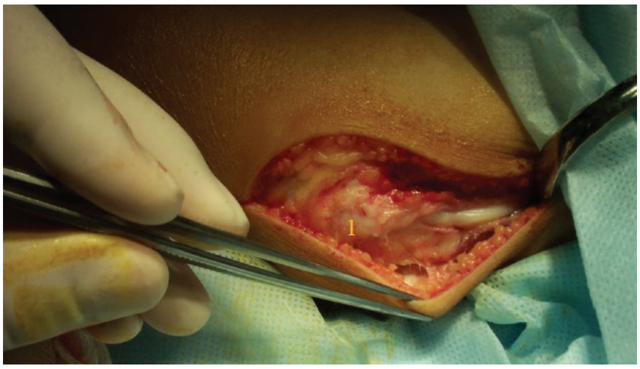

Photo 22. M. accessoris epitroclearis anconeus (1).

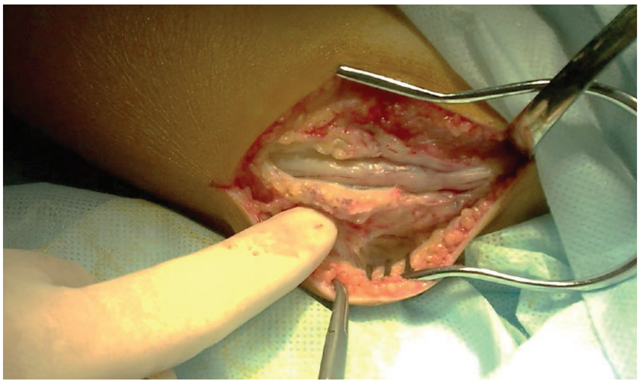

Photo 23. M. anconeus dissection.

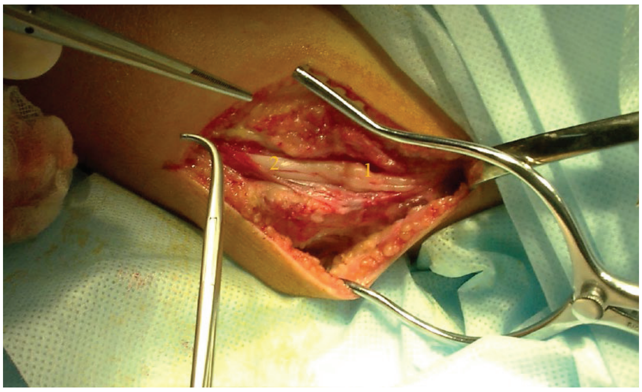

Photo 24. Neuroma (1). Small neuroma in fasciculus superior(2).

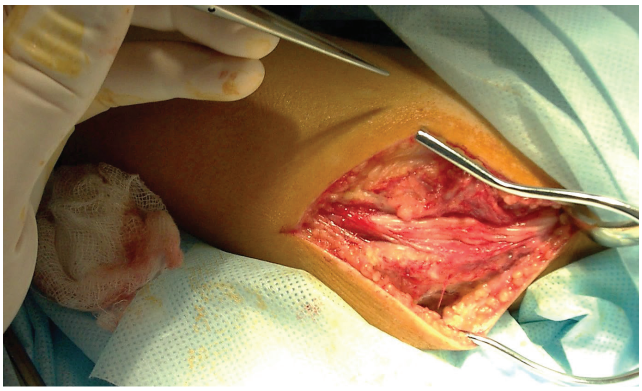

Photo 25. Epineurotomy.

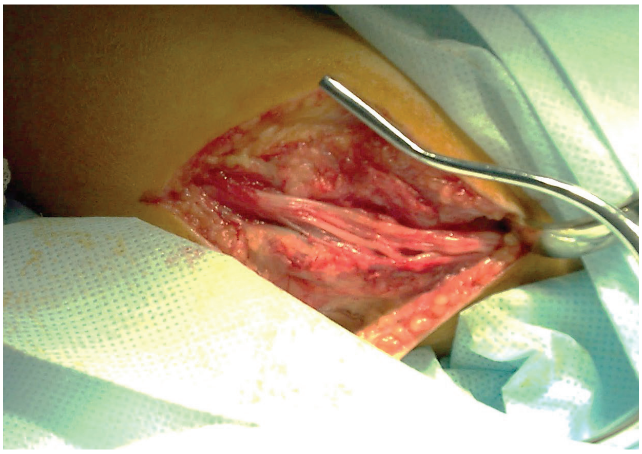

Photo 26. Epineurotomy.

Discussion

A) Evaluation for the most appropriate technique is performed intraoperatively by Neurosurgeons, based on the following criteria:

1. Ulnar sulcus deformation
2. Ulnar sulcus incompetence
3. Intraoperative dynamic test of sulcus competence, to assess ulnar nerve (sub)luxation.

When at least 1 of these 3 criteria is met intraoperatively, transposition is considered. Transposition type is determined based on: surgeon experience, patient anatomical constitution, compression level/levels, patient occupation and injury level.

B) Simple decompression is sufficient in most cases.

C) In cases of neuromas intraoperative finding, epineurotomy with/without neurolysis is considered.

D) In cases of late ulnar paralysis with trauma history, ultrasound examination can help detect synovial cyst, which is a rare event.

E) In cases of bony callus, it must be drilled to relief the ulnar compression.

F) Medial epicondylectomy is not preferred, due to post operative complications and similar effect of a local trauma.

G) Entrapment's clinical stage is the decisive influencing factor of prognosis.

H) Transposition, when needed, prevents neuropathy recurrence or nerve recovery failure.

I) Long-term follow-up shows motor and sensory improvement for gr. II McGowan patients, while gr.III McGowan patients show only sensory and grip improvement.

This study analysis also referred that prior local trauma history at elbow is a poor risk and prognostic factor for eventual surgery, as stated by Dellon et al. [14]

Our study results are in parallel with the conclusions of a 30 studies meta-analysis, published in 2020 with 2894 operated extremities, which refers that 87% of patients benefit from surgery and that open decompression in- situ is associated with better responses to treatment and lower risk of complications. [4]

Secondary Findings to be Discussed

During follow-up, 19% of patients showed post-operative symptomatology with potential recurrence, complication and reoperation in future. Further prospective longitudinal follow-up and examinations are needed for statistically significant results.

Risk of Bias within Study

In our study 9 patients, out of 35 initial patients targeted for the study group, were excluded from data analysis due to lack of access to data. This reduced our study sample to 26 patients over the 6-year study period, January 2017–March 2022.The small sample may increase probability of Type II Error.

Limitations

The sample taken in study is numerically small, therefore conclusions and results should be viewed with a critical eye, without being considered deteriorating or statistically significant. Future studies should be conducted with larger sample numbers.

Disclosure of interest

The authors declare that they have no competing interest.

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Authors Contributions

All the authors read and approved the final version of the manuscript.

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