OVIDIUS UNIVERSITY CONSTANTA

DOCTORAL SCHOOL OF MEDICINE

DOCTORAL THESIS

MODERN MANAGEMENT OF THE CARPAL TUNNEL SYNDROME, ETIOPATHOGENIC, CLINICAL AND THERAPEUTIC FEATURES

SUMMARY

CANDIDATE
DR. PĂNCULESCU FLORIN GABRIEL

SCIENTIFIC COORDINATOR
PROF. UNIV. DR. BORDEIANU ION

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CURRENT STATE OF KNOWLEDGE

THE SPECIAL PART

CURRENT STATE OF KNOWLEDGE

I. Elements of embryology, anatomy and physiology of the carpal tunnel.

The carpal tunnel is a well-defined anatomical structure and is located in the lower third of the forearm, more precisely on the anterior face of the fist joint.

Antero-posterior flattened cylindrical shape, the tunnel has walls made of inextensible anatomical structures, respectively the posterior wall and the two side walls are made of bone structures (carpal bones and distal epiphyses of the forearm bones) and the anterior wall consists of a structure known as the transverse ligament of the carpus (the anterior ligament of the carpus is part of the annular ligament of the carpus that forms the retinaculum of the extensors on the posterior face). [1]

Due to the shape made by the bone structures that make up the carpal tunnel, some authors also use the term "carpal canal"; I will opt for the "carpal tunnel".

Both the notion of "tunnel" and "canal" are equally used in the clinic, but their distinction must be made clearly. The bone structures represented by the carpal bones and the distal epiphyses of the forearm bones form the famous "canal"; further, this channel is covered by the transverse ligament of the carpus which completes the structure and gives it the title of "tunnel" through this previous closure.

The carpal tunnel has an average cranio-caudal height of about 4-6 centimeters and its lumen has an average antero-posterior diameter of 1.5-2.5 cm and a transverse one of 4-5 cm; Inside this space are noble anatomical elements (nine flexor tendons and the median nerve) with an essential role in achieving the motor and sensory functions of the hand.

The median nerve has a complex origin, it derives from the brachial plexus and has a downward trajectory along the entire length of the arm and when it reaches the hand it passes through the carpal tunnel and divides into several branches that innervate the sensory and motor fingers through the tenar branch part of the muscles of the tenar eminence). [2]

At the level of the hand, the median nerve deals with the innervation of the muscles that make up the tenor eminence but also with the lumbar muscles. This is possible with the help of two branches of the median nerve. The first, the recurrent branch, innervates the tenar muscle and the second, the digital palmar branch innervates the two lateral lumbar muscles. [19]

The median nerve is partly responsible for the sensory innervation of the hand. It is divided into two branches: the first branch, the skin palm, which arises at the level of the forearm

and goes to the hand, where the lateral part of the palm innervates. It does not pass through the carpal tunnel and therefore is not affected by carpal tunnel syndrome. The second branch is called the digital skin palm and appears on the hand. It innervates the thumbs, the index, the middle, and partly the annulus, and also the corresponding palmar surface. [20,21]

The flexor retinaculum has a special anatomical and surgical importance being the key element in the treatment of carpal tunnel syndrome. It arises from the fascia of the forearm, which at the level of the radiocarpal joint, is divided into two fibrous strips. The anterior one is the flexor retinaculum and the posterior one is the extensor retinaculum. The flexor retina crosses the entire width of the forearm at its level, from the tubercle of the scaphoid and the trapezius to the pisiform and the hook of the bone with the hook.

At the surface, it is composed of vertical and oblique fibers, and in depth of transverse fibers that form the transverse ligament of the carpus. This ligament delimits the carpal tunnel with the help of the carpus, through which the tendons of the flexor digitorum muscles and the median nerve pass to the palm. The transverse ligament of the carpus is the insertion site for the tenor and hypotenor muscles, acts as a lever for the flexor tendons and stabilizes the structure of the carpal tunnel.

Micro-lesions and fibrosis have been described in the flexor retinaculum but also in the subsynovial connective tissue that can cause neuropathy. Also, morphological and mechanical changes may occur on the transverse ligament of the carpus in the form of hypertrophies or its stiffening which reduce the amount of space available inside the carpal tunnel. Numerous studies have been published in which patients with carpal tunnel syndrome were found to show a **thickened** transverse ligament of the carpus. [6,22-24]

II. PATHOPHYSIOLOGY OF NERVE COMPRESSION

Carpal tunnel syndrome is represented by a mechanical alteration, by moving and changing the shape and size of the elements contained inside the carpal tunnel. These cause compression and lysis of the median nerve, the severity of the nerve injury being influenced by the duration of the nerve compression and the location of the fibers on which the trauma is exerted.

Nervous injury phenomena can be divided into:

1. Ischemia - is the first change that occurs secondary to changes in pressure inside the tunnel, increasing pressure changes circulation - interrupts blood supply.

2. Fibrosis - occurs secondary to ischemia and raises problems due to its irreversibility.

3. Traction - this phenomenon occurs due to compression, which limits the excursion of the nerve and often forms the nerve conduction block.

4. The double-crush phenomenon - a concept first presented by McComas and Upton, who discovered that any nerve compression at a certain level will cause an increased sensitivity of the nerve, in fact, greatly increases the chances of that nerve being destroyed and at another level.

5. Systemic diseases – can affect the nerve function and cause treatment problems; these may be: diabetes, hypothyroidism, chronic kidney disease, alcoholism. [26-28]

Compression of the components of the carpal tunnel induces ischemia, followed by venous congestion and epineural edema, with invasion of fibroblasts into the affected tissue, resulting in constriction and fibrosis of the endoneural compartment of the median nerve. At the local level, fibrosis and / or the formation of vicious callus can also put pressure on the nerve trunks, leading to chronic nerve damage. Intermittent, repeated compression of the vascular-nervous plexus is one of the main incriminating processes in the development of neuropathy. [27,29-33]

Damage to the median nerve causes local, edema, venous congestion, ischemia, and metabolic changes. Ischemia-reperfusion occurs, leading to oxidative stress and tissue inflammation, with a major role in reducing the space inside the carpal tunnel. [32-36]

The effects of nerve compression are divided into three stages by Seddon:

- Neuropraxia - is an early stage nerve injury, axonal continuity is maintained and the distal nerve segment retains its excitability;
- Axonotmesis - intermediate as gravity, axonal continuity is lost in the compression site but the endonerv retains its integrity.
- Neurotmesis - the last stage of nerve damage, nerve continuity is interrupted, Wallerian degeneration is present. [25,26,37,38]

III. CLINICAL, EVOLUTIONARY AND THERAPEUTIC ASPECTS OF CARPAL TUNNEL SYNDROME.

Carpal tunnel syndrome is a relatively common disease in the population, with a prevalence of about 4%, with a predominance of females and a significant increase in global incidence in recent decades.

The etiology of carpal tunnel syndrome is multifactorial, influenced by both local and systemic factors.

The etiopathogenesis of carpal tunnel syndrome can be grouped into three broad groups:

- Reduction of the capacity of the container
- increase in volume of the content
- idiopathic.

Carpal tunnel syndrome is favored by certain conditions: diabetes, rheumatoid arthritis, chronic renal failure, algodystrophy syndrome, Dupuytren's disease, nodular tendonitis, Guyon's canal syndrome, macrodactyly - which make changes at the cellular level with local resonance, either at the level of the endocrine, metabolic or nervous system (the notion of "diathesis"). [48-57]

In the clinic, the diagnosis is established by subjective and objective data. [72-75]. Subjective data are represented by: predominantly nocturnal paresthesias, hypoaesthesia in the sensitive territory of the median nerve, partial functional impotence of the hand (fine-grained bi-digital forceps), palmar pain, pruritus at the level of tender eminence, atrophy of the muscular muscles. [74-79]

Objective data fall into two categories, **clinical** - signs and tests observed and imposed by the examining physician and **paraclinical** - explorations performed to quantify neurolysis.

Clinical signs: lack of sweating, difficulty in opposing the thumb, hypoaesthesia or even anesthesia in sensitivity testing, Tinel's sign, Phalen's test, Durkan's test.

Paraclinical examinations, both those that directly study nerve conduction and imaging, have a particularly important role in establishing and staging nerve pathology and also postoperatively, to assess the therapeutic response. Electromyography is currently the first-line paraclinical investigation in carpal tunnel syndrome, which explores both sensory and motor conduction velocity; It is useful both in the diagnostic stage of the disease and postoperatively, for evaluating therapeutic success. The radiological examination has a narrower indication, especially for cases in which an associated pathology is suspected, which can only be explored imagistically. Ultrasound is used to rule out local conditions or to highlight factors that favor the development of the pathology, rather than to establish a definite diagnosis. Magnetic resonance imaging may show structural changes that occur at various stages of carpal tunnel syndrome, unseen by other imaging methods. The histopathological examination is performed in selected cases and allows detailed observation of the extracted piece.

All these methods help to establish a correct diagnosis, which can frame the carpal tunnel syndrome in the stage: **incipient / intermediate / advanced.**

In its infancy, patients experience paresthesias and / or pain in the palm that extends to the fingers except the fifth finger. These, especially initially, intensify during the night or after activities that put pressure on the carpal tunnel, and can later become persistent.

The intermediate form is characterized by more intense and persistent pain and paresthesias, which at night can even wake the patient from sleep.

Nerve changes begin to occur and the effectiveness of conservative treatment begins to decline, often preferring the establishment of surgical therapy to avoid a nerve lysis, possibly irreversible.

The advanced form shows major nervous changes, severe sensory and motor disorders, even with muscular atrophies at the tenar level. The treatment is exclusively surgical and a good part of the patients responded very well, with ad integrum recovery. [74-80,109]

The treatment of carpal tunnel syndrome focuses on several objectives, the improvement of symptoms, the prevention of complications and the progression of the disease.

The treatments used in the initial stages are the application of a splint at the wrist in a neutral position, accompanied by the oral administration of non-steroidal anti-inflammatory drugs, which quickly relieve local pain and discomfort. These methods have been shown to be effective in comparing local corticosteroid injection with the non-invasive therapeutic advantage. [113-117]

Injection of corticosteroids into the carpal tunnel is used succesfully in both early and intermediate forms, through the immediate effect of reducing tenosynovial volume and ameliorating the suffering of the median nerve. The improvement in symptoms occurs a few days after the injection and has been shown by various studies to be clearly more effective than placebo after one month.

Platelet-enriched plasma (PRP) injection is a treatment that has been studied for several decades, and has grown in popularity in recent years due to its comparable efficacy to corticosteroid injection, but with a focus on cancer risk due to exogenous growth factor intake through PRP. [125-129]

Surgical treatment is recommended in the intermediate or advanced stages of the disease, when other treatments do not control the symptoms and the damage of the median nerve is important. The surgical procedure is performed under local or loco-regional anesthesia and consists in sectioning the transverse carpal ligament, which forms the "ceiling" of the carpal tunnel, being the only anatomical element that allows intervention on it. The results are immediate, with this sectioning, the elements inside the canal being released, the pressure drops a lot, stopping the nerve compression. [134-138]

The classical technique is the oldest form of treatment, but it is still used very often today because it offers the advantage of visualizing the entire anatomical region but also of the transverse ligament, and thus the ideal location for the incision can be decided more accurately. Another important benefit of open surgery is found in cases where the etiopathogenesis is

compressive by local tumors, thus resolving both tumor removal and carpal tunnel syndrome. [136,139-144]

The endoscopic intervention uses a single approach, with the help of a single incision, 1 centimeter, positioned 0.5-1 centimeters proximal to the crease of the wrist, above the ulnar edge of the palmaris longus muscle. Endoscopic intervention is preferred in diabetic patients, in those with chronic kidney disease due to the small incision that promotes faster healing. The contraindication of endoscopy is aimed at neuropathy that occurs secondary to space-replacing pathologies, trauma or children, where anatomical changes require clear vision, for a more complex treatment.

THE SPECIAL PART

II. RETROSPECTIVE CLINICAL STUDY

II. 1. OBJECTIVES AND PERSPECTIVES

The aim of the present study is to identify the main pathologies that predispose to the appearance and aggravation of carpal tunnel syndrome, as well as highlighting some characteristics of the disease, related to age, sex, profession and especially the co-existence of associated (favoring) diseases.

Various diseases, apparently unrelated, influence the appearance and evolution of compressive neuropathy and unfortunately, these pathologies are very common in the general population, with onset even in the first decades of life. Acute and chronic decompensation of these syndromes leads to the favoring of the appearance and / or maintenance of the lysis of the median nerve, with serious repercussions, sometimes irreversible.

The aim of the study is to raise an alarm about the extremely high number of patients diagnosed with carpal tunnel syndrome, which associates diseases that may adversely affect the evolution and treatment of the compressive neuropathy.

The rapid diagnosis and appropriate treatment of the pathology associated with carpal tunnel syndrome is imperative in the fight that the population is waging against a disabling disease, which affects the quality of life of the patient and targets the general population, regardless of sex and age.

Also, knowing the risks that each pathology raises, the study of the patient - as a whole – is recommended and the importance of the collaboration between medicine and surgery is noted, as often patients may present pathologies at the beginning, without clinical resonance, which can be diagnosed and treated early. Carpal tunnel syndrome screening is a growing practice, used more and more often in the population susceptible to this syndrome.

Metabolic syndrome, accompanied by kidney or osteoarticular diseases and even some professional practices (work that subjects the hand joint to certain movements / vicious positions) must be under the close monitoring of the general practitioners doctors and even the occupational physician - these are the main frameworks in the medical field that can detect a compressive nerve pathology early.

Early diagnosis and appropriate treatment of pathology affecting the integrity of the median nerve should be a primary goal in general medicine due to the disabling nature of nerve lysis and the extremely high incidence of diseases associated with this syndrome (obesity, hypertension, diabetes, chronic kidney disease).

As a perspective, I appreciate that we will be able to realize, following the study, the existence of clear, eloquent interdependencies between the associated diseases and the appearance, evolution and severity of carpal tunnel syndrome.

II. 2. MATERIAL AND METHOD

The study is retrospective and was based on a group of 163 patients who were hospitalized and treated in the Plastic Surgery Department, within the County Clinical Hospital "Sfântul Andrei" in Constanta with the diagnosis of carpal tunnel syndrome, with surgical indication, dictated both by the clinical examination and especially by the paraclinical examinations performed.

The analysis of the studied group was carried out over a period of 10 years, respectively 01.01.2008 - 31.12.2018, and for the realization of the study group we pre-established inclusion / exclusion criteria, in order to benefit from the most scientifically conclusive results.

The inclusion in the study was not restrictive, accepting patients of both sexes, of any age and regardless of background. Also, patients with any kind of associated pathology were accepted, emphasizing its notation and highlighting it in medical documents.

The main criterion for inclusion in the study group was the diagnosis of carpal tunnel syndrome, regardless of location.

The exclusion criteria targeted non-compliant patients, as the study required postoperative follow-up, as the associated diagnoses at the time of median nerve damage were sought.

The surgical treatment was performed with the help of the two established techniques (classical and endoscopic), but in most cases the open approach was used, for the macroscopic visualization of the morphological changes of the median nerve and the neighboring structures.

Regarding the methods chosen for collecting and recording the data necessary for the study, they were of several types: interactive, comparative and studies of documentary data. The interactive method was represented by the sociological survey, respectively the direct interaction used to interview both the medical staff and the patients hospitalized in the County Clinical Hospital "Sfântul Andrei" from Constanţa.

All patients enrolled in this study gave their consent to participate and I would like to point out that all patients were informed of the inclusion in the study group and signed the informed consent, as well as the fact that the clinical study benefited from the agreement of the Ethics Commission.

II. 3. RESULTS

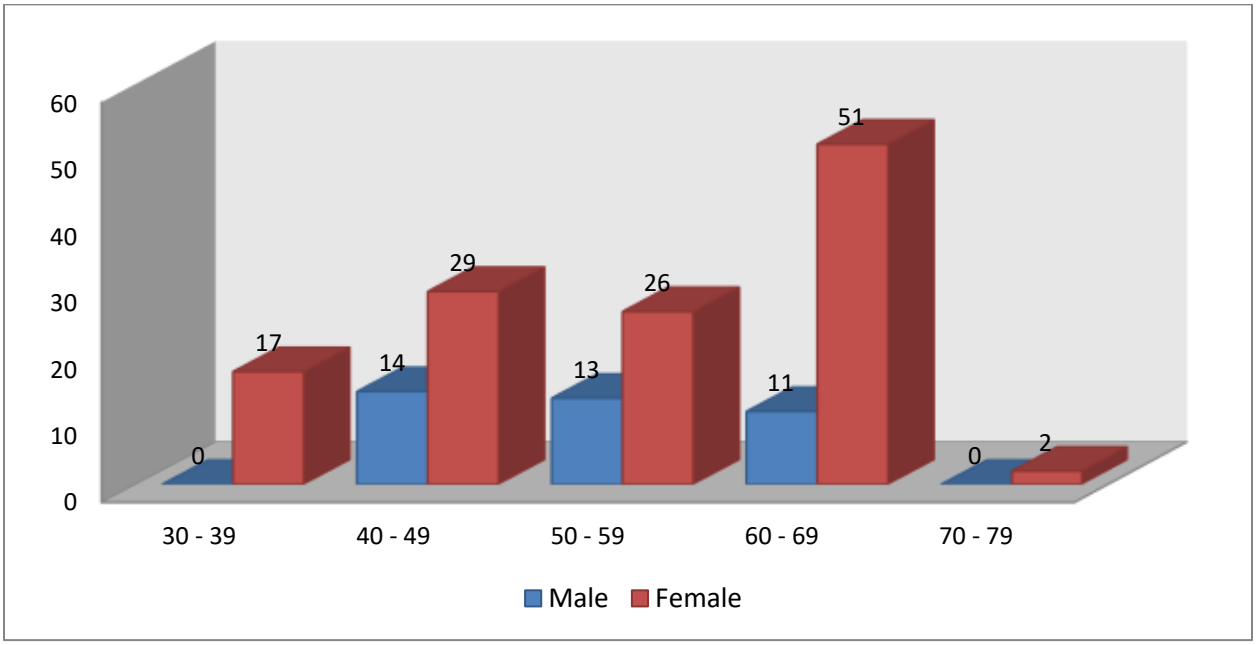
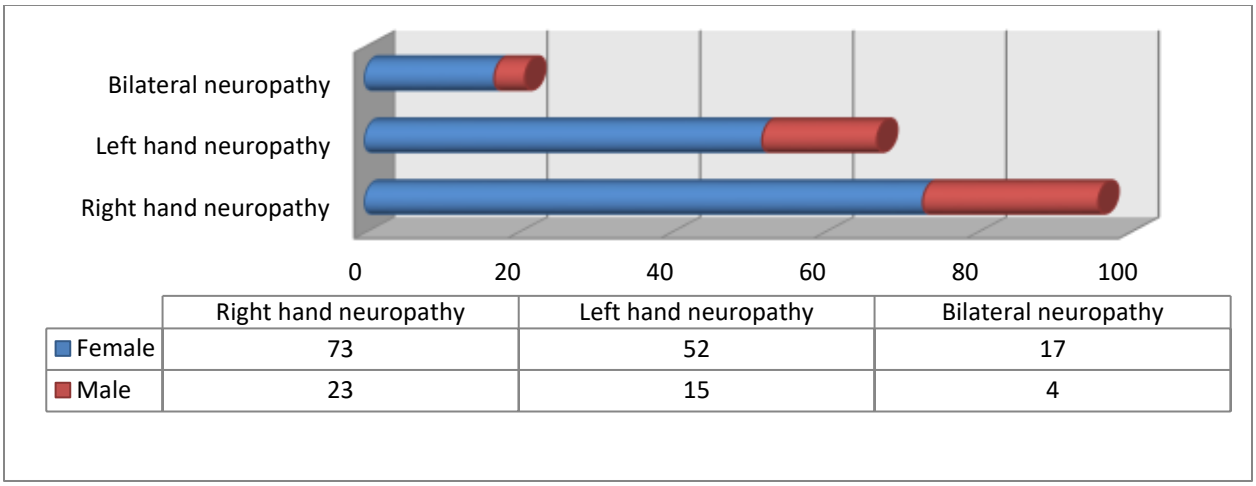


Figure 15. Age and gender distribution of patients.



	Right hand neuropathy	Left hand neuropathy	Bilateral neuropathy
Female	73	52	17
Male	23	15	4

Figure 19. Report of unilateral (left / right) and bilateral impairment by sex.

There is a clear predominance of the number of cases of carpal tunnel syndrome in the right hand - which can be explained by the occupational nature of the etiopathogenesis of the disease, compared to the damage to the left hand.

Bilateral damage is found in a number of 21 patients, in various stages. Most patients with bilateral carpal tunnel syndrome have been associated with systemic impairment, which may contribute to nerve lysis in both hands. The clear preponderance of the female sex is noted, regardless of the location of the median nerve damage.

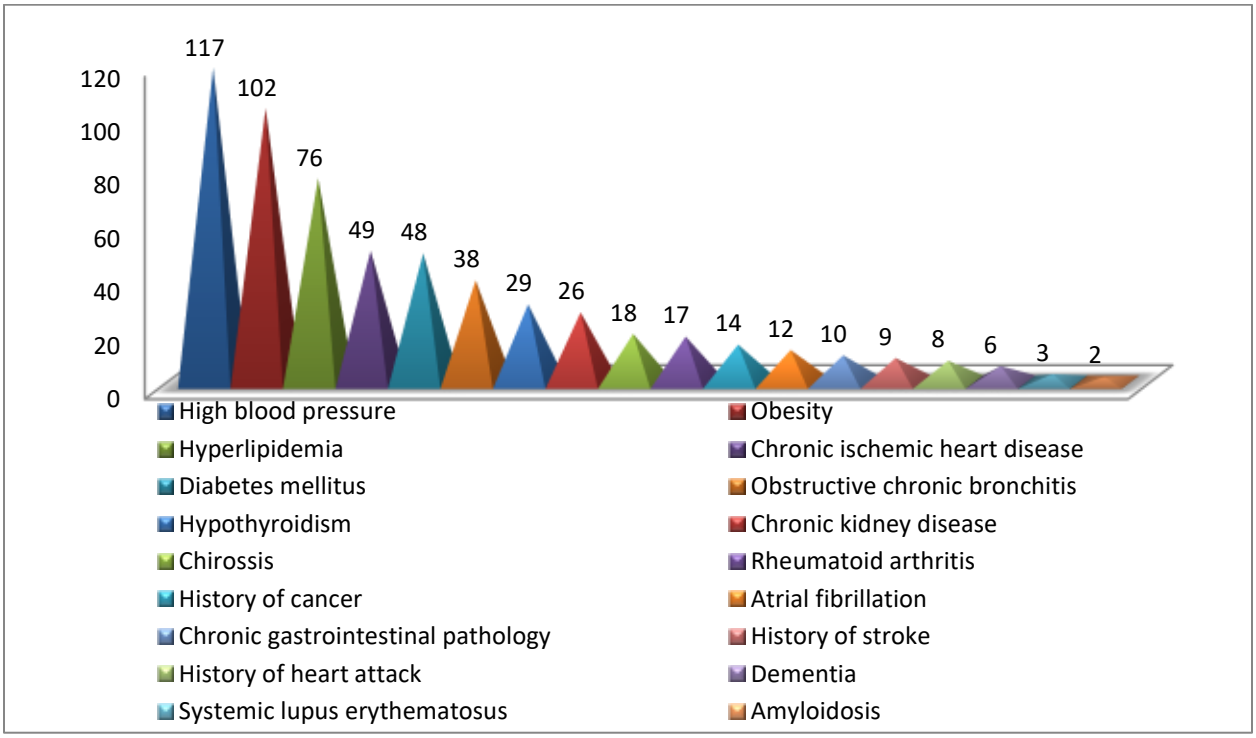


Figure 23. Pathological personal history at admission.

In the study group, 131 patients with at least one disease associated with carpal tunnel syndrome were confirmed. I specify that the patients who discovered in the routine investigations, at the time of the presentation in the clinic, other pathologies that were newly diagnosed, were also taken into account.

The 32 patients without associated disease showed no biochemical changes or occupational risk factors and were diagnosed with idiopathic carpal tunnel syndrome.

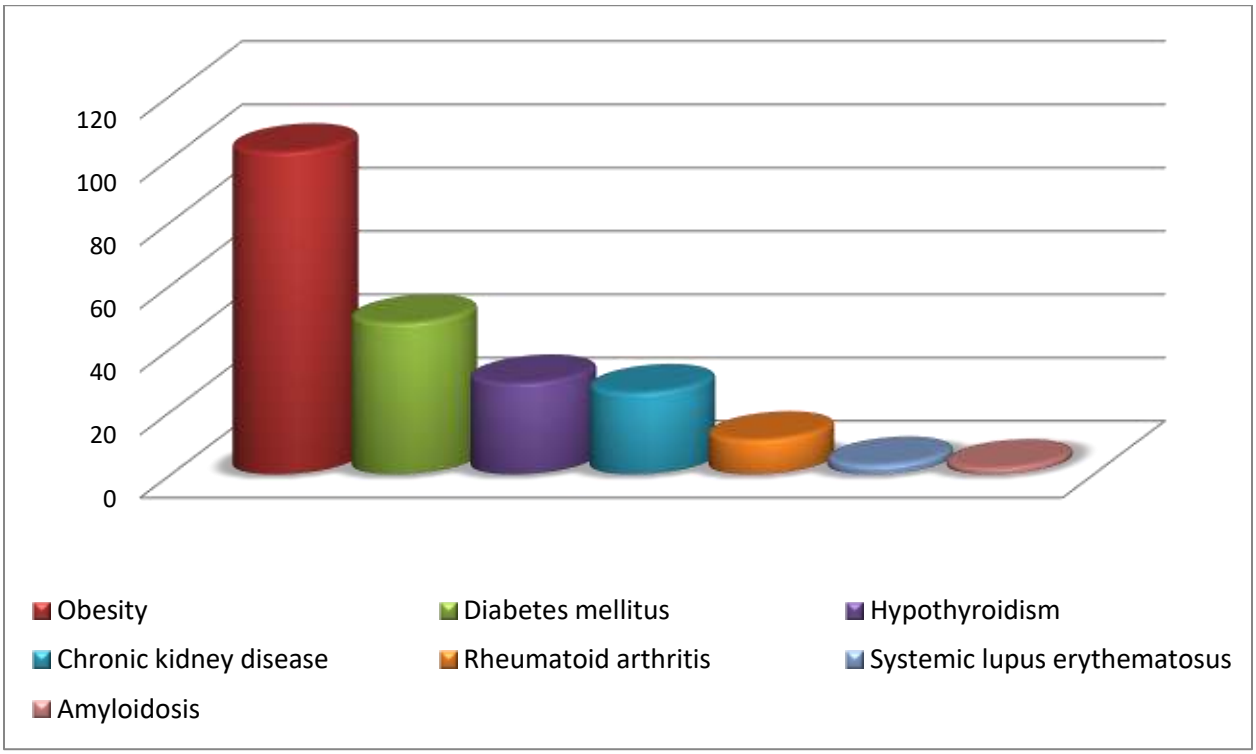


Figure 24. Associated pathology - in relation with the development of neuropathy.

The pathology that patients presented to the clinic is diverse, with certain diseases that predispose to the appearance and maintenance of carpal tunnel syndrome. Unfortunately, the most commonly diagnosed diseases in the study group contribute to the etiopathogenesis of median nerve damage.

A particularly important role due to the extremely high prevalence is represented by the metabolic syndrome (hypertension - obesity - diabetes), occupying the first places in the results of the study.

A relatively large number of patients were found who were not in the therapeutic targets for various associated chronic diseases (36%), and those who contribute to the development of carpal tunnel syndrome can thus accelerate the rate of nerve damage.

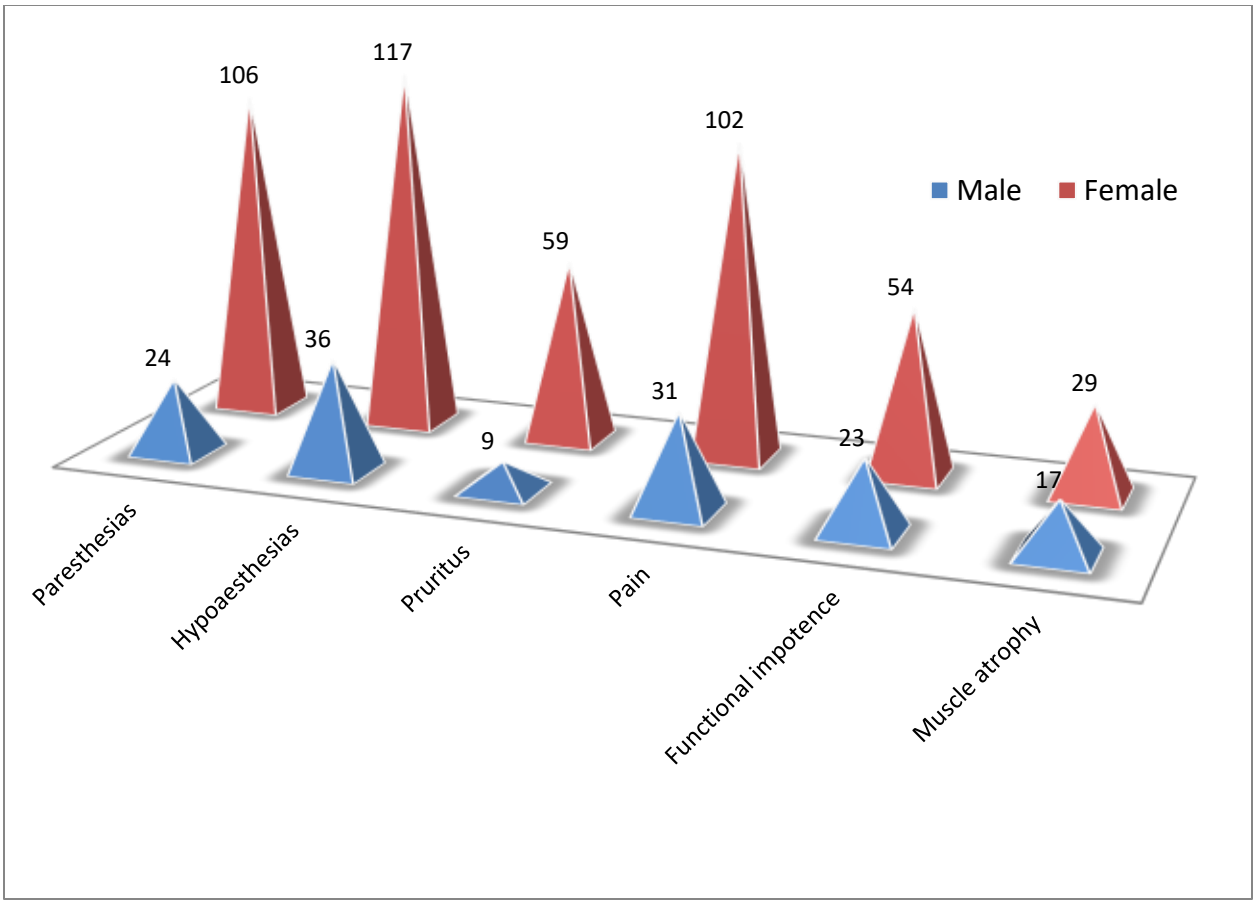


Figure 26. Symptoms at admission in the clinic.

The symptoms and signs that patients presented in the clinic are characteristic of carpal tunnel syndrome, in most cases - two or three symptoms coexisting, depending on the stage of the nerve damage.

The most common symptoms were paresthesias, hypoaesthesia and pain, followed by pruritus and later muscle atrophy and functional impotence, characteristic of an advanced stage of the disease.

The higher number of cases in females maintains the superiority of the ratio in each of the symptoms of presentation in the clinic.

Tinel and Phanel sensitivity tests were performed on all patients in the study, which tested positive in 99% of cases.

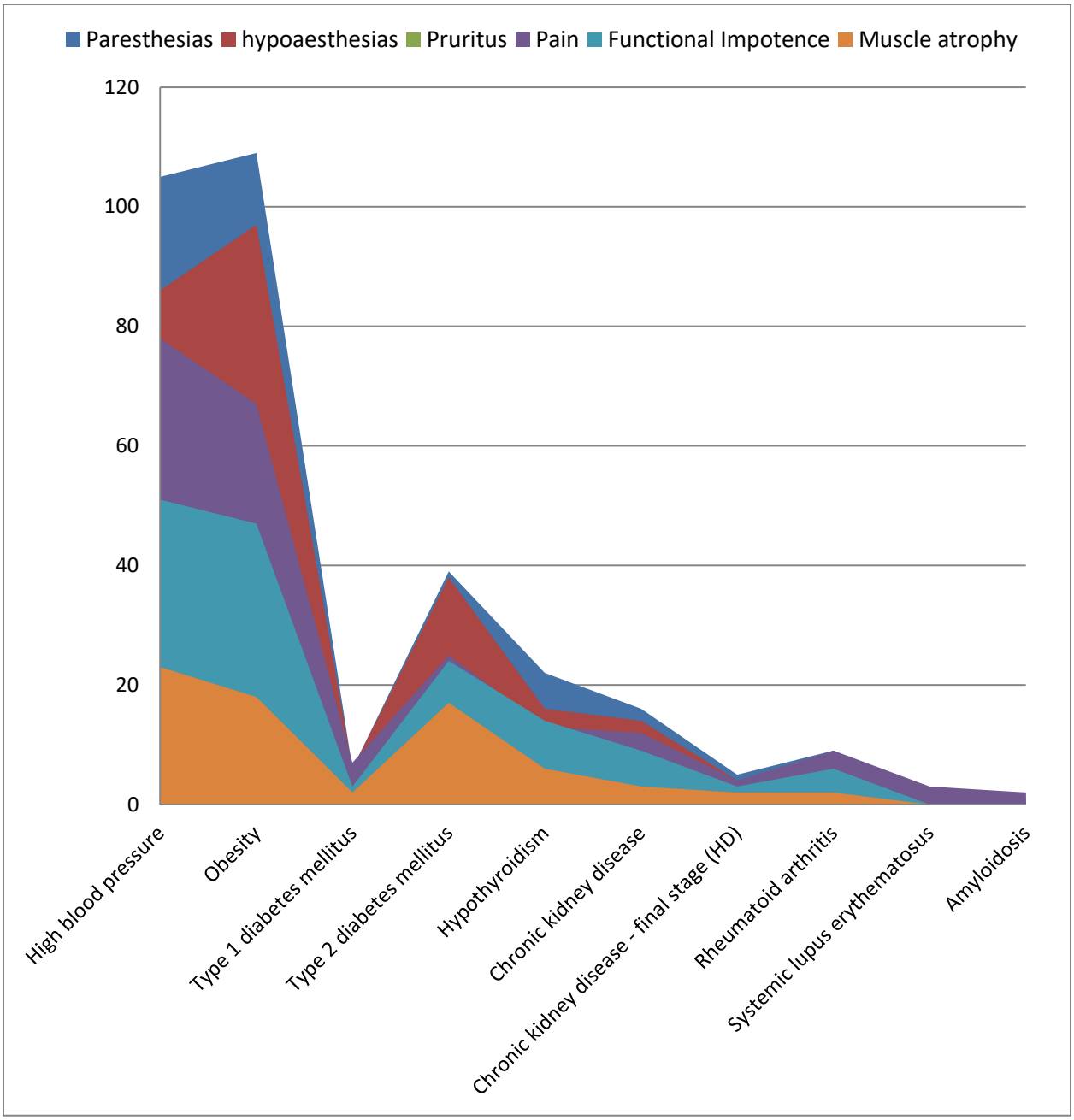


Figure 28. The ratio of the main symptoms, in relation to the associated pathology.

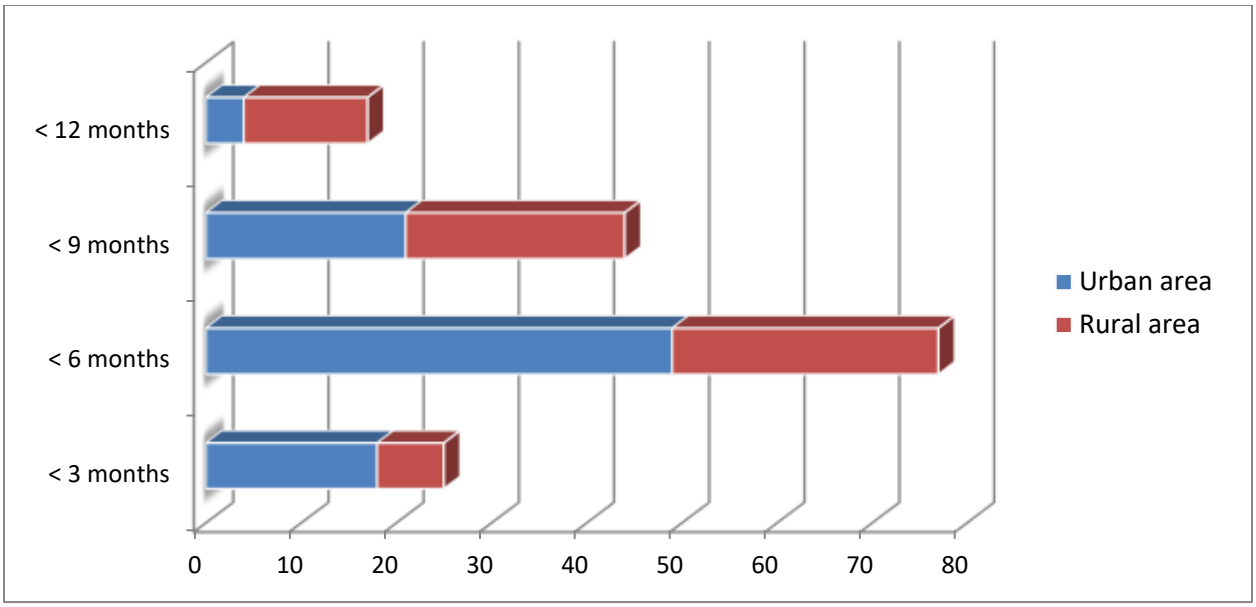


Figure 29. Time interval between onset of symptoms and surgery.

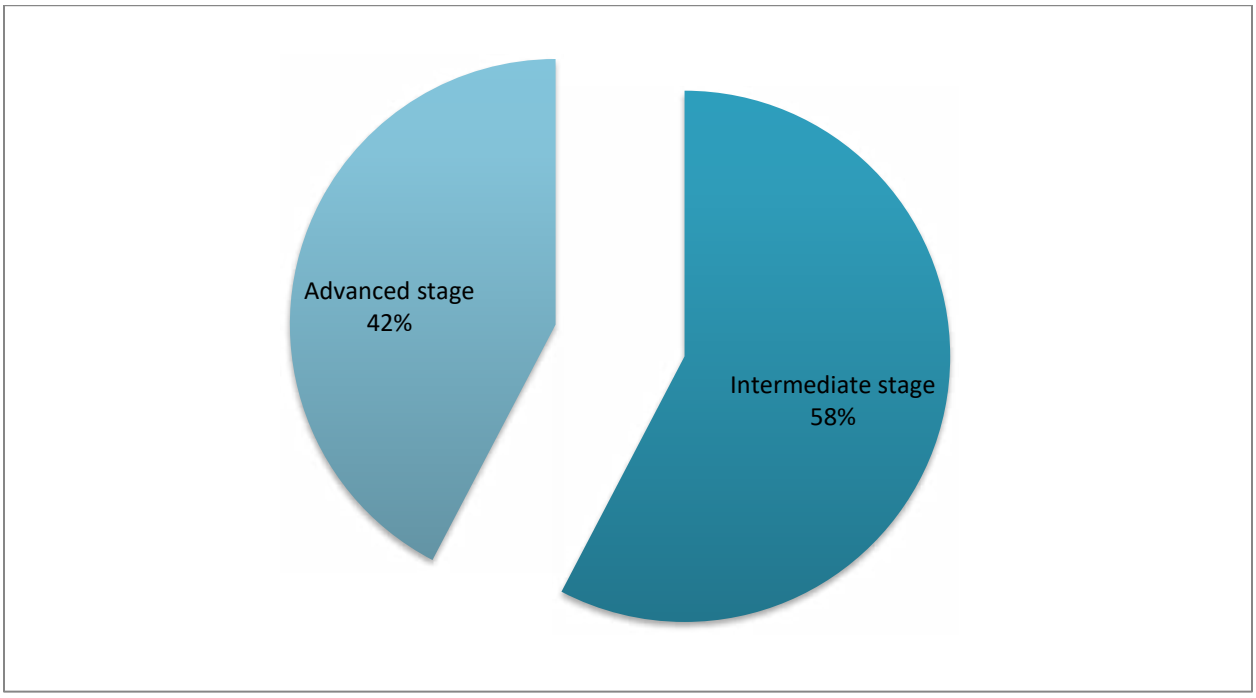


Figure 31. Stage of median nerve damage at admission.

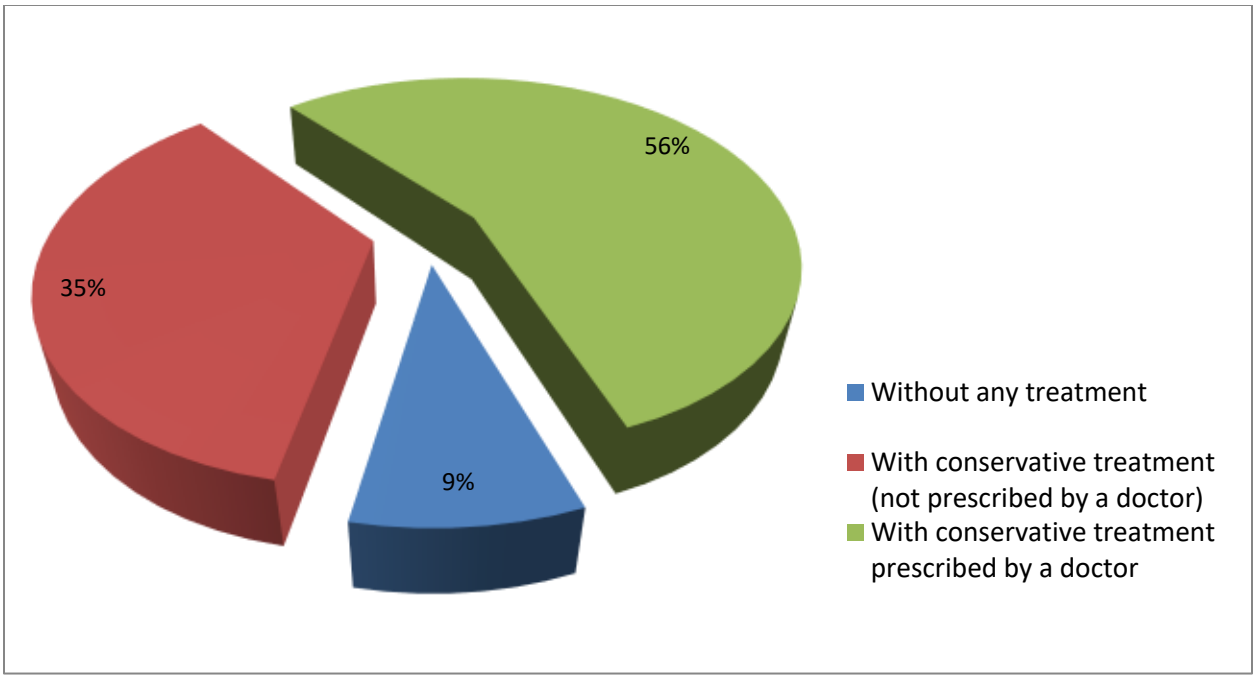


Figure 32. Relationship between patients without preoperative conservative treatment and those with treatment recommended or not recommended by a healthcare professional.

For all patients included in the study, the classic open technique was used for the decompression surgery of the median nerve, represented by the sectioning of the transverse ligament of the carpus.

Although some patients had symptoms and signs specific to an intermediate stage carpal tunnel syndrome, which could indicate a temporary continuation of conservative treatment, it was decided, explaining the risks and benefits of the patient's disease, in all cases, the surgical treatment.

Avoiding procrastination of curative surgery is a key factor in the management of the disease, due to the insidious and disabling characteristics of carpal tunnel syndrome, which often progresses with a minimal clinical picture, to advanced degrees of nerve lysis.

III. PROSPECTIVE CLINICAL STUDY

III. 1. OBJECTIVES AND PERSPECTIVES

The purpose of this study is to verify and validate current methods of diagnosis and treatment of carpal tunnel syndrome.

This compressive neuropathy is diagnosed and treated in several specialties (plastic surgery, orthopedics, neurosurgery, general surgery but also neurology or physical and rehabilitation medicine), so the need for quick and clear diagnostic methods is imperative in the fight against of this disease - at present, in Romania, a diagnostic strategy is not implemented that can speed up the diagnosis of the disease.

It is known that some diseases, common in the population (diabetes, hypothyroidism, chronic kidney disease, obesity) predispose, maintain and aggravate the carpal tunnel syndrome. Certain movements or positions of the wrist have the same effect, if they are maintained for a sufficiently long period of time, as is usually the case in the professional environment. The connection between the nervous suffering and the external stimulus (vibrations, compression) can be made directly, being proven the appearance or aggravation of the symptoms with the application of measures with a negative impact on the wrist.

The objectives of this study are to assess the stage of carpal tunnel syndrome with which patients present to the clinic, as well as the diagnostic methods used to establish appropriate treatment.

Objectification of nerve lesions with the help of magnetic resonance imaging proves, once again, the postponement of the presentation to the doctor, which requires invasive curative interventions, due to the advanced stages of damage of the median nerve.

The implementation of a diagnostic and treatment algorithm, generally applicable in any specialty that treats this neuropathy, would be extremely useful to avoid delaying therapy and obtaining a superior medical result.

Carpal tunnel syndrome is a disabling disease that puts society under great strain, both in terms of human resources and finances. Thus, a quick and efficient resolution of cases would allow the reintegration of patients into society, releasing the stress applied to both the patient and the medical system.

An algorithm for the management of this disease should be based on the combination of clinical data with paraclinical or imaging data, in order to establish a complete treatment that

eliminates both local suffering and systemic factors that may impose an unfavorable long-term evolution.

The warning of individuals with risk factors, pathological or occupational, must be implemented at the level of general medicine or occupational medicine offices, so that, at the first symptom of the disease, the diagnosis is established and treatment is imposed immediately.

Adherence to clear rules and a disease management algorithm leads to the avoidance of human error, with successful therapeutic results.

III. 2. MATERIAL AND METHOD

I performed the study on a group of 23 patients who presented at the County Clinical Hospital "Sfântul Andrei" in Constanţa, in the Plastic Surgery Department, between 01.04.2019 - 30.09.2020 (duration of the study - 18 months), with symptoms suggestive of carpal tunnel syndrome. I mention that all the patients included in the study were informed about the motivation and purpose of the study and gave their consent.

The studied group is represented by adult patients, of both sexes, both from urban and rural areas. Both patients with idiopathic carpal tunnel syndrome and associated pathologies were enrolled.

The suspicion of carpal tunnel syndrome was established based on clinical examination, the anamnesis of patients being characteristic of this condition (paresthesia, hypoaesthesia, pain or decreased muscle strength). Signs of carpal tunnel syndrome (advanced stage) - tenor muscle atrophy have been noted. Specific sensitivity tests were also performed: Tinel, Phalen, Durkan.

The investigation of choice used in this study is represented by magnetic resonance imaging, due to its superiority in terms of objectification of median nerve damage. At the same time, this imaging exploration may reveal local causes that may contribute to the development or worsening of carpal tunnel syndrome. In selected cases, patients also benefited from electrophysiological studies, in order to corroborate the results with objective clinical examination, imaging and intraoperative appearance.

All patients included in the study presented at the MRI examination images characteristic of carpal tunnel syndrome, being clearly objectified morphological changes of the median nerve but also of the anterior carpal ligament. Changes in the shape and size of the median nerve were the main aspects of the study, and staging and treatment criteria were established based on nerve circumference at the site of compression.

The study was not restrictive, but the exclusion criteria were applied to patients who did not comply or could not tolerate magnetic resonance imaging.

All the studied patients were treated surgically in the Plastic and Burn Surgery Department of the Constanța County Hospital, after the clinical and paraclinical \ imaging investigations using the classical / open technique. The use of surgical treatment by the classical approach was chosen for the macroscopic visualization of the morphological changes of the median nerve - especially the narrowing of the nerve diameter at the site of compression.

III. 3. RESULTS

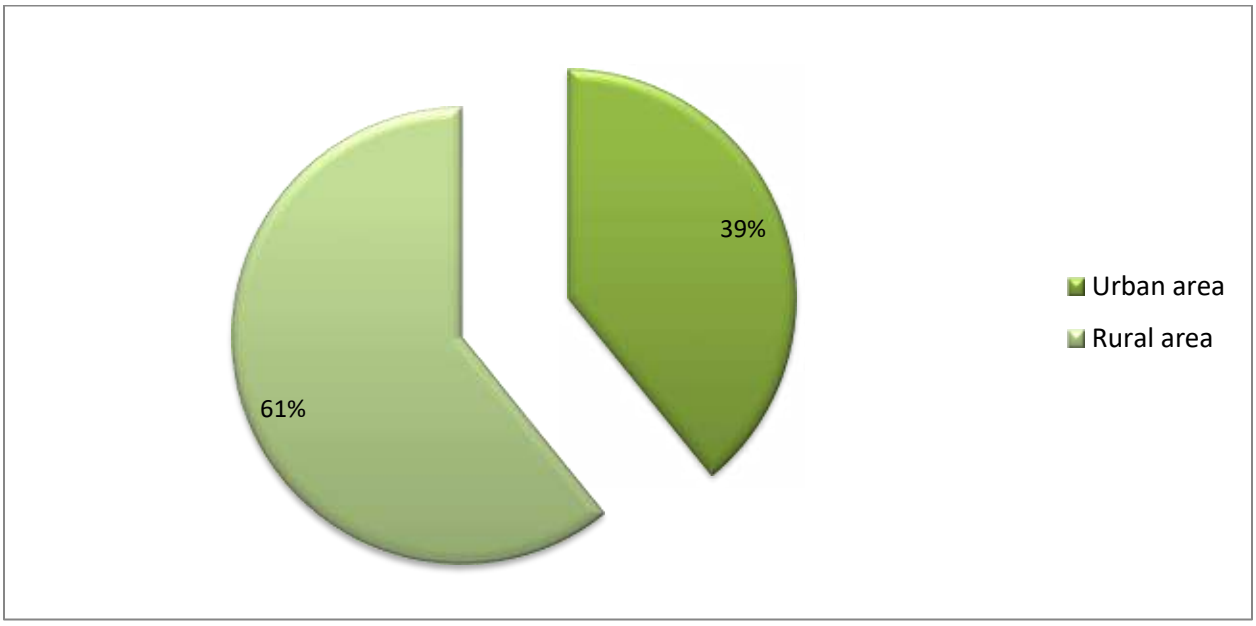


Figure 34. Patient ratio by background.

The 23 patients enrolled in the study are represented by 17 women and 6 men, as follows:

Women:	Men:
• 30 - 39 years: 1 case	30 - 39 years: 0 cases
• 40 - 49 years: 3 cases	40 - 49 years: 1 case
• 50 - 59 years: 6 cases	50 - 59 years: 3 cases
• 60 - 69 years: 7 cases	60 - 69 years: 2 cases

The frequency of the affected hand in carpal tunnel syndrome is approximately equal (left hand - 11 cases, right hand - 12 cases), and there are 5 cases of bilateral carpal tunnel syndrome. The predominance of the disease in males was higher for the right hand, raising the suspicion of an etiology related to the field of work for patients with the dominant right hand. In the case of bilateral carpal tunnel syndrome, only one case was noted for males, in the advanced stage of the disease in the right hand and with minor suggestive symptoms for the left hand.

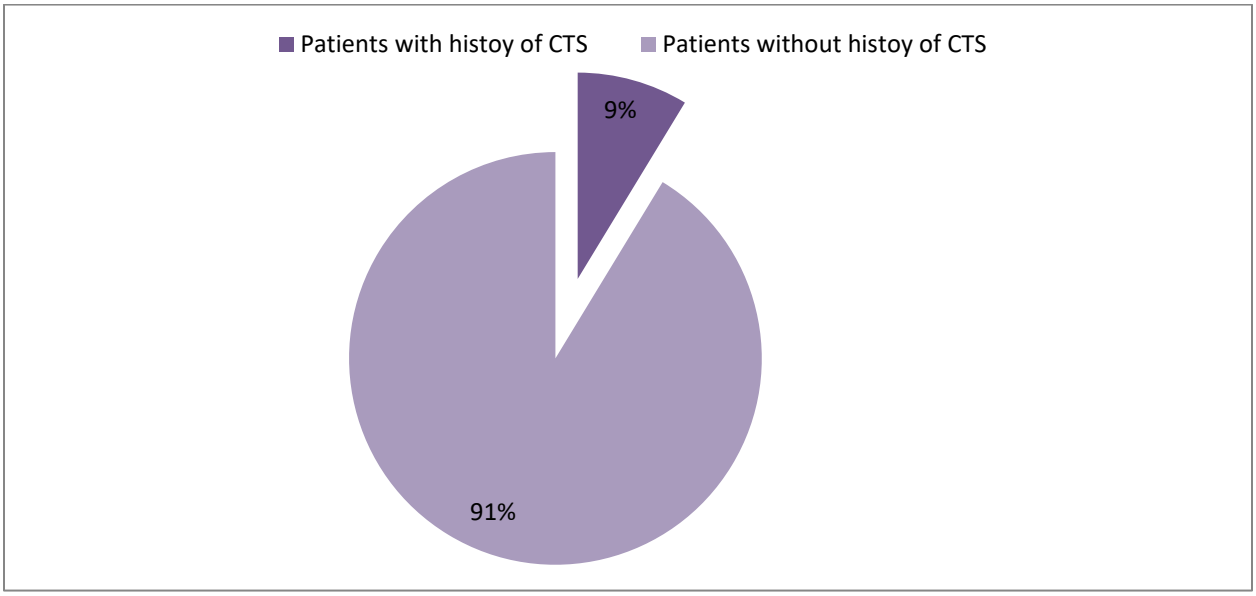


Figure 41. Ratio of patients with a hereditary history of carpal tunnel syndrome.

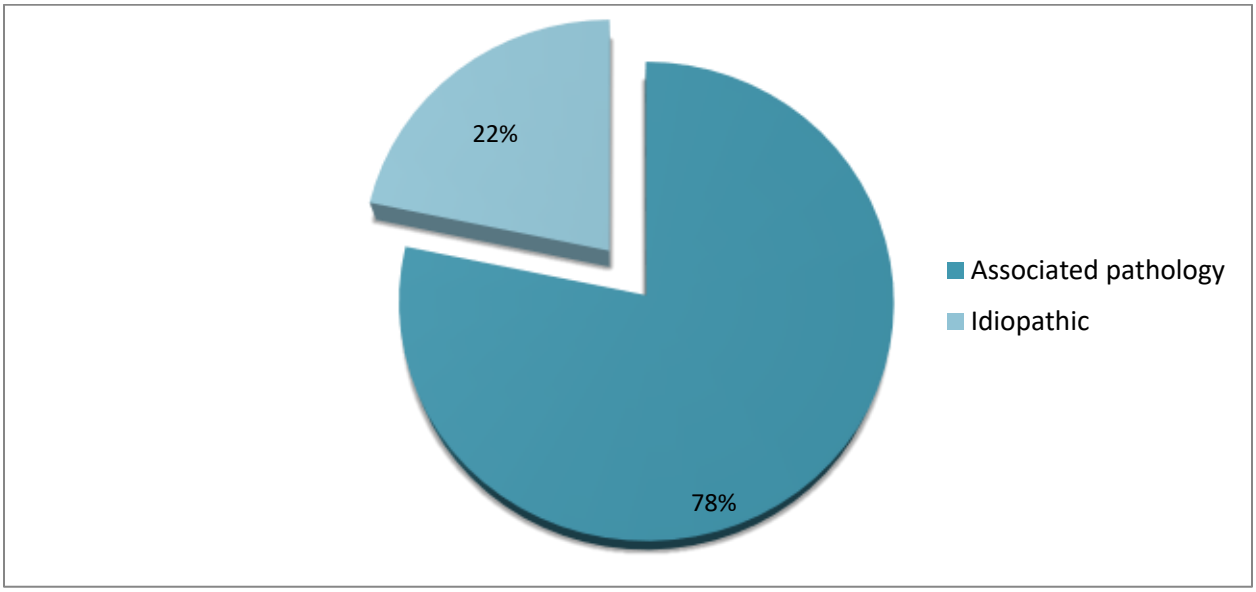
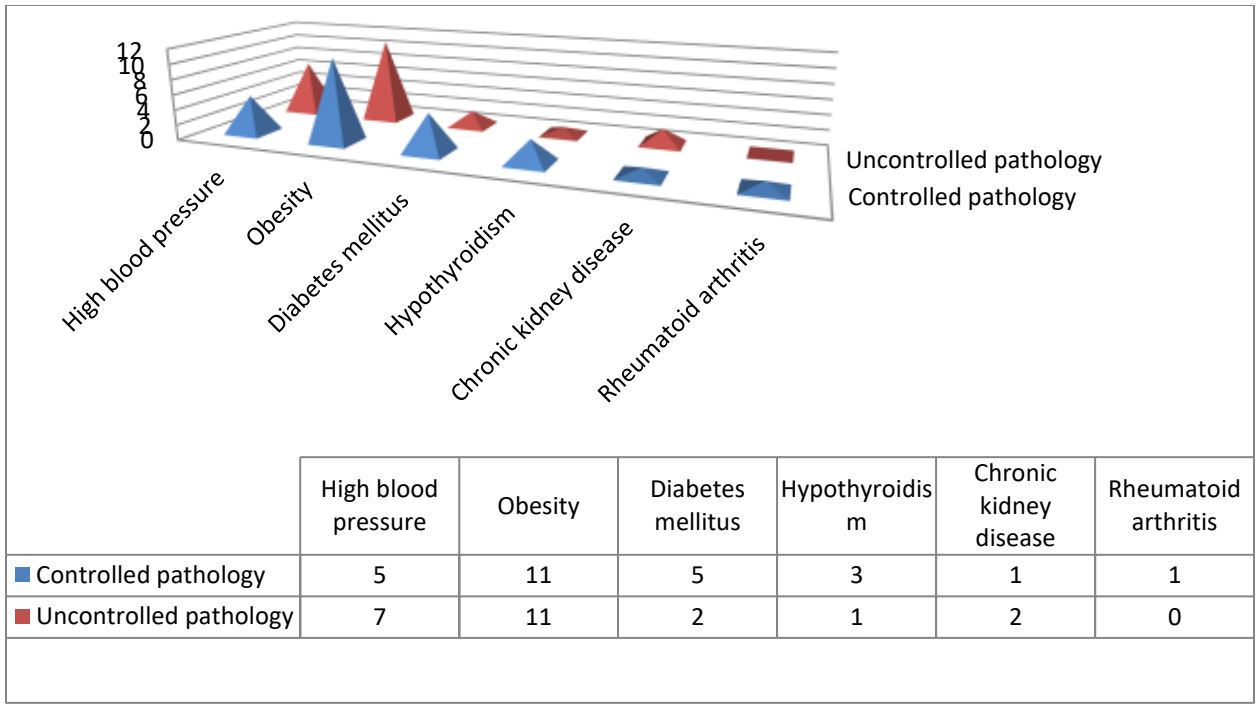


Figure 43. The ratio between patients associated with other pathologies and patients with idiopathic neuropathy (18 patients with associated diseases, 5 patients with idiopathic syndrome).



	High blood pressure	Obesity	Diabetes mellitus	Hypothyroidism	Chronic kidney disease	Rheumatoid arthritis
Controlled pathology	5	11	5	3	1	1
Uncontrolled pathology	7	11	2	1	2	0

Figure 45. The ratio between compensation and decompensation of the associated pathology at the time of admission.

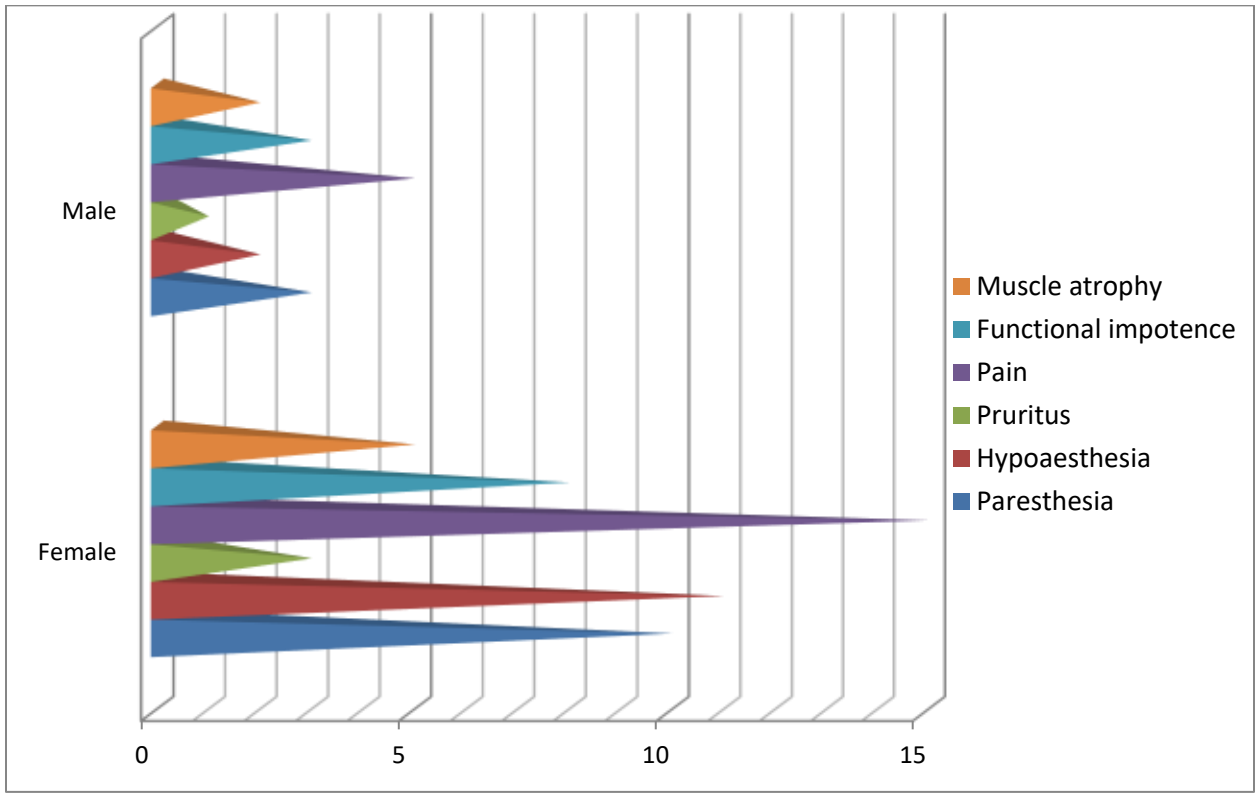


Figure 46. Gender ratio for symptoms confirmed at admission.

The predominant symptom in the studied group, which determined the presentation to the doctor, in most cases, is the pain - at the level of the palm and wrist. Hypoaesthesia and paresthesia have been reported in about half of the cases in both sexes. A high percentage is observed for partial functional impotence of the hand and tenarian muscular atrophy, specific for advanced stages of median nerve lysis.

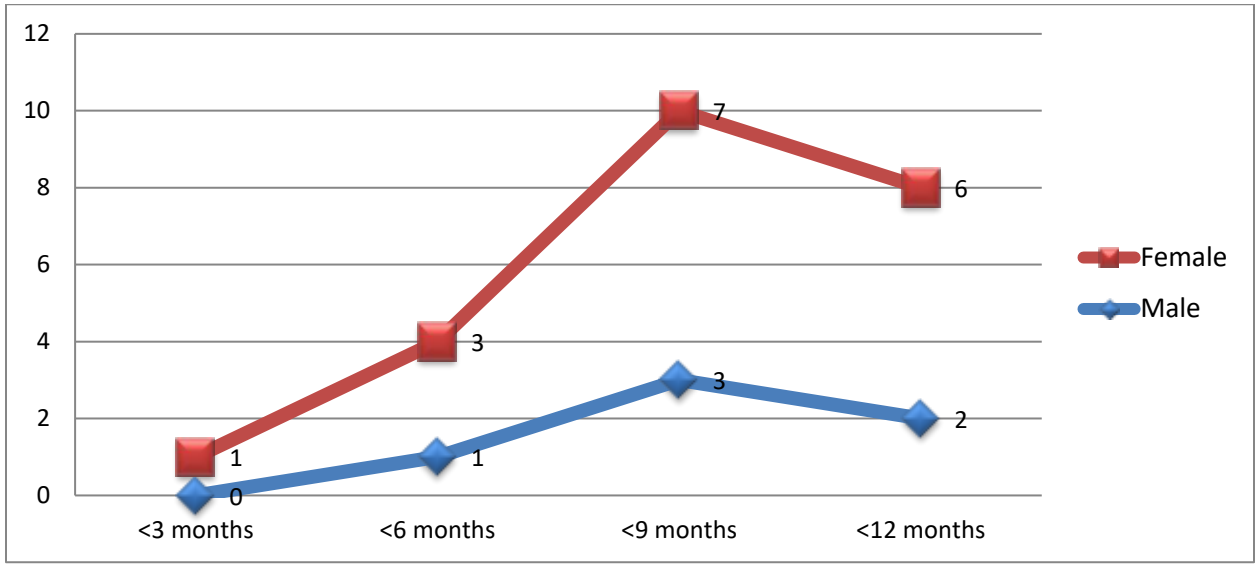


Figure 47. Gender ratio for the length of time since the onset of symptoms and presentation to the doctor.

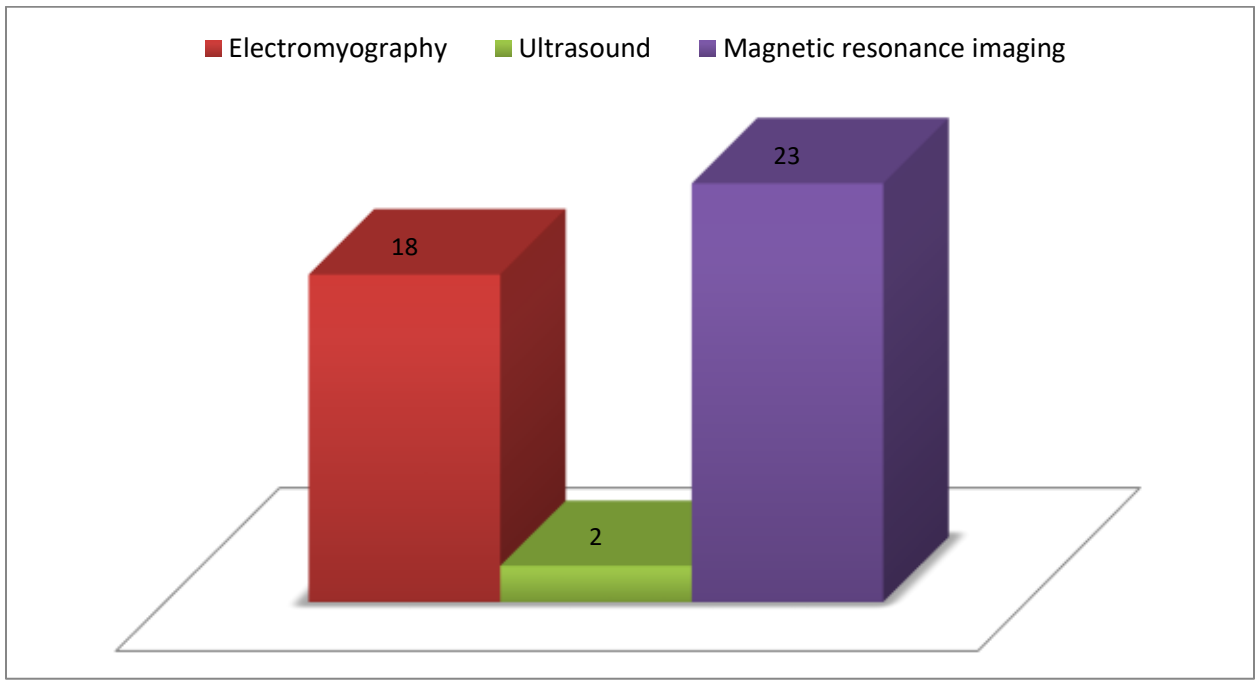


Figure 49. Electrical and imaging explorations used for the study.

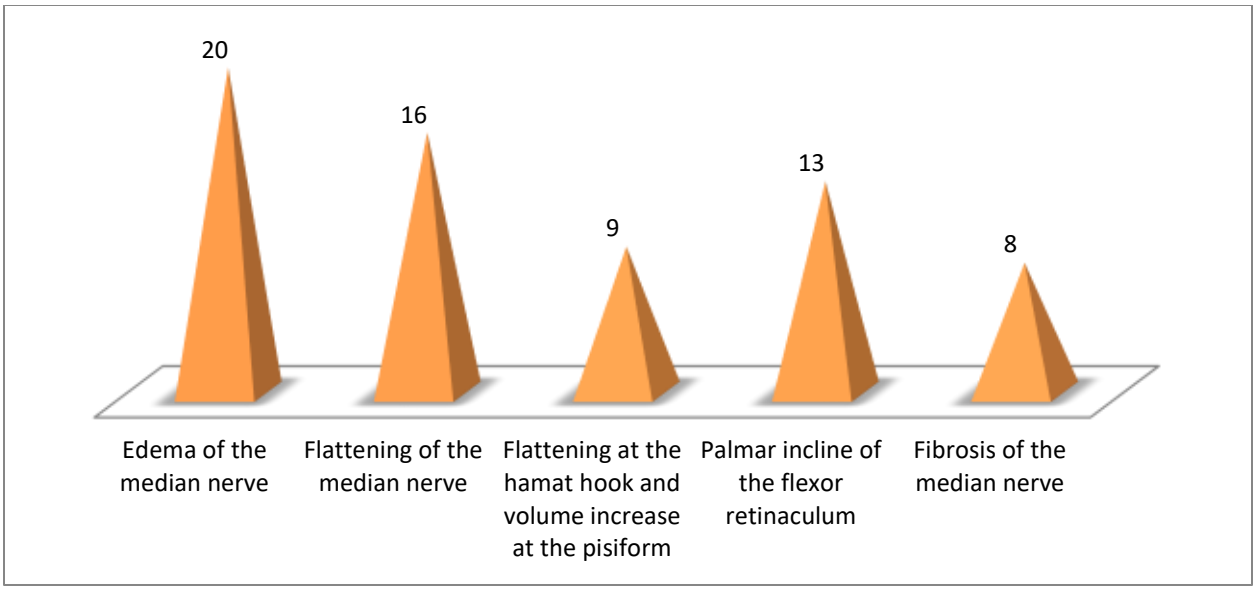


Figure 50. Incidence of morphological changes visible by MRI examination.

The number of morphological changes identified by magnetic resonance imaging is increased, especially characteristic of the advanced and intermediate stages. The main feature of the median nerve, in carpal tunnel syndrome, is edema, followed by changes in shape and size but also by altering the position of the flexor retinaculum.

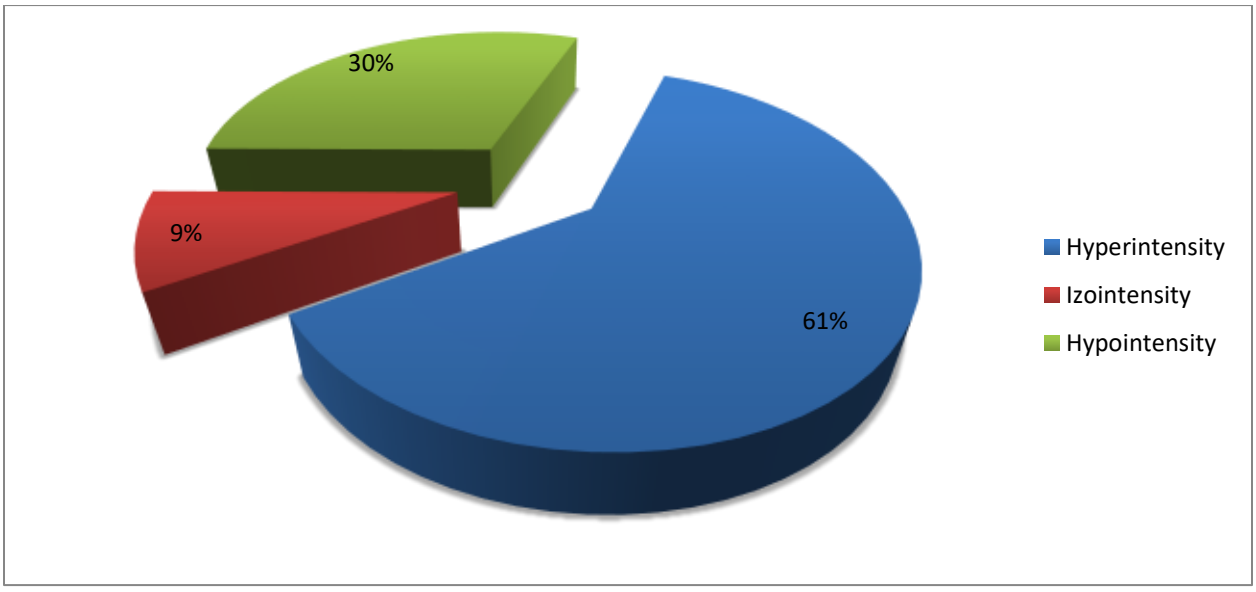


Figure 51. Ratio of the median nerve signal in the T2 MRI sequence.

The median nerve hypersignal on magnetic resonance imaging is specific for carpal tunnel syndrome, is present in 61% of patients studied and represents its edema, as well as the loss of myelin fibers. most likely due to the presence of fibrosis tissue formed as a result of a long course of the disease.

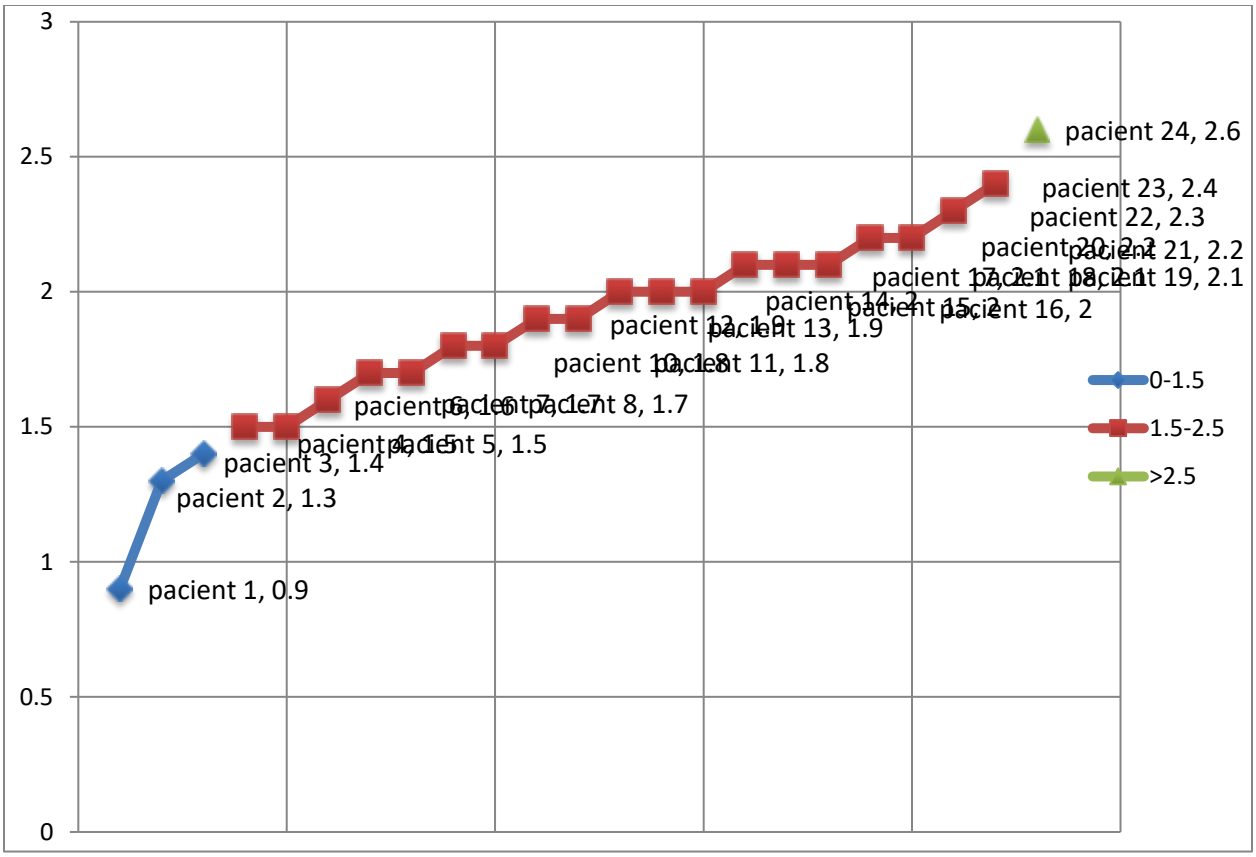


Figure 52. Reduction in diameter of the median nerve at the site of compression, for each patient in the study group.

There is an extremely high incidence of reduction in diameter of the median nerve, over 1.5 mm at the site of compression, the minimum limit set in the study for the recommendation of surgery, only on this criterion.

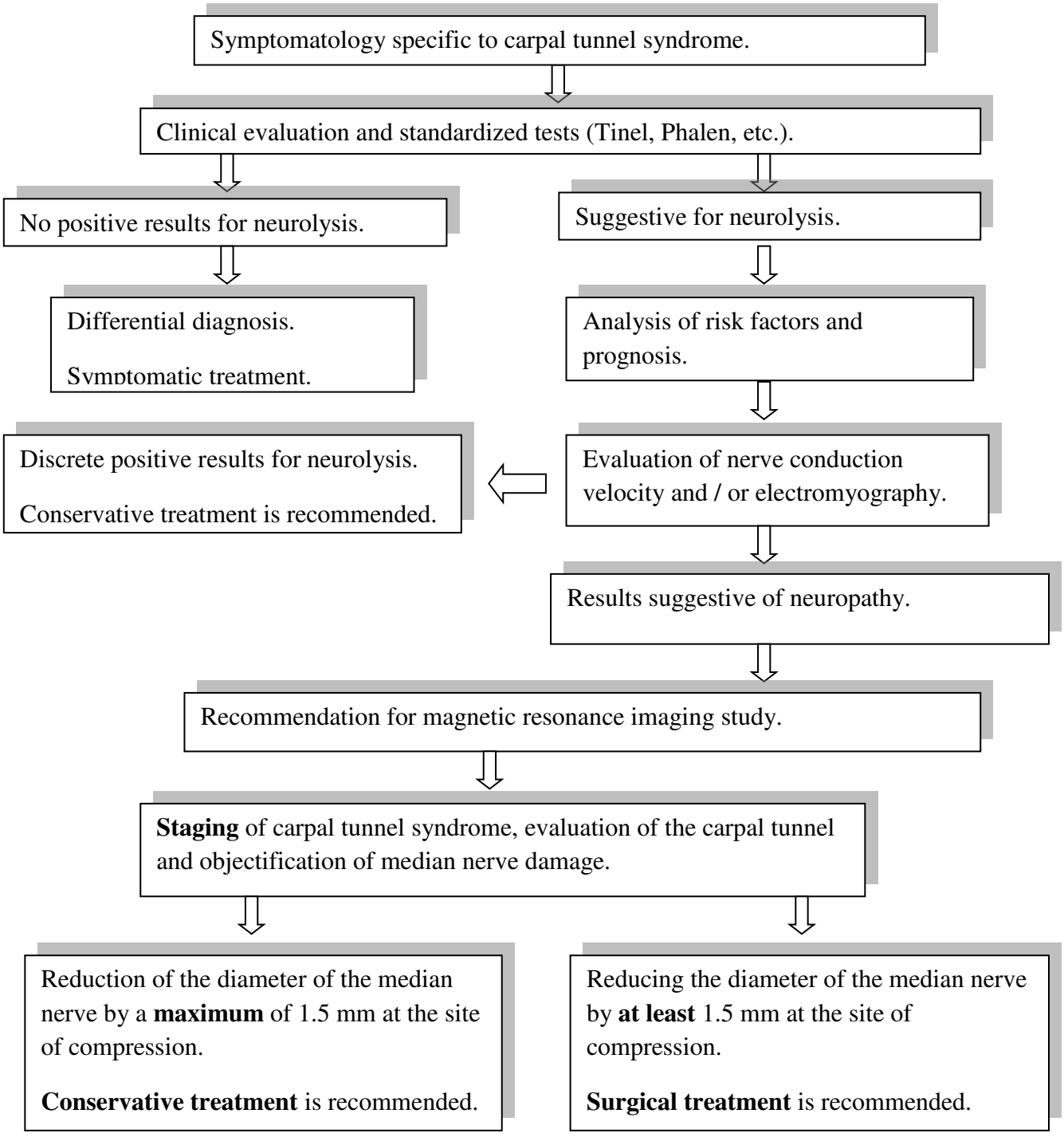
A number of 19 patients showed diametrical changes between 1.5 and 2.5 mm at the site of compression, and one case noted a decrease of 2.6 mm.

Three patients were below the 1.5 mm threshold, but with a clinical picture that advocated for immediate curative surgical treatment, in order to avoid the evolution of neuropathy.

Parameters	Criteria	Points
Sex	Female Male	0.5 0
Age	<30 years >30 years	0 1
At risk pathology	Absent Present	0 1
Occupational factor	Absent Present	0 1
Paresthesia / Hypoaesthesia	Absent Present, only at night Present	0 0.5 1
Pain	Absent Present, only at night Present	0 1 2
Functional impotence	Absent Present	0 3
Electric tests	Negative Pozitive	0 3
Reduction in diameter of the median nerve at compression site	<1.5 mm >1.5 mm	0 3
Symptoms relief with conservative treatment	Yes No	0.5 2

Risk group	Prognosis	Total score
A	Good, characteristic of an early carpal tunnel syndrome.	0 – 4
B	Requires consultation and specialized treatment.	4– 8
C	Surgical treatment is required as soon as possible.	>8

III. 5. PROPOSAL OF DIAGNOSIS AND THERAPEUTICS ALGORYTHM



VIII. ILLUSTRATIVE CLINICAL CASES

CASE 1

A 53-year-old obese patient presents to the clinic for paresthesias and pain in the right wrist, exacerbated especially during the night, which began 3 months ago.

From the anamnesis we found hypothyroidism, high blood pressure and mixed dyslipidemia. The associated pathology is in the therapeutic targets at the time of presentation in the clinic.

She was treated with nonsteroidal anti-inflammatory drugs, administered locally and orally, but without complete therapeutic success, with the constant recurrence of symptoms.

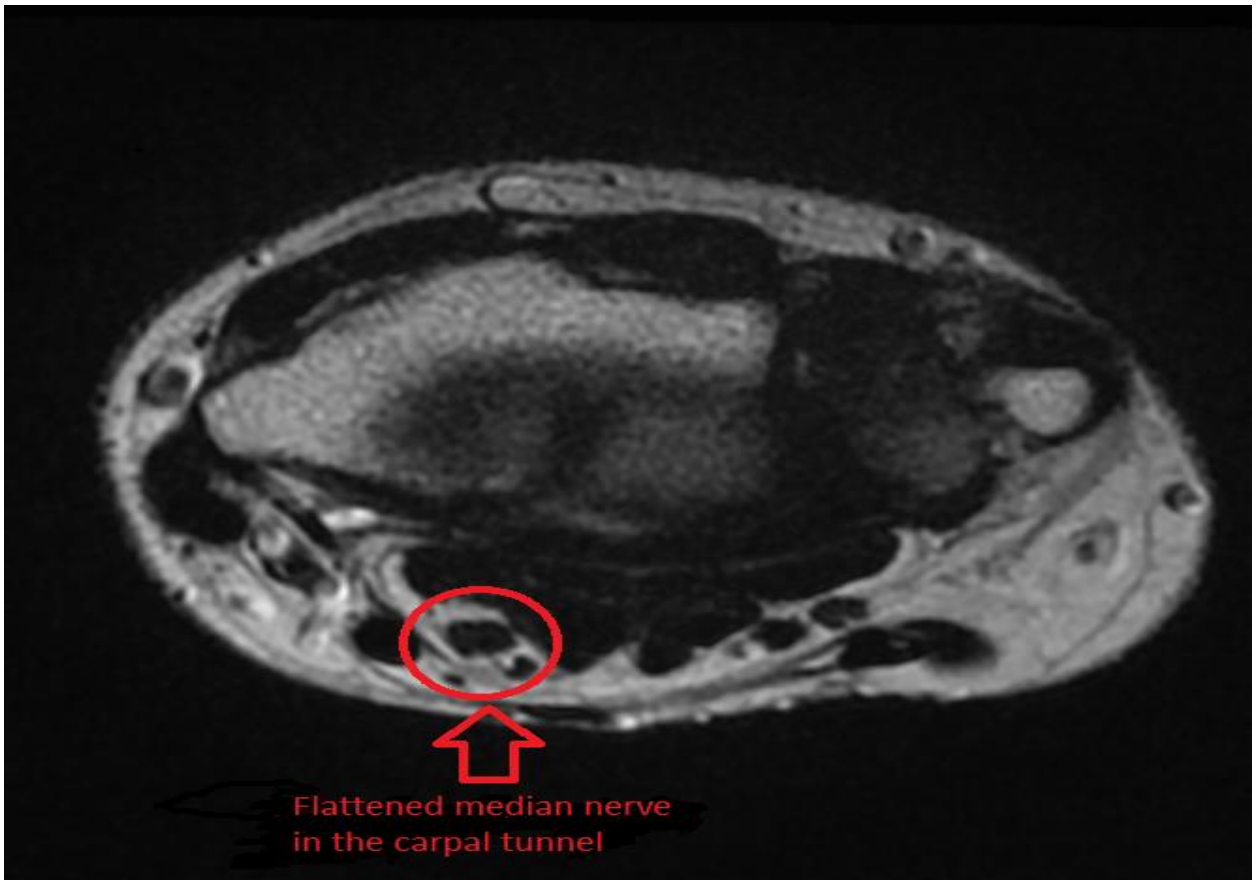


Figure 55. Preoperative MRI - flattened aspect of the median nerve.

Clinical examination shows specific positive signs of sensitivity - Tinel and Phalen tests were applied. Objectively, the tenar muscle is not affected, being possible to perform bi-digital forceps.

The patient underwent electromyography, with a specific result for carpal tunnel syndrome and MRI, for imaging of the characteristics of the median, preoperative nerve.

The therapeutic technique used was the classic, open, with complete resection of the flexor retinaculum.

Figure 57. Intraoperative aspect - Highlighting the anterior carpal ligament after sectioning its ulnar insertion.

CASE 2

A 58-year-old male patient presents to the clinic for persistent pain in his left wrist, with partial motor deficit, especially for bi-digital forceps.

The symptoms started about 8 months ago, but were neglected - the patient did not consult any specialist and underwent non-specific analgesic treatment.

Pathological history of type 2 diabetes mellitus, with insulin deficiency, high blood pressure and mixed dyslipidemia.

The anamnesis describes a poor control of the associated pathology, with glycemias outside the therapeutic targets and oscillating blood pressure values.

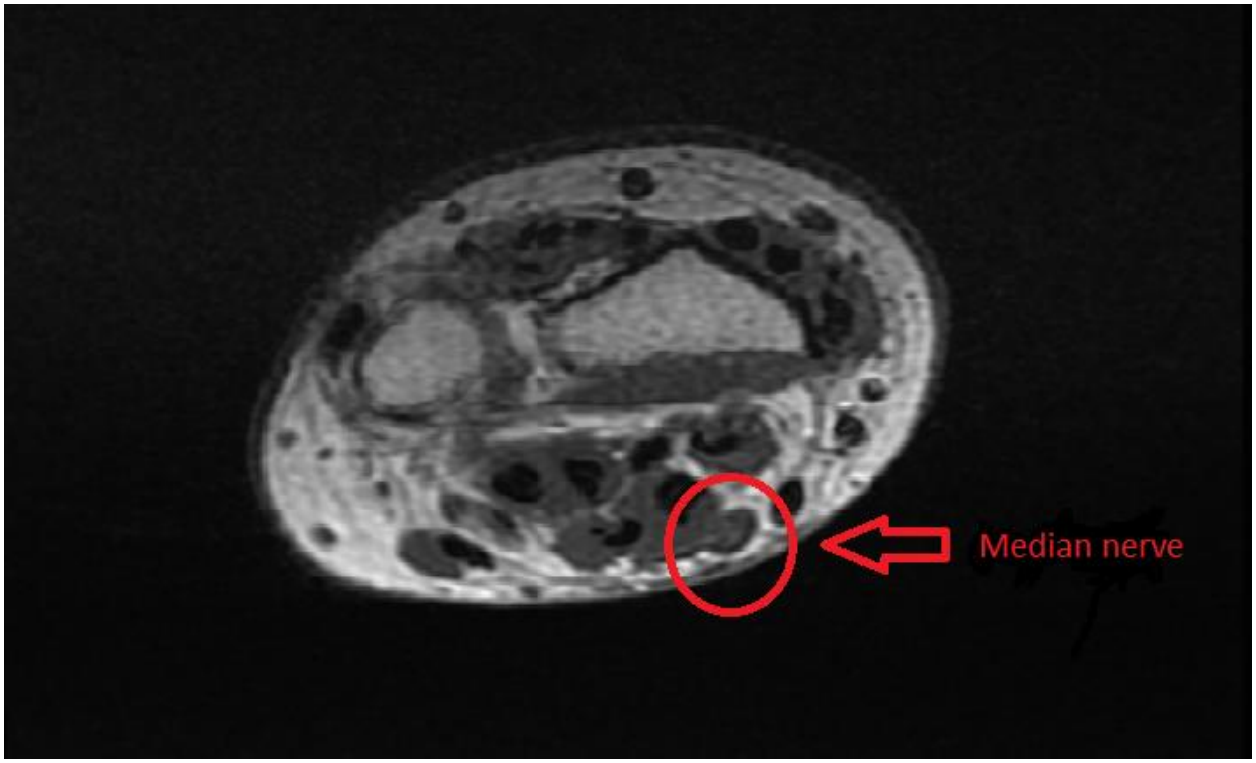


Figure 58. Median nerve with small diameter, characteristic of advanced neuropathy.

The objective examination does not describe the atrophy of the tenar muscle but the patient has difficulties in achieving bi-digital forceps. The Tinel and Phalen tests are positive.

He benefits from electromyography and magnetic resonance imaging, preoperatively, which confirmed the clinical data and showed the narrowed median nerve at the site of compression, thus confirming the advanced stage of neurolysis.

The classical surgery method was preferred as it provided a specific intraoperative image for advanced median nerve damage.

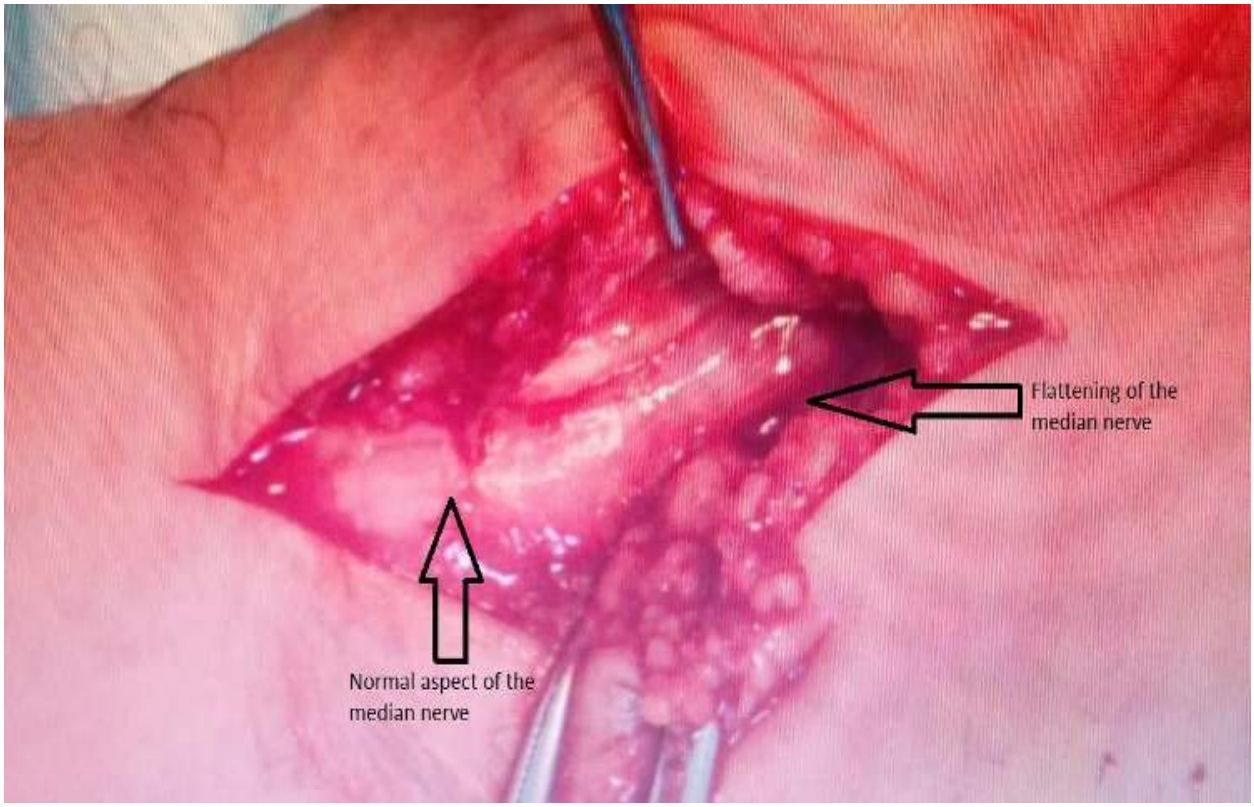


Figure 60. Intraoperative aspect – Median nerve with much narrower diameter at the site of compression.

X. CONCLUSIONS

- Compressive neuropathies of the upper limbs are some of the most common disabling conditions in the clinic, with an incidence constantly increasing, explained both by the association of predisposing pathologies and by the increasing of the addressability of patients to the doctor, resulting in diagnosing neuropathy by specific methods.
- Among the compressive neuropathies of the upper limb, carpal tunnel syndrome is the most common condition, which has a higher incidence for females, the most affected decades being the fourth, fifth and sixth, occurring in both patients from both urban and rural areas.
- Although access to medical services is much easier today, the diagnosis of carpal tunnel syndrome is still delayed, most patients treat this condition superficially, with advanced stages of neurolysis a few months after the onset of symptoms, where the only indication remains surgery.
- The etiology of neuropathy is incompletely elucidated, revealing multiple diseases or external factors, which influence the appearance, evolution and prognosis of carpal tunnel syndrome.
- The identification of all risk factors for the development of neuropathy involves clinical and paraclinical examinations, recommended by a multidisciplinary medical team, to evaluate and treat the patient, in order to complete clinical-metabolic balance.
- The vast majority of the patients studied presented at least one associated pathology and over half of them were not in the therapeutic targets of the diseases, which raises an important alarm signal.
- Metabolic syndrome occupies a leading place in terms of the conditions with which patients with neuropathy have been diagnosed. Obesity and diabetes are known due to its negative effects on the peripheral nervous system and, implicitly, on the median nerve, in the carpal tunnel.
- Vicious positions and movements are another factor that aggravates the symptoms of neuropathy, a relevant number of patients were able to confirm the presence of activities that increase the pressure inside the carpal tunnel and contribute to neurolysis.
- Urban patients tend to intervene more quickly on neuropathy, with fewer cases of advanced neuropathy than patients in rural areas.
- Self-medication is maintained at a high level, both for patients in urban and rural areas, thus resulting, almost exclusively, in advanced cases of neurolysis, which require surgery immediately after diagnosis.
- The diagnosis of carpal tunnel syndrome is based on the patient's clinical examination, corroborated with electrical and imaging investigations (which can obtain detailed

information about the anatomy and pathology of the carpal tunnel) and confirmed intraoperatively.

- Magnetic resonance imaging is a modern, non-invasive investigation that provides details about the carpal tunnel and can accurately measure nerve diameter, along with its characteristics and neighboring structures.
- The morphology of the carpal tunnel reveals important data that can participate in the staging of the disease and the application of appropriate therapeutic sanctions.
- The low nerve dimensions at the site of compression, inside the carpal tunnel, suggest important neurolysis, based on which a curative surgery algorithm could be established, respectively - the diameter reduction of the median nerve by at least 1.5 mm.
- Medical education, interdisciplinary collaboration and access to modern investigations and therapies are the key factors in the management of carpal tunnel syndrome.

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