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The Final Thesis

Most Common Benign Tumors in the Hand: Epidemiology, Clinical Features, Basics of Differential Diagnostics, Treatment Options. Literature Review

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SUMMARY

Tumors can occur in every tissue of the human body. Even though they are rare, tumors of the hand have a great impact on our daily lives. The lesions can be classified into soft tissue tumors, including fat tissue, vascular tissue, neural tissue, and cartilage as examples, and bone tumors. Ganglion cysts are considered the most frequent benign soft tissue lesions occurring on the hand, closely followed by giant cell tumor of the tendon sheath. In the bones of the hands, enchondromas are found most often. Commonly, tumors of the hand present as asymptomatic and solitary lesions that only cause symptoms when they reach a size large enough to compress adjacent nerves or vessels which, in turn causes pain or restricted movement of the affected finger or the whole hand. They can all be detected by simple imaging methods like ultrasound, computed tomography or magnetic resonance which in the majority of cases is sufficient for the clinical diagnosis. For the definite diagnosis, a biopsy of the affected tissue can be taken. For the treatment, surgical excision is curative in most cases. Other therapies such as laser ablation, cryotherapy, or topical pharmacotherapy can be used as alternatives in certain cases, but generally they demonstrate a higher recurrence rate in comparison to surgery.

KEYWORDS

Benign tumors, hand, surgery

INTRODUCTION

Our hands are important tools in our everyday life. We need them not only for daily activities such as eating, brushing our teeth, or typing on a computer, they are also very important for communication in form of body language. Our hands can do much more than only grasping things and moving, they are capable of sensing temperature, pressure and vibrations but also pain. Nowadays, the work with our hands requires even more precise movements since the tools we use become smaller and more complex such as the smallest technology in our smartphones. Also in the medical field, giving microsurgery as only one example, a very precise use of our hands is of highest importance. To be able to fulfill all of these important functions, our hands consist of several different structures and materials including bone, muscles and tendons, blood vessels,

nerves as well as connective tissue which all work together as one functioning unit. Figure 1 and 2 demonstrate how complex the structure of our hands is constructed in order to work properly as we want them to do.

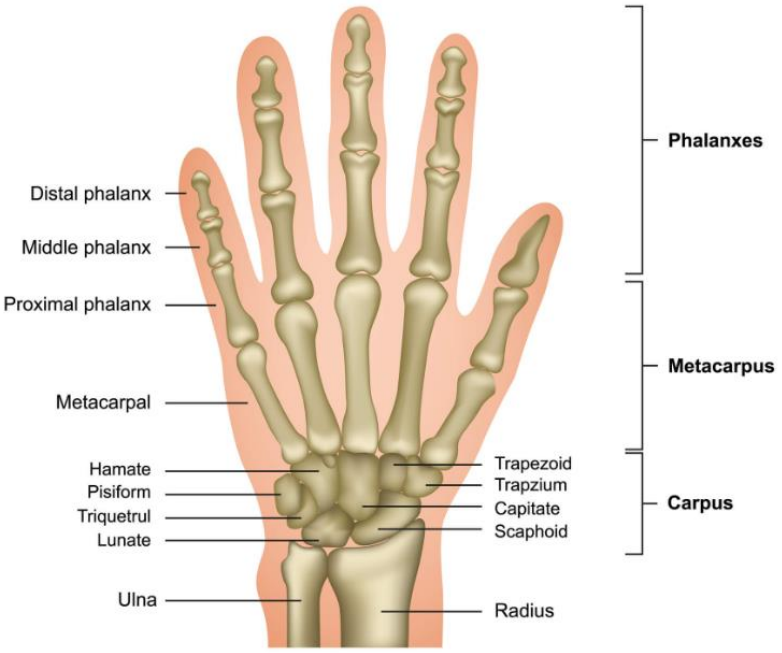

Figure 1: *Bones of the Hand;* ***Source:*** *Anatomy, Pathology and Treatment of the Wrist & Hand - Articles & Advice | White House Clinic [Internet]. [zitiert 16. Januar 2023]. Available from: https://www.whitehouse-clinic.co.uk/articles-and-advice/anatomy-pathology-and-treatment-of-the-wrist-hand*

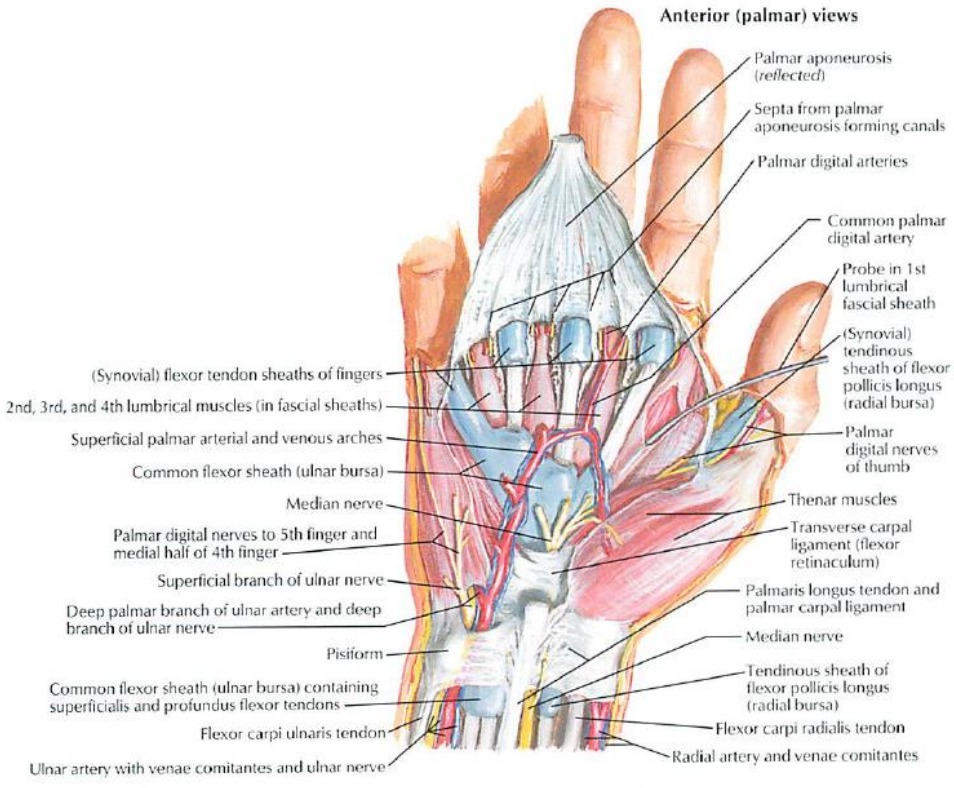

Figure 2*: Deeper Palmar Dissection of the Hand;* ***Source:*** *Netter, Frank H. Atlas of human anatomy. 5th , 6th , 7th Philadelphia, PA: Saunders/Elsevier, 2011*

Each tissue type is capable of undergoing cellular renewal. However, the body's ability to self-renew also carries the risk of unnecessary proliferation, eventually leading to uncontrolled tumorous growth.[1] Gene mutations are most often responsible for this phenomenon, inhibiting cell growth suppressors and promoting the expression of growth factors, leading to the self-renewal of stem cells.[1,5] Yet, it is not fully understood when and why genetic mutations promoting tumorous growth appear and especially how they are predestined to grow in a benign or malignant pattern.

Benign tumors usually do not depict a life-threatening situation since they rather grow and compress neighboring or distant anatomical structures instead of invading them, thus, causing symptoms, for example, by mechanical compression.[2] Metastases, on the other hand, belong to the characteristics that can only be attributed to malignant tumors. However, under certain circumstances, benign tumors can become malignant lesions, which tend to spread rapidly and eventually cause systemic illness. That is why proper diagnosis, observation, and – if indicated – treatment are necessary to avoid serious harm to the body.

Clinically, hand tumors are classified as osseous and soft-tissue lesions. Most tumors are found to be benign; ganglion cysts being the most common nonneoplastic lesion in that anatomical area.[3,4] According to their histological origin, benign hand tumors can be further subdivided into osseous lesions, soft tissue lesions, cutaneous lesions, vascular lesions, and neural lesions.[4] All of these lesions do have their own specific characteristics in appearance, anatomical location, distribution among age and gender, and also can present in different clinical manner, which emphasizes the importance of being capable to identify clinical symptoms, and choosing an appropriate diagnosis and treatment plan for the patient.

Several mono- and multi-centered studies, case reports, scientific articles, as well as existing literature reviews do give a brief overview of hand and wrist tumors, either going more into detail in treatment or diagnosis and including not only benign but also malignant lesions. However, an overall image of the incidentally most frequently encountered lesions met in clinical practice.

The goal of this literature review is to create this overview of the most common benign tumors of the hand, to layout their epidemiology, clinical presentation, possible diagnostic techniques as well as treatment methods.

LITERATURE SELECTION STRATEGY

For the conception of this literature review, already existing literature reviews, mono- and multicenter studies, case examples, retrospective studies and case reviews, as well as scientific articles from medical journals were used. For this purpose, the research was performed via Google Scholar, PubMed, ResearchGate, National Center for Biotechnology Information (NCBI), Sage Pub, ScienceDirect, AccessMedicine as well as ClinicalKey.

Difficulties in the selection of literature occurred due to the denial of access to platforms such as Thieme and Elsevier due to the lack of a purchased license.

To create an epidemiological overview over the most common benign lesions of the hand, several sources were chosen, and the median percentage was estimated; a ranking was established for the general understanding.

In order to establish a representative number of articles to review, 173 articles were read whereas 102 of these turned out to contain useful information for this literature review. Eventually,76 of these articles were used for referencing in this literature review whereas only the most recent literature was selected. Diagram 1 depicts the distribution of literature used for referencing according to their years of being published. Not included in the diagram due to the small amount is one article published in 2023, two articles from 2017 as well as one article each from 2012 and 2001 as the oldest ones used.

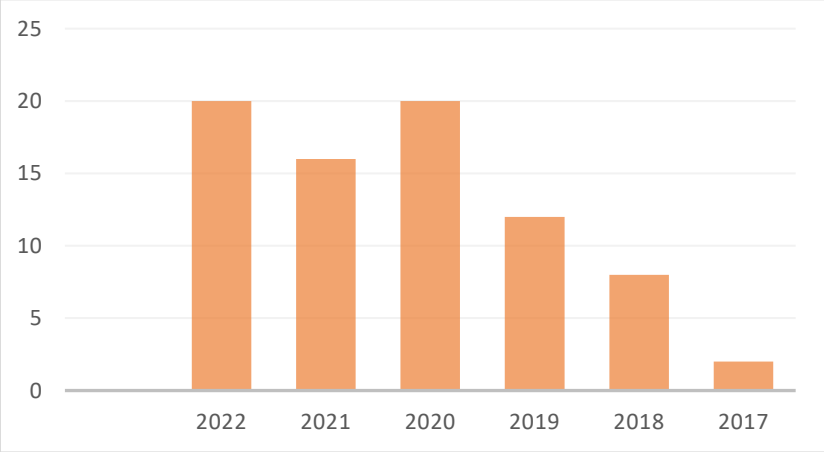

Diagram 1: *Distribution of referenced articles based on their year of publishing*

The research first aims to achieve a general overview of all possible tumors of the hand as well as epidemiological data to filter for the most common benign tumors of the hand and to emphasize their peculiarities in clinical picture, diagnosis, and treatment.

MAIN PART

The etiology and pathogenesis of tumors are still under investigation; however, genetic mutations and rearrangements are found to be the underlying mechanism of tumor growth. Carolina Cavalieri Gomes CC [5] describes in her article that cells are required to possess six core biological capabilities to be capable of tumorous growth. These are "sustaining proliferative signaling, evading growth suppressors, resisting cell death, enabling replicative immortality, inducing angiogenesis, and activating invasion and metastasis, representing the hallmarks of neoplasms". These hallmarks are met in both, malignant and benign lesions, but they still present histologically and clinically in different ways. It is important for the treatment and follow-up to distinguish them properly. Generally, in the hand, tumors are not a very common finding. But in the case of a tumorous lesion, benign tumors are encountered more frequently than malignant ones.

Focusing on benign masses in this review, they can be classified as soft tissue and bone tissue tumors. Soft tissue tumors of the hand comprise about 15% of overall soft tissue tumors. [3,6]
A retrospective case review by Cavit et al. [7] states that among soft tissue lesions, ganglion cysts are the most common found tumor, followed by giant cell tumors of tendon sheath (GCTTS) and hemangiomas. Also, lipomas, glomus tumors, schwannomas, and epidermal cysts are found frequently. Osseous tumors are found less frequently but still contribute a significant number. Enchondromas are found to be the most common primary osseous lesion.

Table 1 depicts an epidemiological ranking of benign hand lesions. It is arguable whether ganglion cysts or GCTTS are the most common tumor since different literature sources here present different findings. Therefore, the tumor type being mentioned as "most common" in majority of the literature was ranked first in this review.

	Affected Tissue	Incidence (in %)	Mean age	Gender distribution	Tumor name
1	Soft tissue	15% of overall soft tissue lesions 25-30% of hand lesions	20-40 years	F > M	Ganglion cyst
2	Soft tissue	25-27 % of hand lesions	30-50 years	F > M	GCTTS

3	Vascular tissue	15% of overall hemangiomas 10-15% of hand lesions	Early in-fancy	n.a.	Hemangioma
4	Soft tissue	7% of hand lesions	n.a.	F > M	Lipoma, Lipofibroma
5	Vascular tissue	1-5% of hand lesions	30-50 years	F > M	Glomus tumor
6	Neural tis-sue	1-2% of hand lesions	30-60 years	F = M	Schwannoma, Neurofi-broma
7	Cutaneous tissue	Up to 1% of hand lesions	20-50 years	F > M (under debate)	Pyogenic granuloma
1	Bone tissue	90% of overall osseous tumors 10% of hand tumors	20-40 years	n.a.	Enchondroma
2	Bone tissue	10 % of osseous hand tumors	20th decade	M > F	Osteoid Osteoma

***Table 1**: Ranking of the most common benign soft tissue and bone tissue tumors created on the basis of findings of Cavit et al., Hacisalihoglu and Ozcelik, Strike and Puhaindran, Marteau et al. as well as a journal article published in MedScape.*[3,4,6,7,8]

The epidemiology, clinical features, differential diagnostics, and most appropriate treatment tactics for each tumor will be discussed in the following.

Ganglion Cyst

Lacking the previously mentioned hallmarks of neoplasm, ganglion cysts cannot be classified as a tumor. However, they are considered as the most common soft tissue mass and overall, and therefore the most common benign lesion of the hand and wrist [3,4,7] which is the reason they should be mentioned.

The cyst is filled with gelatinous mucoid material that is surrounded by fibrous tissue wall and located close to muscle tendons and/or joint capsules. The exact etiological mechanism is not known but it is believed that repetitive trauma may cause the degeneration of connective tissue in the hand.[4] The stress caused by trauma to the joint may lead to disruption of the wrist joint capsule, creating an exit for the synovial fluid out of the joint. Trauma additionally provokes fluid production, causing the formation of a cyst. [9,12] On microscopical view, a “pedicle” with lumen

can be observed which connects the cyst to the underlying joint. Most of the cysts are found on the dorsal wrist due to their origin from ligamentum schapholunatum but can also present on the palmar wrist where they are commonly located close to the radial artery. [7, 9,10] The most frequent locations of cysts are seen in Figure 3.

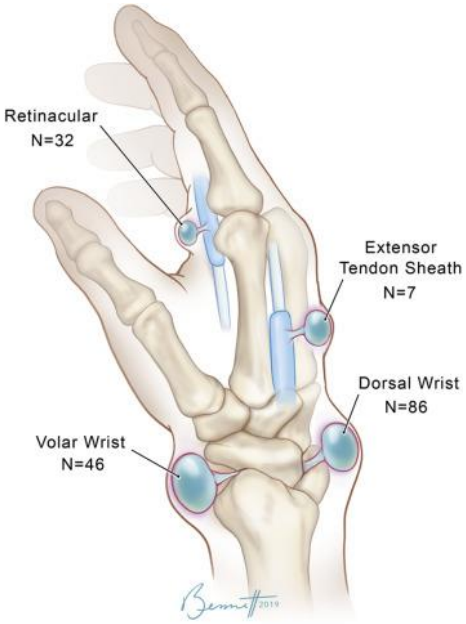

Figure 3: *Most common locations of ganglion cysts;* ***Source****: Bram JT, Falk DP, Chang B, Ty JM, Lin IC, Fazal FZ, et al. Clinical Presentation and Characteristics of Hand and Wrist Ganglion Cysts in Children. The Journal of Hand Surgery. 2021 Dec 1;46(12):1122.e1-1122.e9.*

In articles by Gregush and Habusta and Cavit et al. [7,9], a female predominance of this lesion type can be observed which can affect individuals of any age, but most commonly they are observed among people aged 20 to 40 years. [9,12]

Clinically, most cases of ganglion cysts present without any symptoms, however, in the case of larger lesions, the patient may complain about tenderness or muscle weakness in the affected area, which in turn has an impact on daily activities.[7] Due to their location, symptoms related to median nerve compression at the carpal tunnel are seen most often. Patients rarely report pain but, in some cases, pain could present as the cyst compresses nerves on the wrist or when constant irritation leads to inflammation as a complication; then called tenosynovitis.[9]

Ganglion cysts can easily be diagnosed clinically and do not necessarily require further imaging, laboratory tests, or histological confirmation. Physical examination of the lesion reveals that the cyst has a rubbery consistency and is fixed to a tendon or joint and therefore is only slightly mobile.[12] By transillumination (holding a light source against the cyst from the outside), it can be approved that the lesion contains fluid and is not a solid mass.

In case of doubt, ultrasound or magnetic resonance imagining (MRI) can be used to confirm or deny the diagnosis. On ultrasound examination, a hypoechoic, well-demarcated appearance should be obtained. A communicating stalk to neighboring tissues can be identified in some cases. Doppler Ultrasound flow cannot be observed since the lesion is avascular.[10] Figure 4 provides a typical example of ganglion cysts on ultrasound imaging. The wall of a ganglion cyst can only be assessed in case of a rather chronic lesion, where it can be found to be hyperechoic with internal septations. MRI is a common method of choice when the cyst has atypical appearance or characteristics where further investigation is indicated. When using MRI, again, a homogeneous cyst can be observed which appears as isointense with muscle on T1-weighted (T1W) and hyperintense on T2-weighted (T2W) imaging.[11] MRI is also useful for the planning of surgical treatment. Thompson et al. [12] recommends the use of arthroscopy when initial workup is nondiagnostic and conservative treatment is not effective to investigate further.

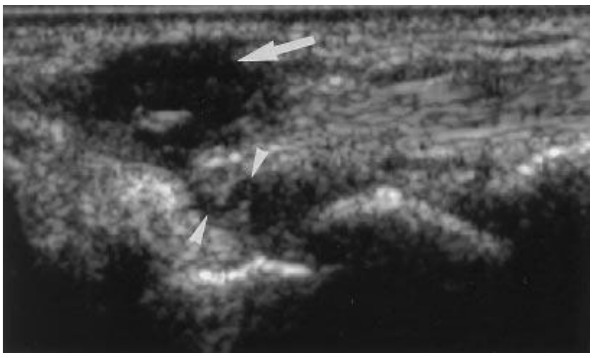

***Figure** 4: "A 27-year-old woman with dorsal ganglion of the wrist. Ultrasound, sagittal plane: The lesion (arrow) appears as a hypoechoic mass located in the subcutaneous tissue. A tortuous pedicle connecting the ganglion to the joint is evident (arrows)" [11]*

A simple ganglion cyst usually appears as single lesion. In cases where multiple lesions or cysts are located, for example at the distal interphalangeal joints, a differential diagnosis of osteoarthritis and mucous cysts should be considered. It is also important to differentiate the cyst from solid lesions, which rather would suggest benign or malignant tumors as cause.

Considerations for treatment should be made as done as the diagnosis of ganglion cyst is made. Both, surgical and non-surgical management of ganglion cysts is available. [7] In case the patient is asymptomatic, the first step that should be taken is a watchful-waiting approach since ganglion cysts are very unlikely to be malignant and disappear in 50% without any intervention.[12] Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) can be prescribed if the patient feels any discomfort.

A surgical approach is recommended for all symptomatic patients and for patients where non-surgical methods have failed. When choosing surgery as a treatment, it is important to decide for an appropriate procedure since ganglion cysts have a recurrence rate of approximately 15% to 20%. Strike et al. [3] mention that aspiration technique results in recurrence of cysts in 15-89% of the cases. Open or arthroscopic excision, on the other hand, appears to be more effective in respect to recurrence rates.

Aspiration with or without steroid injection as one possible interventional treatment method shows to be effective in 15-98% of cases. Frequently, not all cystic tissue is removed during the procedure. However, aspiration for dorsal wrist ganglions appears to be an effective treatment.[9,13]

A surgical approach may follow via open surgery or arthroscopically as minimally invasive surgery (MIS) under ultrasound guidance. A study by Yamamoto et al. [14] established that there is no significant post-surgical pain after arthroscopic removal of palmar or dorsal wrist ganglion cysts, however it was observed that the recurrence risk is lower (zero) in palmar wrist ganglion cysts. An example of open surgical approach is described by Gregush and Habusta. [9] After achieving access to the hand, the first cut should be done via a transverse incision right over above the cyst, avoiding rupture of the pedicle, and followed by detachment of the stalk and capsular attachment close to the ligamentum scapholunatum. The approach to the cyst should be done with caution due to the proximity of nerve branches and surrounding vessels. Proper debridement of the ligament is necessary to achieve a low recurrence rate.

Giant Cell Tumor of Tendon Sheath (GCTTS)

The second most common lesion of the hand is the Giant Cell Tumor of Tendon Sheath (GCTTS). Based on different pathophysiological hypotheses, sometimes the lesion is being referred to as “localized nodular synovitis”, “pigmented villonodular synovitis (PVNS)” or “tenosynovial giant cell tumor”. [15, 16] It is a slow-growing tumor, consisting mainly of synovial cells, macrophages, multinucleated giant cells, and hemosiderin deposition; most commonly occurring on the distal joints of the ring- and index fingers. However, GCTTS can also occur on the feet and larger joints such as the knee and hip. In very rare cases, they are being found in spinal tendon sheaths. [17]

The exact etiology of the tumor is not known. Even though it is considered as neuroplastic lesion, it is believed that underlying inflammatory processes and metabolic disease may contribute to the development of GCTTS, but generally, the etiology of the lesion is considered as idiopathic. Reviewed case studies as well as literature reviews observe a female predominance, with the most common occurrence at 30 to 50 years of age. [16, 18, 19, 21]

GCTTS today is still classified using the Al Quattan classification from 2001 which categorizes the lesion into localized (Type I) and diffuse (Type II) which can be further subdivided as described in Table 2 below. [18]

Type I: The entire volume is surrounded by a pseudo - membrane	Type II: The entire volume is not surrounded by a membrane
a. Solitary nodule in a thick whitish membrane. b. Solitary nodule in a thin film. c. c. Lobar lesion surrounded by a common pseudo membrane.	a. A main node (in a pseudo-membrane), which is accompanied by a separate satellite lesion. b. Widespread type with many granular tumors without membrane. c. Polycentric type with many separate lesions in the same finger.

***Table 2**: "Al Quattan classification of tendon sheath giant cell tumors of the hand" [18]*

Clinically, GCTTS presents most of the time as a non-painful, nodular enlargement at the volar aspects of phalanges and palms. Decreased movement as well as impaired sensation can occur in case of a large mass on the joint. On clinical examination, the lesion presents as non-tender and fixed to underlying tissues. [16]

The diagnosis of GCTTS can be made on clinical appearance and imaging sufficiently, however, Fine Needle Aspiration Cytology (FNAC) may assist in case of uncertainty. As imaging techniques, X-Ray may be used for the initial investigation, revealing the presence of a soft tissue mass. MRI then may be used for further evaluation of the tissue involvement of the tumor as well as for planning the surgical procedure. The hemosiderin content of the tumor causes decreased

intensity of the signal or isodensity to skeletal muscle in both T1- and T2- weighted images. The intravenous injection of gadolinium may enhance the signal [11] as also seen in Figure 5.

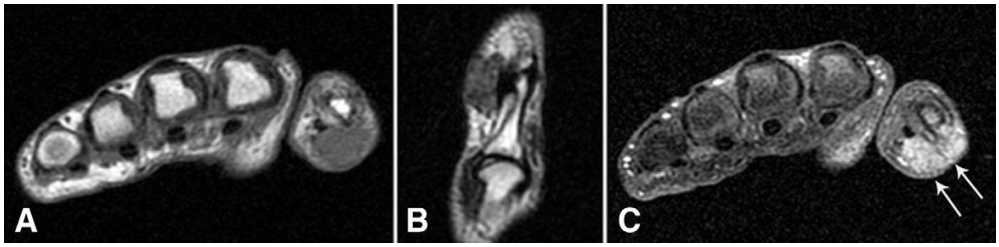

Figure 5: *"[…] (A). The mass has a low signal on the sagittal T2W image (B) owing to hemosiderin presence. A significant contrast enhancement of the smooth-contoured mass is observed on the axial fat-saturated T1W image (C) following intravenous gadolinium administration (arrows)."* ***Source:*** *Ergun T, Lakadamyali H, Derincek A, Cagla Tarhan N, Ozturk A. Magnetic Resonance Imaging in the Visualization of Benign Tumors and Tumor-like Lesions of Hand and Wrist. Current Problems in Diagnostic Radiology. 2010 Jan 1;39(1):1–16.*

Usually, a biopsy is taken during surgical excision for a definite diagnosis, which, as well as FNAC, reveals the histological characteristics of the tumor.

Whenever the diagnosis of GCTTS is made, it is important to differentiate it from other benign or malignant lesions that may have an influence on the treatment of a patient. So should a doctor exclude the diagnosis of lipoma, epidermal cysts, hemangiomas, gout, or rheumatic nodules, which can be done clinically and by the aforementioned diagnostic techniques. [16]

In most of the cases, and as the current treatment of choice, GCTTS are removed surgically by simple excision. During the surgery, it might be necessary to reconstruct part of the tendons if these are affected by the tumor. For this purpose, an adjacent piece of tendon on the ipsilateral side can be used for grafting. [16] In rare cases, such as complications like cortical erosion or perforation, enucleation with curettage is required. Amputation is the method of choice when there are many recurrencies of the lesion, even though, this is a rare occasion. [15]
During the excision, a possibly capsulated, (multi-) lobulated yellowish lesion is removed, as seen in Figures 6 and 7.
Post-surgical rehabilitation with first passive and later active mobilization is included in the treatment plan for each patient.

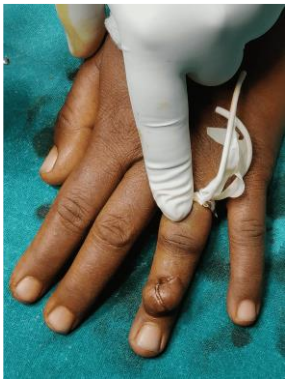

***Figure 6**: "Curvilinear incision over the swelling" [19]*

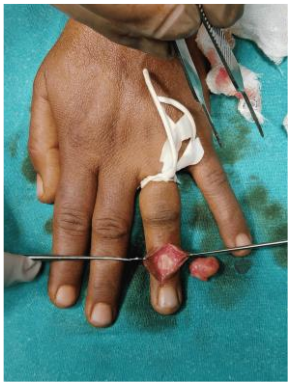

***Figure 7**: "Tumor excised completely" [19]*

Another treatment recently introduced and now explained in the paper by Shan et al. [17] is the use of pexidartinib, a "small-molecule kinase inhibitor of colony-stimulating factor 1 receptor (CSFR-1)" which revealed a successful lesion shrinkage of 50% within 25 months.

There are cases where excision is not sufficient and where radiotherapy is applied either in addition to surgery or as the only therapy for the patient. This is the case when GCTTS is of an infiltrative nature, including invasion of local soft tissue like ligaments or tendons as well as involvement of bones or joints in proximity. [15] However, it is debatable whether radiation therapy is to be used for the treatment of benign lesions.

It is to be mentioned that GCTTS presents with a high rate of recurrence, ranging from 9 to 44% which occurs most of the time within 1 to 2 years after the resection.
Kara et al. [20] reports that recurring lesions may be related to the location of the tumor. Lesions that are on the distal interphalangeal joint are more difficult to excise due to the limited space and close location to nervous and vascular tissues which therefore might not be excised properly and, as a result, be more prone to recurrence. Not only the location but also the morphology depict a risk for recurrence. So are Al Quattan Type II lesions associated with a higher recurrence risk. Comorbidities such as osteoarthritis and stress erosions are believed to contribute to the recurrence as well. [19]

Hemangioma

Hemangiomas are considered to be the overall most common benign vascular tumor in the body, very often presenting in early infancy (congenitally) and resolving by itself whereas the upper extremity presents as not commonly affected site.[22] The International Society for the Study of

Vascular Anomalies (ISSVA) and the World Health Organization (WHO) categorizes vascular tumors into “benign vascular”, “locally aggressive”, “intermediate malignant” and “malignant”.[23] Hemangiomas as one group of benign vascular tumors can be further sub-classified according to their tissue involvement: Pyogenic granulomas or also called lobular capillary hemangioma, spindle cell he, angiomas, epithelioid hemangioma, synovial hemangioma and intramuscular hemangioma naming as examples and best described benign vascular lesions of the hand[23, 24] and shortly described in the following.

Pyogenic granulomas are capillary proliferations that grow in a lobular pattern and can be easily diagnosed clinically. They usually remain less than 2cm in size. On the clinical picture, Blum et al. describe pyogenic granulomas as solitary fleshy lesions, which often occur at sites of trauma or insect bites and present as hyper vascular lesion. [23] This type of hemangioma will be discussed in detail later in this literature review.

Spindle cell hemangiomas are slow growing, usually solitary lesions that involve the skin and subcutaneous tissue. When presenting as multiple lesions, the diagnosis of Maffucci syndrome can be established, which originates from a somatic mutation and is characterized by enchondromatosis appearing together with hemangiomas. [25]

Epithelioid hemangiomas, like spindle cell hemangiomas, affect not only the skin but also the arteries. For this type of vascular tumor, a male predominance and an increased appearance in the extremities can be observed. In this case, differential diagnosis is very important since this tumor may “mimic a focal artery aneurysmal dilatation, a malignant vascular neoplasm or a […] epithelioid sarcoma”. [23]

Intramuscular hemangiomas (IMHs) are very rare, but due to their severity, they are worth mentioning. They manifest as a new mass that is accompanied by chronic pain, weakness, and possible painful contractions or tingling sensations. [24, 26]

A case of synovial hemangioma of the wrist is presented by Zhao et al. [27] Typically, these tumors arise in children and young adults and present with swelling of the joint or masses in proximity to the joint. It is important to differentiate the lesion from trauma, hematoma, ganglion cysts […] osteochondrolysis […] and rheumatoid arthritis. For this purpose, imaging techniques are required.

But not only for the differential diagnosis and differentiation between hemangioma types, but also for the evaluation of the extent and tissue involvement of hemangiomas, imaging is the preferred method of choice. In the first place, Doppler ultrasonography is the first method to use since it is non-invasive and without any radiation. It may reveal hypervascularity, seen as increased blood flow in the lesion. The method of choice, however, is MRI [23] Imaging methods assist in differentiating hemangiomas from other vascular malformations such as aneurysms or simple cysts. On MRI, hemangiomas are often depicted as iso- or hypointense lesions in T1-weighted images and are enhanced on fat-saturated T1-imaging (Figure 8). An X-ray of the hand may be performed as well, but only shows calcifications in most of the cases (Figure 9). CTA (Figure 10) and MRA images may be useful for planning surgical procedures as treatments. Skin biopsy is rarely needed and is only used for a definite diagnosis after surgical removal.

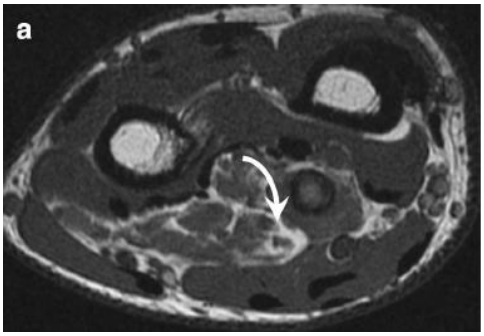

Figure 8: *T1-weighted MRI of an intramuscular hemangioma [23]*

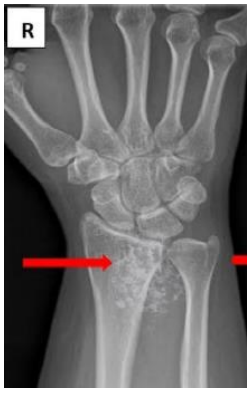

Figure 9*: Calcifications on an X-Ray Image of Pronator Quadratus Hemangioma* ***Source****: Kumar R, Ranjan R, Jeyaraman M, Chaudhary D, Arora A, Kumar S. Pronator Quadratus Hemangioma (PQH): A Rare Case Report and Review. JOIO. 2021 Aug 1;55(4):1056–63*

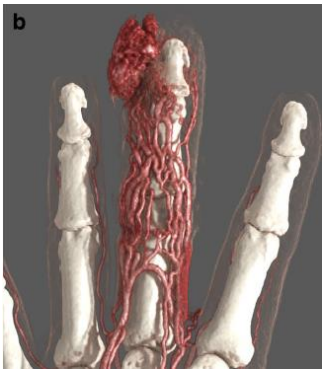

Figure 10: *Dynamic CTA of a hemangioma [23]*

In the case of congenital hemangiomas, the lesion usually resolves without any intervention. Depending on the type of hemangioma, the severity of symptoms, and aesthetic reasons, treatment may be indicated for the patient.

For the treatment of infant hemangioma, if necessary, Liu et al. [28] on the one hand suggest the standard care using topical beta-adrenergic blockers for superficial hemangiomas as well as laser treatment and eventually surgery if pharmacotherapy fails, but on the other hand present the treatment with the antifungal itraconazole orally.

For adult and symptomatic patients, surgery should be offered for the removal of the lesion. Similar to previous mentioned tumors, precise and simple complete excision is sufficient. In case of a large part to be excised, grafts can be used for reconstruction. A frequently used method for skin harvesting is an abdominal flap (Figure 11). [30]

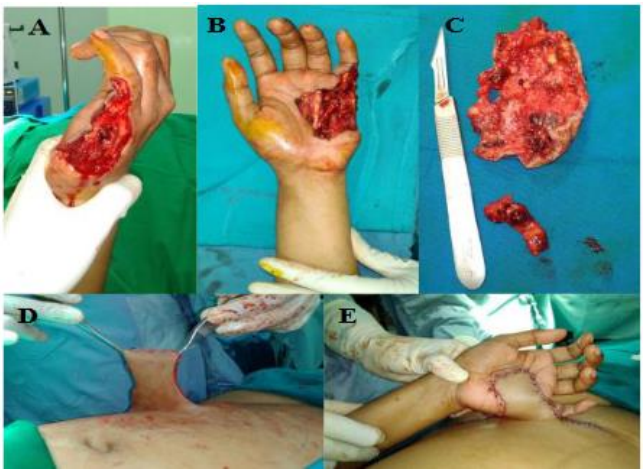

Figure 11*"A-C) An 8 x 6 cm mass infiltrating the muscles and fascia was excised, resulting in a large defect on the medial palmar side of the hand. (D-E) The resultant defect was reconstructed with an abdominal flap" [30]*

Adjunctive to surgery or as a single treatment for superficial hemangiomas, sclerotherapy combined with embolization can be used when the lesion is locally limited and small. The effect might not be long-lasting, which is why surgery remains the method of choice. [29]

Lipoma, Lipofibroma

Lipomas are the most common benign soft tissue tumor in the adult population, but they are more often found in other body areas like the trunk than on the hand. Lipomas are composed of normal human adipose tissue as well as lipofibromas, which additionally have a fibrotic or connective tissue as a component. [31, 32] Similar to other tumorous lesions, the exact etiology is unknown, however, there is thought to be in relationship to trauma, metabolic, or genetic factors. Case reports by Tellier et al. [33] and Barreira et al. [34] both show patients with comorbid hypercholesterolemia which might be interpreted as a risk factor for lipoma development. The majority of the case reports used for this literature review depict a female predominance, which therefore could be suspected for this type of tumor. [33, 34, 36]

On physical examination, lipomas and lipofibromas present as a non-tender, movable lump. The lesion is slow-growing and usually asymptomatic. Symptoms occur especially when the mass is

on the volar aspect of the hand and large enough to impair flexion movements. Paresthesia, tingling sensation, muscle weakness, or even pain might occur when lipomas compress adjacent nerves, which is often the case with giant lipomas which are defined by their size of >5cm when they might provoke symptoms of carpal tunnel syndrome. [33, 34] Symptoms of neuropathy can also be caused by intraneural lipomas, which grow within the epineurium of the affected peripheral nerve.[35] The extent of nerve involvement in the case ofa lipoma is illustrated in Figure 12.

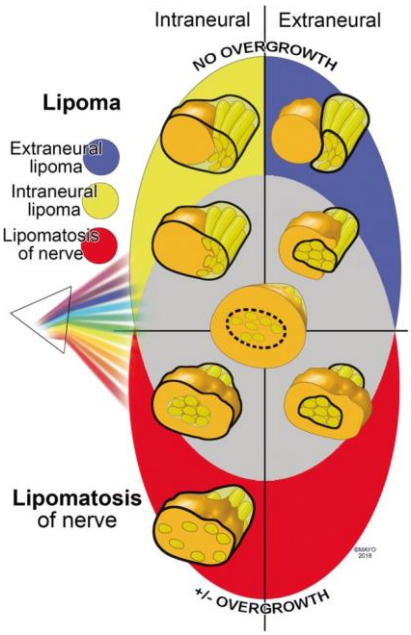

Figure 12: *Venn diagram of adipose lesions of peripheral nerves. The thick black line represents the epineurium and therefore shows in which cases growth into the epineurium is given or not.* [35]

For the diagnosis of a lipoma or lipofibroma, or any other adipose lesion, imaging strategies are required and are diagnostic in the majority of cases. Ultrasound imaging of the lesion will reveal hyperechogenic masses; most often surrounded by a capsule, as seen in Figure 13. Since a lipoma consist of adipose tissue, no blood vessels are observed during imaging. The preferred imaging for diagnostic purposes remains MRI, which reveals a hyperintense lesion on T1-weighted images, as demonstrated in Figure 14, which can also be used for a more detailed evaluation of the involvement of anatomical structures and for preoperative planning. In very rare cases, electromyography is performed for the evaluation of muscle strength in cases of loss of function.

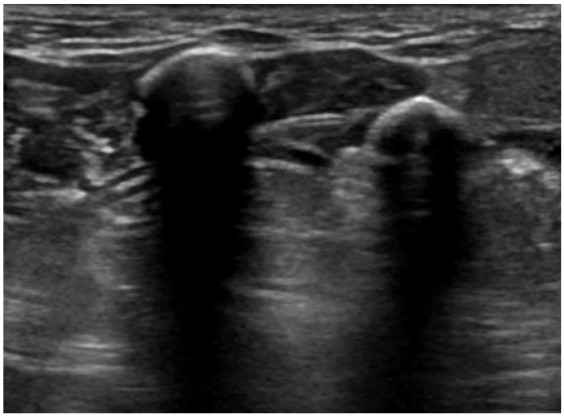

Figure 13: *Ultrasound showing encapsulated iso-hyperechoic avascular lesion extended dorsally from the II to the IV metacarpal bone" [36]*

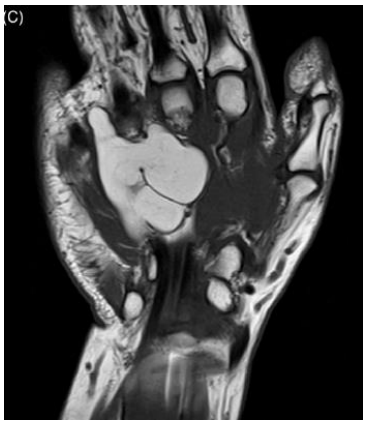

Figure 14: *"Coronal MRI image showing a large hyperintense well-defined mass occupying the left-hand recesses from the III to the IV" [36]*

Not only on clinical presentation but also on diagnostic imaging, it is hard to distinguish lipomas from malignant liposarcoma, and sometimes even on histological analysis, they might appear very similar [31]. Therefore, the differential diagnosis should be done cautiously. Moreover, the diagnosis of lipoma or lipofibroma should be differentiated from other afore- and later mentioned benign lesions of the hand, such as cysts or vascular tissue tumors.[36]

Principally, all lipomas and lipofibromas are preferred to be excised surgically. Even asymptomatic lesions should be removed to prevent complications and symptoms in the future. For giant lipomas and lesions causing symptoms, there is even a definite indication for surgical removal. [33, 34, 37] The focus here is on decompression and alleviation of the neuropathic symptoms. In most cases, a local anesthesia is sufficient for the surgery. Since most lipomas are surrounded by a capsule, the removal is performed without any further complications. However, the excision of intraneural lipomas turns out to be more complicated due to their close connection to the nerve. For approaching the tumor, different types of incisions can be chosen based on the anatomical location of the lipoma, ensuring the best approach and the least harm in combination with the best healing outcomes. Figures 15-17 below show different types of incisions for the surgical removal of lipomas at different anatomical sites.

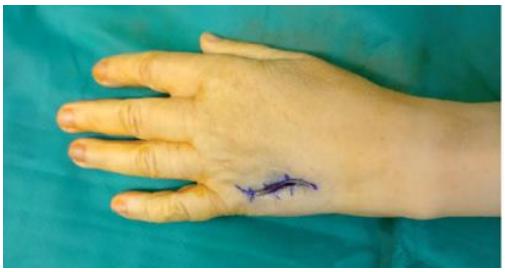

***Figure 15**:" Curved skin incision over the IV inter-metacarpal space."*
***Source**: Bocchiotti MA, Lovati AB, Pegoli L, Pivato G, Pozzi A. A case report of multi-compartmental lipoma of the hand. Case Reports in Plastic Surgery and Hand Surgery [Internet]. 2018 May 2 [cited 2023 Jan 3]; Available from: https://www.tandfonline.com/doi/abs/10.1080/23320885.2018.1469988*

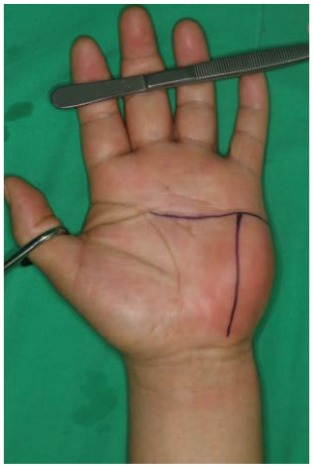

***Figure 16:** T-shaped incision*
***Source**: Kim KS, Lee H, Lim DS, Hwang JH, Lee SY. Giant lipoma in the hand. Medicine (Baltimore). 2019 Dec 27;98(52):e18434.*

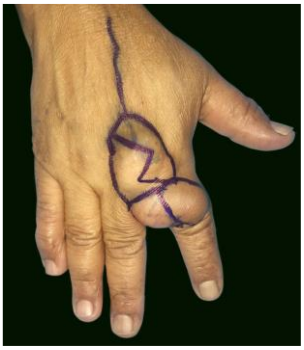

***Figure 17:** Bruner incision*
***Source**: Santacoloma K, Barreto GM de S, Loda G, Miller MDB. Lipoma gigante na mão: um desafio cirúrgico. S&CD [Internet]. 2021 [cited 2023 Jan 3];13(4). Available from: http://www.surgicalcosmetic.org.br/edicoes-anteriores*

Glomus Tumor

The glomus body is a structure located in the human dermis and is composed of neuromyoarterial receptors which are responsible for thermoregulation based on the flow control of the microvasculature. The glomus tumor therefore a result of the proliferation of the neuromyoarterial tissue. On cellular level, it consists of glomus ells, smooth muscle cells, and vasculature. [38, 39, 40] Glomus tumors are most often found in the hand under the nail (subungual); the thumb being the most affected digit, where a female predominance, especially in the age range of 30 to 50 years can be observed. The involvement of the pulp space of the finger is a rather rare, but also a possible location on the hand. For lesions that are not located on the hand, for example, in the lung or the kidneys, a male predominance can be observed.

On clinical examination, Pertea et al. [38] describe a classical symptomatic triad which – if all three are positive – can give the diagnosis of glomus tumor:

1. Love's pin test: pressure is applied over the suspected area of tumor with a pinhead. The sign is positive if the pressure is considered to be painful.
2. Hildreth's test: a torniquet is applied proximally to the lesion. The test is positive if this relieves pain and tenderness sensations.
3. Cold sensitivity test: cold water is applied over the suspected area of tumor (for example with an ice cube). The test is positive if there is an increased pain sensation to cold.

Pertea et al. also describe pain as being the most specific symptom of glomus tumors, which differentiates it from previously discussed lesions. Also, the tumors are rarely palpable.
In the case of subungual glomus tumor, nail deformities such as convexity and reddish-blue, oval or round nail discoloration, and sometimes even nail erosions can be observed as demonstrated in Figure 18. [41]

***Figure 18**: A: Discoloration, B: Nail deformity and onycholysis [41]*

It is very common that glomus tumors are misdiagnosed, for example, as neuropathies, neuralgia, arthritis, or Raynaud's phenomenon [42], especially when not all typical signs of the clinical triad are present. To avoid this situation, ultrasound should be performed in case of any uncertainty. [43] Ultrasound and MRI not only give more information about the possible glomus tumor, but also assist in the differential diagnosis and to rule out more severe diseases, like, for example squamous cell carcinoma, which might have similar clinical appearance but exhibits another tumor shape, borders and location as described by Sechi et al. [44] On MRI imaging, glomus tumors express low-intensity on T1-weighted and hyperintensity on T2- weighted images as well as enhancement after the injection of gadolinium. [41, 45] A biopsy and immunohistochemical analysis are not required for the diagnosis of glomus tumors, but after all, they are found to be α-SMA and h-caldesmon positive. [38] Pangtey et al. [40] additionally report the increased expression of vascular endothelial growth factor (VGEF) on analysis in a case of glomus tumor on the V digit of the hand.

The mentioned diagnostic tools help additionally to differentiate glomus tumors from other diseases such as "angiofibroma, pyogenic, granuloma-like Kaposi sarcoma [..]" [45] Though very rare, the possibility of malignant glomus tumors also should be excluded.

For all glomus tumors, surgical treatment is curative and therefore the treatment method of choice. Depending on the location of the lesion, there are different surgical approaches. However, for all surgical approaches, it is important not to damage the nail matrix to avoid long-lasting issues related to nail-growth and -health. To prevent the recurrence of the tumor, proper excision

is crucial. It is also of high importance to avoid cutting into/in very close proximity to nerve fibers to prevent the loss of sensation in the affected digit.

For subungual glomus tumors, Deoraj et al. [42] present the transungal approach (Figure 19; A) where the nail bed is cut vertically to approach the tumor. After tumor removal, the nailbed is put back into its position. If the tumor is located in the pulp space such as presented in a case by Pangtey et al [40], a volar incision (Figure 19; C) can be done for the easiest access to the tumor.

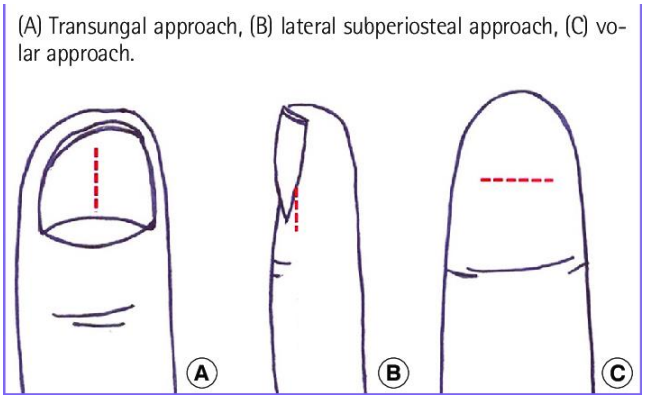

Figure 19: *Different Surgical Approaches for Glomus Tumor Surgery;* ***Source****: Lee W, Kwon S, Cho S, Eo S, Kwon C. Glomus Tumor of the Hand. Archives of plastic surgery. 2015 May 1;42:295–301.*

A new approach for the removal of subungual glomus tumors is introduced by Bae et al. [46]; using a so-called "eponychial flap elevation method". The technique is suggested due to the decreased risk of post-surgical nailbed deformities, which often occur after transungual or lateral subperiosteal approach methods. Nambi and Varanambigai [47] give the following justification for using this technique more frequently: the approach via a flap provides lots of space for operating and therefore allows the "complete exposure of the underlying bone and the glomus tumors". In addition to that, a good basis for the future nail is provided. Using the eponychial flap (Figure 20), the nail folds are cut on both sites of the nail, the nail and the nail bed are separated from each other, whereas access to the tumor under the nail is generated. After removal of the lesion, the nail bed is repaired, and the nail plate is sutured to the nail bed. Bae et al. suggest this technique especially for the replacement of lateral periungual approaches since the recurrence outcomes are the same (zero, if done properly) but the risk of nail deformities is decreased.

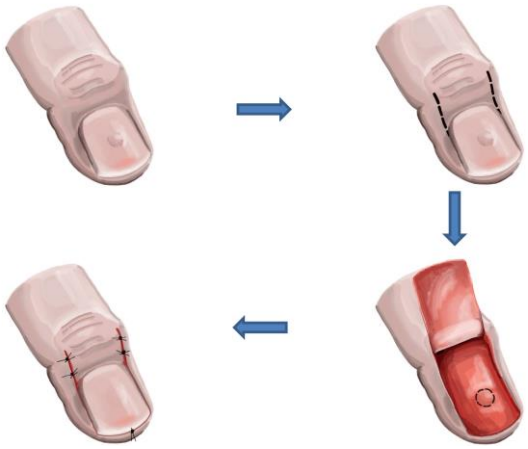

Figure 20: *Eponycheal flap elevation method [46]*

Schwannoma, Neurofibroma

Schwannomas (sometimes called neurilemmomas) and neurofibromas are classified as peripheral nerve sheath tumors. Schwannomas contribute to the majority of all peripheral neural tumors, followed by neurofibromas, even though both are not found in the hand very frequently. [48] Schwannomas, on a cellular level, are made up solely of Schwann cells. They manifest especially in individuals aged 30 to 60 years without any differences in distribution between the sexes. Neurofibromas, on the other hand, are more common in younger individuals aged 20 to 30 years. Histologically, they contain cell populations of Schwann cells, fibroblasts, collagen fibers, and other minor cell populations. While a schwannoma usually occurs only as a solitary lesion, neurofibromas more commonly occur within the setting of neurofibromatosis [49], an autosomal dominant disease that (among other pathological conditions) increases the likelihood of the development of benign and malignant lesions.

Based on their anatomical location, neurofibromas can be sub-classified into plexiform, cutaneous, intraneural, and massive soft tissue neurofibromas, as also demonstrated in Figure 21.

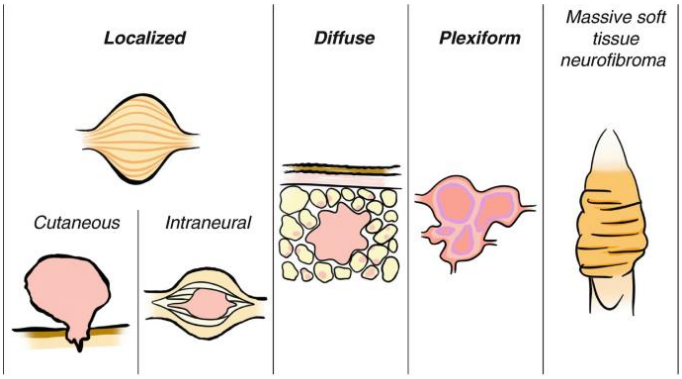

Figure 21: *Neurofibroma subtypes;* ***Source****: Rasulic L, Lepić M, Savić A, Samardžić M. Neurofibromas. In: Guedes F, Zager EL, Garozzo D, Rasulic L, Socolovsky M, editors. Diagnostic Assessment and Treatment of Peripheral Nerve Tumors [Internet]. Cham: Springer International Publishing; 2021 [cited 2023 Jan 5]. p. 167–76. Available from: https://doi.org/10.1007/978-3-030-77633-6_16*

Both tumors are growing very slowly, which delays the diagnosis. Xarchas et al. [50] report about cases of schwannomas where the onset of symptoms occurred only after 2 years and mention that the average symptom onset is after 35 months. Before that, a slowly growing palpable mass might be the only clinical picture of these tumors. Neurofibromas tend to grow near areas of flexion, therefore, the mass might be observed in these locations. When the lesion is large enough, paresthesia and/or pain might occur. Another clinical presentation specific for schwannomas is the Tinel sign which is described in the case reports of El Sayed et al. [51], Dasgubtar and Kumar [52] as well as Xarchas et al. [50]. The Tinel sign is positive when the patient feels a tingling sensation or paresthesia when the examiner is tapping over the distribution area of the Nervus Medianus along the forearm and the palmar aspect of the hand. Furthermore, Xarchas et al. describe that on examination of the lesion itself, schwannomas are movable in a perpendicular, but not in a longitudinal manner.

The diagnosis of benign neural tumors via clinical picture and/or imaging turns out to be very difficult. Both, schwannomas and neurofibromas present as well-defined and encapsulated lesion and both depict as iso- or hypointense on T1-weighted and hyperintense on T2-weighted MRI pictures.[48] Also, both tumors exhibit the "target sign" (Figure 22) revealing a hypointense area in the center surrounded by a hyperintense ring peripherally on T2- weighted images with gadolinium enhancement. [49, 50] MRI therefore is rather assistive in determining the extent and exact location of a lesion. Ultrasound imaging only reveals the well-defined borders of the tumors as well as very high vascularization. Since none of these findings are specific for schwannoma or neurofibroma, histology is the only way to receive the definite diagnosis, assessing the cell populations described earlier. On histological examination, Schwannomas can be further classified into Antoni type A and Antoni type B, whereas type A exhibits compact Schwann cell bundles and type B resembles a "loose matrix of oval cells".[53]

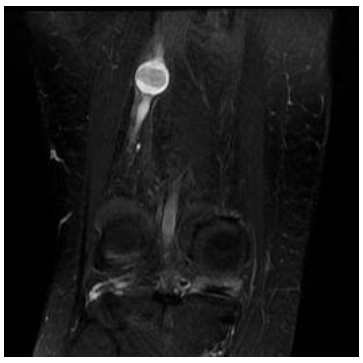

Figure 22: *Target sign of a peripheral nerve sheath tumor in Nervus Sciaticus;* ***Source****: Gaillard F. Target sign (peripheral nerve sheath tumor) | Radiology Reference Article | Radiopaedia.org [Internet]. Radiopaedia. [cited 2023 Jan 5]. Available from: https://radiopaedia.org/articles/target-sign-peripheral-nerve-sheath-tumor*

For the proper choice of treatment, it is very important to differentiate between schwannomas and neurofibromas, but also to differentiate them from neoplasms of non-neural sheath origin like neuromas, as well as taking into consideration previously discussed lesions like ganglion cysts, fibromas, and lipomas. [49,53] In the case of multiple neurofibroma lesions (and not only located on the hand but also in other body regions), the diagnosis of neurofibromatosis should be taken into consideration.

The treatment of schwannomas and neurofibromas is under debate. While El Sayed et al. address the high risk of neurological damage due to surgery and therefore discuss the suggestion of simple monitoring of the lesion, Ubong et al. [54] emphasize the importance of surgical removal using the appropriate instruments that enhance the outcome for example, via the use of a 3D microscope while Zhou et al. explain that neurofibromas should not be removed surgically unless they are symptomatic. In the case of any symptoms or a size of the lesion exceeding the average (which is around 3cm maximum for a schwannoma and 5cm maximum for a neurofibroma [48]), surgery is indicated. Because schwannomas as well as neurofibromas are tumors of the peripheral nerves, it is very important to enucleate the tumor very precisely which is the reason why Ubong et al. introduce the heads-up ergonomic approach for hand surgeons (Figure 23). Through the use of 3D glasses in combination with the standard microscope, it creates a more comfortable operating position, which in turn will benefit the outcomes of the operation.

Figure 23: *"A Pre-operative marking. B Set-up of the 3D microscope, the arm can be mobilized easily and adapt in different angles. C Dissecting the median nerve schwannoma using the 3D microscope"* [54]

For patients with neurofibromas in the setting of neurofibromatosis which cannot be surgically removed, imatinib currently is the only currently available pharmacological therapy that shows an appropriate effect. [55] Otherwise supportive measures like Non-Steroidal Anti-Inflammatory agents (NSAIDs) can be given for pain relief if surgery is currently not suggested or available for the patient.

Pyogenic Granuloma

As already discussed earlier, pyogenic granulomas (PG) belong to the benign vascular tissue lesions. It is considered as non-neoplastic, but, however, a proliferative condition and therefore should be addressed in this literature review. Previously, the etiology was believed to be of inflammatory origin, which is why the tumor received its name, however, more recently, it has been named more accurately "lobular capillary hemangioma" based on the appearance. [56] It is believed that the etiology of this tumor is associated with trauma and an imbalance of angiogenic factors, promoting the proliferation of vessels in a lobular pattern. But not only trauma can cause pyogenic granulomas. Benedetto et al. [57] report cases of PG growth under the nail after the treatment of acne with the systemic retinoid isotretinoin. It is believed that these retinoids cause lysis of the nail and additionally promote angiogenesis, facilitating the growth of PG. Also, treatment with antineoplastics such as epidermal growth factor receptor inhibitors (EGFR-I) can cause pyogenic granuloma as a side effect, as reported by Sollena et al. [58] which causes the thinning of the epidermis and therefore increases the predisposition for vessel proliferation after a trauma.

Different literature reviews and case reports discuss whether there is a female predominance in the development of pyogenic granulomas or not, but they agree on the fact that pyogenic granulomas mostly develop among individuals aged 20 to 50 years.

The clinical examination of the lesion classically reveals a solitary small, red or purplish papule that can present with or without a stalk growing exophytically. The tumor additionally can also start bleeding easily and present with ulcerations. Patients often complain about pain related to the lesion. [23, 56, 59] It most often occurs on the palm, but if the PG is of drug-related origin, it more likely can be found under the nail as presented by Benedetto et al. even though, this location can also be related to trauma as shown by a case report published by Oulehri et al. [60] The development of PG might also manifest early as erythema, edema, and tenderness of the lesion where it develops. A demonstration of PG on the palm and under the nail can be seen in Figures 24 and 25.

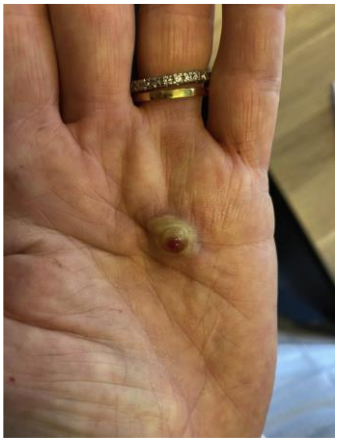

***Figure 24**: Pyogenic granuloma of the palm [62]*

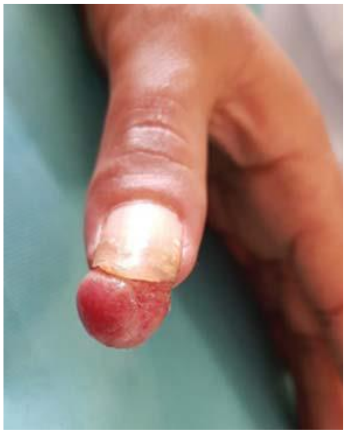

***Figure 25:** Subungual pyogenic granuloma [60]*

The diagnosis of pyogenic granulomas is mainly clinical, with a careful anamnesis taken for recent trauma and/or medication use. Dermoscopy can assist in the proper evaluation of the lesion. For the definite diagnosis, a histological analysis of the tumor is necessary.

Even though the clinical diagnosis of pyogenic granuloma is quite safe, a differential diagnosis should always be made. In this case, other vascular tumors such as Masson's tumor – a painful tumor that also arises after trauma [61], cysts, lipomas, as well as malignant lesions such as melanoma are possible due to the possibly similar clinical presentation.

The treatment of pyogenic granulomas depends on the etiology. For PG secondary to the treatment of an individual, for example, with EGFR inhibitors, immunosuppressants, or systemic retinoids, if possible, the discontinuation of the drug is recommended. [57, 58] Sollena et al. additionally suggest the treatment with topical corticosteroids and especially topical beta blockers such as timolol for beneficial outcomes.

Other suitable approaches are CO2 laser therapy, pulse dye laser therapy, cryotherapy, curettage in combination with electrocautery or topical treatment with silver nitrate [59, 61, 62] but these techniques show higher recurrence rates. Therefore, the best choice is the complete excision of the lesion, which also represents the lowest rates of recurrence. Complications of PG – if present - such as ulceration, hemorrhage, or secondary infections should be treated as well.

Enchondroma

Enchondromas belong to the group of chondromas which are benign tumors of the hyaline cartilage. When they originate from the medullary cavity of the bone, they are categorized as enchondroma, which are the most common chondroma subtype and the most common benign bone tumor of the hand. [63] Other common locations include the humerus, femur, and feet. In the hand, they most often affect the proximal phalanges followed by the middle phalanges, whereas the little and ring finger are most affected fingers. Miwa et al. created an overview of the cases of enchondroma in the hand and their distribution they observed in their study, seen in Figure 26. They may present during any time during live, but most cases are observed between the ages of 20 and 40. [64,65]

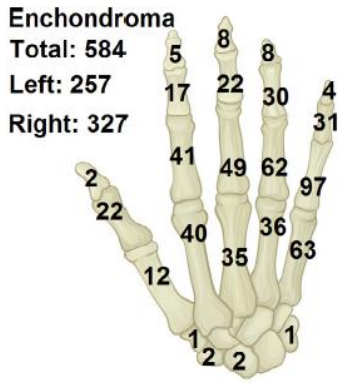

Figure 26: *Distribution of enchondromas in the hand [63]*

Usually, enchondromas occur as a single lesion. If multiple, the condition is called Ollier disease (enchondromatosis) and/or Maffucci syndrome - a combination of enchondromas and hemangiomas.

In the majority of cases, enchondromas are asymptomatic and an incidental finding during the investigation of a bone fracture rather than the actual cause of complaints. If symptomatic, they present with pain and swelling of the affected area.[65]

Since enchondromas are incidental findings, actual diagnostic workup is rare. The major tools for visualization of the lesions are X-ray and/or CT. These imaging techniques reveal well-defined lytic lesions of the affected bone, which can present either with or without calcifications [65] as presented in Figure 27. Ciobanu et al [66] describe the Takigawa radiological classification of enchondromas, whereas type A is described as central type, type B as eccentric type, type C is called associated type, type D a polycentric, and type E is a giant form of enchondroma as seen in

Figure 28. Similar to other discussed benign hand tumors, the definite diagnosis is based on histological examination of the tissue, however, this is rarely needed or performed.

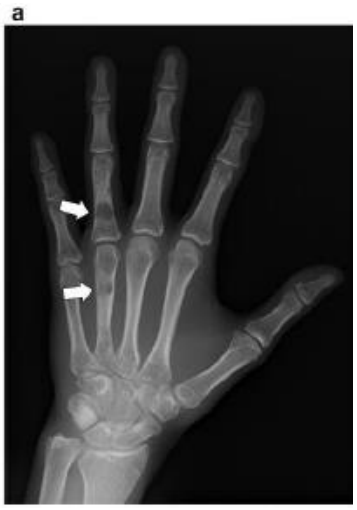

Figure 27: *Enchondroma seen in an X-ray (indicated by arrows)* [63]

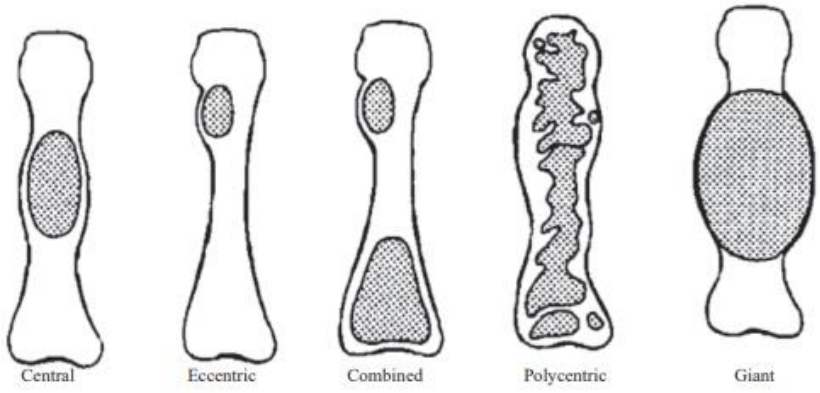

Figure 28: *Takigawa classification of enchondroma;* ***Source****: Jm FV. Enchondroma of the distal phalanx. ACTA ORTOPÉDICA MEXICANA.*

Again, since enchondromas are incidental findings, it is very rare that the treatment of an asymptomatic lesion is performed. All reviewed literature on this tumor agrees that curettage with bone grafting (if necessary) is the appropriate treatment for symptomatic enchondromas. The operation usually occurs either under general anesthesia or with a block of the brachial plexus. Xing and Mao [67] found out that even the use of a tourniquet during the operation for less bleeding might not even be required if local anesthesia with epinephrine is used. Different types of bone grafts and bone substitutes for the filling after tumor removal are weighted against each other by Ciobanu et al.[66] who suggest that autologous bone grafts (for example from ulna or ileum) remain the gold standard.

Osteoid Osteoma

Osteoid osteomas (OO) are bone-forming lesions that most often occur in long bones, especially in the lower extremity, but are also frequently found in the hand, with the proximal and middle phalanx affected predominantly. [68] Epidemiologically, a male predominance, especially among the ages 5 to 30 can be observed for these lesions with a peak incidence among individuals in their 20s. The tumor consists of a central part called the nidus and the surrounding bone.

Different literature sources argue on the pathophysiological mechanism, but Tepelenis et al. [68] and Erdogan and Gurkan [69] agree on the hypothesis of an ongoing inflammatory process. They describe the findings of highly increased amounts of prostaglandins in individuals, which promote vasodilation and edema in the surrounding tissues and therefore might also be responsible for the clinical picture of the lesion which will be described later. Depending on the localization of the nidus, osteoid osteomas can be classified into subperiosteal, intracortical, which is the most frequent found form, endosteal, and intramedullary; last being the most frequent form found in the hand. [70]

On appearance, an osteoid osteoma can be described as a small, round, or oval lesion with a red surface, not exceeding the size of 1,5 to 2cm. The most frequent symptom described is a dull pain which worsens during nighttime and is relieved by the use of Non-Steroidal Anti-Inflammatory drugs (NSAIDs) which supports the hypothesis of pathophysiological prostaglandin involvement. [68, 71] In cases of osteoid osteoma in a rather rare location like the distal phalanx of the thumb as presented in a case by Bailey and Holbrook [72] nail deformities, clubbing, and nail hypertrophy can also be observed.

The diagnostic workup for osteoid osteomas is a combination of the typical clinical presentation and simple radiologic imaging and/or CT, which is sufficient in most cases. On X-Ray images [68, 70, 73] the round or oval shape of the lesion can be observed as radiolucent, surrounded by sclerotic changes around the nidus. Depending on the location of the tumor, X-ray might not give sufficient information, whereas CT imaging will provide appropriate data, which is nowadays also considered the modality of choice for diagnostic workup. On CT, the nidus appears as a ring-like structure with clear borders as seen in Figure 29.

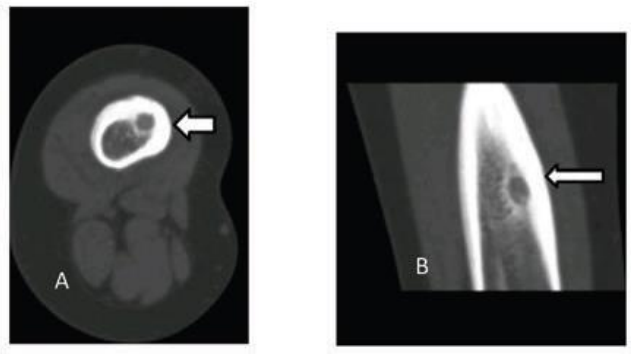

***Figure 29**: CT of an osteoid osteoma of the femur (A axial, B coronal), indicated by arrow [75]*

It is arguable whether MRI is helpful in the diagnostic procedure since it often leads to misdiagnosis of osteoid osteoma, as described by French et al. [74] But in his paper, he also

addresses the superiority of contrast-enhanced MRI, which indeed can aid in the diagnosis, especially in cases of doubt. Osteoid osteomas are highly vascularized and highly innervated, revealing an intense contrast enhancement of the nidus that is more intense when compared to the adjacent bone marrow. Even though it is rarely necessary for the diagnosis of osteoid osteoma, but other options are available, including bone scintigraphy and SPECT/CT. [73]

Altogether, the imaging methods might eventually be very useful for the differential diagnosis of osteoid osteomas, since there are some lesions that mimic their picture very well. [71, 73]. So is the clinical picture similar to that of osteomyelitis or intraosseous abscesses. Due to the age distribution, pain in the bone might also be first suspected to be caused by a fracture or stress reaction, however, this can be easily excluded by radiographic imaging. On images, osteoid osteomas look very similar to osteoblasts which therefore should be differentiated from each other carefully. Another lesion that may mimic the tumor is the Brodie abscess, which also depicts as a radiolucent center and surrounding sclerosis.[75] It must be noted that the abscess has irregularly shaped borders and therefore should not be mistaken for osteoid osteoma. If, after all, the diagnosis is still uncertain, an excisional biopsy reveals the definite diagnosis.

It is to be mentioned that osteoid osteomas might resolve without any treatment over a period lasting from 2 to 10 years. This period can be shortened by the conservative treatment with salicylates or NSAIDs, which is recommended in first place. [68-71] If the lesion does not resolve spontaneously, the pain is unbearable or untypical symptoms appear, surgical excision is recommended. The previously standard of open resection nowadays is replaced by minimally invasive surgery (MIS) whereas different methods are weighted against each other by Permeggiani et al. [76] The report analyzes the main differences of all possible techniques (seen in Table 3) and concludes that for osteoid osteoma of the hand, radiofrequency ablation (RFA) remains the best option for percutaneous surgery.

Treatment	Biopsy	Ionizing radiation	Ablated zone identification	Locations full accessibility
Radiofrequency ablation (RFA)	+	+	-	+
Interstitial laser ablation (ILA)	+	+	-	+
Microwave ablation (MWA)	+	+	-	+
Cryoablation	+	+	+	+

Magnetic resonance-guided focused ultrasound (MRg-FUS)	-	-	-	-

Table 3: *Main differences of each MIS analyzed [76]*

CONCLUSIONS

1. Even though they are rare in comparison to other locations of tumors, benign tumors of the hand are a pathology that should not be underestimated since our hands are important tools for every part in our lives. Lesions can be categorized into soft tissue tumors, including fat tissue, vascular tissue, cutaneous tissue, neural tissue, and cartilaginous tissue; and bone tissue tumors, covering enchondromas and osteoid osteomas, whereas ganglion cysts and giant cell tumors of the tendon sheath are the lesions that are met most frequently on the hand in clinical practice.
2. Six of the seven reviewed soft tissue tumors are found to have a female predominance, affecting populations in the age spectrum of the 20^{th} to 60^{th} decade of life, in contrast to bone tissue tumors, where in osteoid osteoma a male predominance is observed in a similar age range. The etiology of benign lesions of the hand is not fully understood, but a relationship to trauma is suspected in many cases.
3. The anatomical location of benign hand tumors varies greatly, depending on the type of tissue that is affected. So do enchondromas occur more frequently on the phalanges, whereas ganglion cysts are rather found in the area of the wrist, and glomus tumors, on the other hand, are mostly seen under the nail.
4. Hand tumors rarely present with clinical symptoms unless they grow large enough to compress neighboring structures, including nerves, thus, causing pain and irritation, and vessels. Due to their size, they might also restrict the patient's range of motion in the affected or neighboring joint. The most common clinical finding is a hypertrophic solitary lesion.
5. For the diagnosis, the clinical presentation and appearance raise the first suspicion for a tumorous lesion, which can be confirmed by imaging techniques. Ultrasound gives a gross overview of the encapsulation, vascular supply, and content of the lesion in the first line. For more precise investigation, computed tomography and/or magnetic resonance are

the method of choice which provide a wider picture about the extent and the involved tissues. In cases of doubt, excisional biopsies can give the definite diagnosis.

6. For all types of hand tumors, complete surgical excision is the recommended and preferred treatment method. It shows the lowest recurrence rate in comparison to other techniques such as cryoablation, laser therapy, or topical pharmacotherapy as used in hemangioma, as one example. Depending on the location of the lesion, different surgical incisions, and sites for approaching the tumor are applicable to achieve the best outcomes for the patient. The precise excision is necessary to prevent the recurrence of the tumor and not to cause any damage to structures such as nerves and vessels in close proximity to the tumor.

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