

General

Synovial ganglion of the wrist. Is it a common tumor or an important symptom?

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Relevance

Synovial ganglia, also known as joint hernias, “fluid tumors”, synovial cysts and hygromas, despite their widespread prevalence among the world’s population, oddly enough, are still a little-studied part of hand surgery.

The aim

Generalization and structuring of information on the main causes of the occurrence of synovial ganglia of the hand, their connection with damage in the structure of the ligament-articular apparatus, as well as the features of the conservative and surgical treatment.

Materials and methods

A systematic literature review

Results

Based on the literature review, it becomes clear that over the many years of studying the etiology and pathogenesis of ganglion cysts of the hand, research on this topic has made only limited progress, with abstracts still labeled “possible cause.” This situation can be explained more from a practical perspective: it is far more important to understand and explore new methods of diagnosing and treating an existing condition, which in most cases leads to good outcomes with minimal complications and relapses. However, the extensive data currently available on the association of this condition with damage to the ligamentous and articular apparatus of the hand, and in particular SLIL, indicate an emerging consensus on the direction of future research.

Conclusion

Based on the literature review, it becomes clear that over the many years of studying the etiology and pathogenesis of ganglion cysts of the hand, research on this topic has made only limited progress, with abstracts still labeled as “possible cause” which emphasizes the need for further study of the problem.

RELEVANCE

Synovial ganglia, also known as joint hernias, “fluid tumors,” synovial cysts, and hygromas, despite their widespread prevalence worldwide, are surprisingly still a poorly understood aspect of hand surgery. The topic of the etiology, pathogenesis, and optimal treatment methods for synovial ganglia is regularly addressed in modern literature.¹⁻⁵

Numerous authors annually publish their observations of individual clinical cases, while others conduct cohort studies to determine and refine statistical data. However, most of these studies share a common theme: the lack of clear, established data on the causes of the pathological process, its properties, and its relationship with adjacent structures. Furthermore, the relevance of this work is underscored by the more than two-century history of synovial ganglia research, which still leaves open the question: is this soft tis-

sue neoplasm a primary and independent pathology or does it represent an important symptom of incipient changes in the articular apparatus of the hand?

THE AIM

The aim of this study was to analyze current literature to summarize and structure data related to the history of studying the main causes of the occurrence of synovial ganglia of the hand, and modern concepts of their connection with damage in the structure of the ligament-articular apparatus, as well as the features of conservative and surgical treatment.

MATERIALS AND METHODS

The authors analyzed over 30 literature sources and examined both the historical development of the issue and current understanding of the problem under study. Particular attention was paid to theories of ganglion etiology and pathogenesis, as well as related changes in treatment approaches.

RESULTS

HISTORICAL BACKGROUND

Today, there are various theories regarding the etiology of ganglion cysts. For example, Euler proposed a theory in 1746 that ganglion cysts are the result of synovial tissue protrusion from the joints. In the early 19th century, the connection between these pathological formations and tuberculosis infection was thoroughly studied, and Hooftman and Floederus proposed the idea of a synovial dermoid cyst arising from the displacement of germ cells. Another theory, postulated by Karp and Stout in 1926 and which partly forms the basis of most modern concepts, suggests that, firstly, ganglion cysts arise as a result of mucinous degeneration of connective tissue secondary to chronic injury, and, secondly, the lack of anatomical connection between the joint structures and the hygroma.¹

The history of studying the etiology and pathogenesis of ganglion cysts of the hand dates back to the 18th century, when in 1778, the eminent Swedish surgeon Olaf af Ackrel first described a fluid-filled tumor on the dorsum of the wrist, associating its appearance primarily with inflammation of the adjacent tendons and tendon sheaths of the extensor muscles of the hand.^{1,2} Later, to describe space-occupying lesions on the dorsum of the wrist, the eponymous term "Ackrel's ganglion" appeared in morphology, which is currently used to denote a thickening of the posterior interosseous nerve.³

Subsequently, some authors examined the ganglia by injecting contrast agents into their cavity. These agents were retained within the cavity, confirming the theory that they were not connected to adjacent structures. However, McEvedy, when staining the wrist joint, later discovered that a contrast agent had leaked into the ganglion cavity,

which, in turn, indicated their connection to the wrist ligaments via a one-way valve.¹

In accordance with the change in the understanding of the etiology, pathogenesis and structure of the synovial ganglia of the hand, the approach to their treatment has also changed fundamentally: starting from the long-gone local application of mercury, a blow with the "spine of the Bible" and tying a bullet to the wrist (preferably after a deer hunt), ending with the use of arthroscopic techniques and the formation of "gold standards" of therapy.^{1,4,5}

MODERN IDEAS

Currently, most authors agree that ganglion cysts arise from mesenchymal cells in the synovial-capsular junction as a result of continuous trauma. Repeated injury to the supporting capsular and ligamentous structures appears to stimulate fibroblasts to produce hyaluronic acid, which accumulates to form the mucinous "jelly-like" material typically found in ganglion cysts.⁶

Today there are also several theories of the pathogenesis of hygromas:

1) The theory of metaplasia: the ganglion is a transformation of embryonic, post-traumatic periarticular remnants or stem cells, 2) synovial theory: synovial fluid migrates from the joint and forms a new cavity connected to the joint by a pedicle, and 3) that the area of the joint capsule or ligament that stimulates mucin production is subsequently encapsulated.⁷

In such an abundance of opinions about the origin and development of pathology, one thing remains certain: synovial ganglia are the most common tumors of the soft tissues around the hand and wrist.^{1,4,7-10}

The etiology and pathogenesis of synovial ganglia of the wrist joint itself remain unknown. A statistically significant correlation has been found between ligament sprains and dorsal ganglia, but the details remain unclear.¹⁰ Various theories have been proposed to explain the etiology, ranging from scapholunate joint injury and synovial sac formation to periarticular tendon/tendon sheath degeneration. Intra-articular pathology is detected in 50% of patients with ganglia during arthroscopy.^{1,7} However, a correlation between intra-articular pathology and ganglionic recurrence has not yet been found.

Synovial ganglia are the most common soft tissue tumors around the hand and wrist. J. Hussein et al. present the results of their statistical analysis: 60-70% of nodes are located dorsally, 13-20% arise laterally and originate from the joint between the radius and scaphoid bones, between the scaphoid and trapezium bones, and between the trapezium and first metacarpal bone, and 10% arise around the flexor tendon. Intraosseous and intratendinous ganglia are less common.⁷

Dorsal ganglion is considered the most common variant of pathology and is found in patients of all ages, with the highest incidence in the age group of 20-50 years and with a predominance among women with a ratio of 2.8:1.^{8,9} However, A. Zang et al., studying by sonography the palmar and dorsal surfaces of the wrists of 98 people with a total number of neoplasms of 124, determined the most frequent lo-

calization of the ganglion in this sample as palmar (volar) - 69% (86/124), especially often between the radial artery and the tendon of the radial flexor carpi radialis 63% (78/124), thereby emphasizing the importance of a thorough examination of both soft tissues and the tendon apparatus of the wrist using ultrasound and MRI.¹¹ This fact is also noted by a number of authors who describe individual clinical cases of association of hygromas of this localization with deformation of the superficial radial nerve, compression of the ulnar nerve in the Guyon canal, flexor tendons of the fingers with the appearance of symptoms of "trigger finger", as well as with the presence of adhesions with a pathologically altered radial artery.¹²⁻¹⁴ This once again emphasizes the importance of radiographic imaging methods in the diagnosis of hygromas not only as an isolated pathology of the wrist, but also associated with pathology of blood vessels and nerves, which, according to some authors, fundamentally changes the approach to the treatment, giving preference to conservative therapy (aspiration of the contents followed by the introduction of fibrin or steroid drugs), due to the high probability of reconstruction of arteries and nerves during surgical treatment (open or arthroscopic).^{12,13}

An interesting fact is that with a relatively small number of dorsally located ganglion cases identified, 20% (25/124) were located above the scapholunate ligament (SLIL), and only in 2 cases was SLIL pathology associated with hygroma detected, which the authors did not pay close attention to, as this was not the purpose of the study.

Of particular interest in relation to the specific causes explaining the anatomical relationship of hygromas with the scapholunate joint is a clinical case of postoperative instability of the scapholunate joint from the practice of M. Hossein and D. Mc. Michael.¹⁵ In their work, the authors, like most contemporaries, once again emphasized the most common location of the nodes - the dorsal surface of the wrist (70%). In the remaining cases of palmar localization, pathology of the radiocarpal, scaphotrapezoid joints (20%). It is emphasized that cases of location on the dorsal surface of the wrist originate from the scapholunate joint with direct attachment to the scapholunate interosseous ligament (SLIL) through the pedicle. For this reason, it has been recommended that surgical excision of the ganglion be accompanied by excision of a small cuff surrounding the dorsal joint capsule and removal of all ganglion attachments to the SLIL, which is believed to minimize the recurrence rate. The main complication following surgical excision of a ganglion cyst associated with SLIL is instability of the scapholunate joint, as determined by the Watson test. Interestingly, the authors of the study highlighted changes in the dorsal portion of the SLIL. The dorsal portion, which is the strongest component of the scapholunate ligament, was subject to myxoid changes, which presumably led to both the development of synovial ganglia and postoperative joint instability.

Theodora C. Dworak and a group of co-authors conducted a statistical analysis to confirm their hypothesis about a higher incidence of dorsal carpal ganglion in military personnel compared to the civilian population.¹⁶ An analysis of 1,000 medical records of the civilian population

and 1,000 medical records of military personnel, dated between 2009 and 2014, revealed that the annual incidence of the disease among military personnel is twice that of the general population: 14.25/10,000 and 7.01/10,000, respectively. In addition, a correlation between the incidence of pathology and gender was also determined in the military group: women suffer 2.26 times more often than men, and young people (25-34 years) suffer 1.74 times more often than the older group (45-63 years). Among the civilian population, the incidence of hygromas was 2.59 times higher in women and 2.56 times higher in young men. The authors explain these findings with currently available data on the etiology of synovial ganglia. The authors believe that although increased ligament laxity may be a significant risk factor for the development of synovial ganglion, the possible etiology appears to be related to cumulative trauma or chronic repetitive motion. Repeated stress on the wrist leads to rupture of the tendon capsule, creating a one-way valve for fluid, leading to the formation of a soft tissue mass. Increased ligament and soft tissue laxity potentially accelerates the consequences of repetitive trauma leading to cyst formation. This may explain the higher incidence in female military personnel compared to males, given the increased prevalence of ligament laxity in women.

In 2013, information appeared about the connection between ligamentous weakness and the incidence of dorsal carpal ganglia.¹⁷ Ligamentous laxity, both systemic and localized, was assessed using the Beighton scale and the scaphoid displacement test (positive in only 1/4 of the cohort—24/96). Preliminary imaging studies confirmed intact wrist ligaments. In a cohort of 96 individuals, symptomatic dorsal carpal ganglia were associated with both generalized hypermobility (27/96), as demonstrated by the Beighton scale, and localized capsular-ligamentous laxity (24/96), as assessed by the scaphoid displacement test. A positive scaphoid displacement test indicates localized capsular-ligamentous laxity, allowing subluxation of the scaphoid from the scaphoid fossa during testing, which may ultimately indicate the involvement of SLIL in the pathology.

In 2019, V.F. Baitinger and M.Yu. Stepanov conducted a literature review to summarize the causes of postoperative hygroma recurrence. The study emphasized that subacute tendovaginitis in this anatomical region is currently considered the main cause of synovial cysts on the hand. Furthermore, the identified connections between the neoplasm cavity and the radial-scaphoid, scapholunate, and scaphotrapezoid joints increasingly lead surgeons to believe that dorsal wrist hygromas are, in most cases, not so much an independent pathology as a symptom of wrist joint instability.²

TREATMENT

Currently, there are numerous individual clinical observations and large-scale statistical studies examining and comparing various methods of treating synovial ganglia. Some authors are conducting a comparative analysis between conservative and surgical treatment methods, which, given the specifics of the pre- and postoperative periods, is particularly interesting and important for study in pe-

diatric practice¹⁸]. Individual reviews of clinical cases describe spontaneous regression of the pathology with a high rate of relapse. The general theme in the study of the issue of synovial ganglion therapy remains the recognition of the pathology as a surgical one, requiring appropriate treatment that minimizes the risk of relapse^{1,2,4,5,18}

CONSERVATIVE TREATMENT

Aspiration, with or without the use of glucocorticosteroid drugs, is currently known as the simplest and least effective method of treating ganglion.^{4,5} In their study, D.V. Nield and D.M. Evans determined that more than half (20/34) of primarily aspirated ganglia are prone to relapse, while V.N. Zubowicz and C.H. Ishii found that in 15% of cases (7/47), relapse of an aspirated ganglion leads to the need for more than three repeat punctures.^{19,20} G.W. Varley et al., using, in addition to aspiration, the introduction of glucocorticosteroids into the ganglion cavity, also observed a high relapse rate of 67% (29/43), which was also associated with the appearance of undesirable local side effects.²¹ Subsequent immobilization did not help either, maintaining a high risk of recurrence of hygromas of 48% (16/33).²² A large number of studies conducted back in the 20th century largely determined this method to be ineffective and unreliable.

Sclerotherapy was initially a proven method for rapid and conservative treatment. However, with the emergence of information about the connection between ganglion cysts and the ligamentous-articular apparatus of the hand, the prospects for injecting sclerosants into the ganglion cavity faded, as this could lead to severe and irreversible damage.²³

A similar fate befell hyaluronidase therapy. In 1992, A.A. Otu described the method of hyaluronidase injection followed by aspiration of the contents as an excellent method of conservative therapy—the recurrence rate during the entire observation period (6 months) did not exceed 5% (17/349).²³ However, subsequent prospective studies by other authors with a post-treatment observation period of 2 and 1 year revealed a recurrence rate of 51% (18/35) and 77% (33/43), respectively.^{24,25}

SURGICAL TREATMENT

In 1976, Angelides and Wallace described a method of excision of the synovial ganglion of the wrist together with the site of its attachment to the SLIL.²⁶ The recurrence rate of 0.87% (3/346) stated by the authors has not stood the test of time; in the modern literature there is a wide range of descriptions of the frequency of repeated postoperative occurrence of pathology: from 0% to 31.2% during removal of the ganglion of the dorsal surface of the wrist.⁴ During resection of the ganglion of the volar surface, the recurrence rate ranges from 14% to 42%, which is also associated with frequent complications in the form of damage to the nerve fibers of the median nerve (10%), radial artery (5%).²⁷ In 2023, A.E. Muhammad et al. assessed the outcomes of dorsal carpal ganglion ablation surgeries in 125 military personnel.²⁸ According to the study's results, the recurrence

rate was only 9%. Furthermore, a modern, standardized surgical technique was described in detail and its key principles were defined. According to the authors, adherence to these principles minimizes the risk of both recurrence and postoperative complications. The relative ease of learning and performing the surgery, the lack of need for high-tech equipment, and the extensive evidence base of this method have earned it the deserved status of “golden method” in the treatment of wrist ganglion cysts.

In 1995, A. Lee Osterman and J. Raphael first described the technique of arthroscopic removal of the dorsal carpal ganglion.¹ The obvious advantages of the method include minimizing the surgical scar, limited only to small areas of the arthroscope and instrument ports, and the ability to fully assess the condition of the articular apparatus of the hand. In the initial study, A. Lee Osterman and J. Raphael did not observe postoperative recurrence of pathology in any of the 18 operated patients, but a prospective study by L. Kang et al., conducted in 2008, indicates a similar recurrence rate with both open (2/23) and arthroscopic (3/28) removal.²⁸ In 2016, N. Borisch, having analyzed the results of 92 arthroscopic resections of the dorsal ganglion of the wrist in 88 patients, established a recurrence rate of 12.5% (11/88).²⁹ In 2003, P.C. Ho et al. described a technique for arthroscopic removal of the ganglion on the anterior surface of the wrist.³⁰ Only in one of the six operated patients, the authors encountered technical difficulties during the operation, which required switching to open surgery; in the remaining cases, no cases of recurrence were observed during the postoperative observation period. Much later, in 2013, S. H. Fernandes and a group of co-authors conducted an extensive systematic analysis of articles on the general topic of arthroscopic treatment of volar ganglion of the wrist, where, based on the results of the analysis of 11 of the most cost-effective articles, they established a fairly wide range of recurrence rates: from 0% to 20%.²⁷ In 2023, M. W. Konigsberg et al., analyzing 172 cases of operated dorsal ganglion (54 arthroscopically and 118 openly), established the fact of 16.7% (9/54) of cases of recurrence in the group operated arthroscopically, and only 6.8% (6/118) of cases in the group operated openly.³¹

CONCLUSION

Based on the literature review, it becomes clear that over the many years of studying the etiology and pathogenesis of ganglion cysts of the hand, research on this topic has made only limited progress, with abstracts still labeled as “possible cause.” This situation can be explained more clearly from a practical perspective: it is far more important to understand and explore new methods of diagnosing and treating an existing condition, which in most cases leads to good outcomes with minimal complications and relapses. However, the extensive data currently available on the association of this condition with damage to the ligamentous and articular apparatus of the hand, and in particular SLIL, indicate an emerging consensus on the direction of future research.

ABBREVIATIONS

Not applicable.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors declare no competing interests.

DATA AVAILABILITY

The dataset analysed during the current study are available from the corresponding author on reasonable request.

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AUTHORS' CONTRIBUTIONS

A.D., G.T. searched for recent publications
A.A., I.D. wrote the main manuscript text

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