Arch Orthop Traumat Surg (1982) 99:247-252

Archives of Orthopaedic and Traumatic Surgery

Pathogenesis, Clinic, and Treatment of Ganglion

Arnold Soren

Dept. of Orthopedic Surgery and Rheumatic Diseases Study Group, New York University School of Medicine and Veterans Administration Medical Center, 550 First Avenue, New York, NY 10016, USA

Summary. In clarification of various theories on the pathogenesis of the ganglion, histopathologic examinations indicate that the ganglion develops from connective tissue by myxoid degeneration and disintegration of collagen fibers. Increasing amounts of mucinous fluid accumulate by the progressive liquefaction of collagen fibers and are surrounded by densifying collagen bundles which form a delimiting capsule. In view of the inadequacy of conservative treatment and the shortcomings of excision, the subcutaneous (s.c.) discission of the ganglion with a tenotome is recommended. Of 184 patients treated in this way, 151 displayed full healing, six underwent a successful repetition of the procedure, nine underwent an excision of the recurrent ganglion, and 18 rejected further treatment.

Zusammenfassung. Zur Klärung der verschiedenen Theorien über die Pathogense der Ganglien erwiesen histopathologische Untersuchungen, daß das Ganglion aus Bindegewebe durch Zerfall und myxoide Degeneration von Kollagenfasern mit Ansammlung schleimiger Flüssigkeit und Verdichtung der umgebenden Kollagenbündel entsteht. Als Behandlung wird die subcutane (s.c.) Diszission des Ganglion empfohlen. Von 184 derartig behandelten Patienten boten 151 vollständige Heilung dar, sechs unterzogen sich einer erfolgreichen Wiederholung des Verfahrens, neun machten eine sekundäre Exzision mit und 18 lehnten eine weitere Behandlung ab.

The ganglion, regarded as overbone by lay people because of its firmness, may sometimes be confused, even by physicians, with a solid tumor like a lipoma or fibroma. Actually, the nature of this formation was already known to Hippokrates, who designated it as ganglion which meant a lump filled with mucus. However, the mode of origin was unclear.

Volkmann (1882) considered the ganglion as a prolapse of synovial tissue, and based this view on the fact that the ganglion occurs in the proximity of joints and tendon sheaths. The bulging synovial membrane maintains its function in producing synovial fluid; because of the latter's impaired outflow, the pouch gradually widens and the entrapped fluid becomes thicker. Kuettner and Hertel (1925) as well as Ollerenshaw (1921) explained the ganglion as a formation from embryonically displaced arthrogenic tissue which upon irritation is instigated to assume its inherent capacity of producing synovial fluid. Floderus (1915) even designated the ganglion as arthron on the basis of the similarity of its capsule with that of the joint capsule. Herzog (1940) considered the ganglion as a primary formation of myxomatous nature and explained the predominant affliction of the periarticular tissue by its special loose texture. On the other hand, Ledderhose (1893) for the first time regarded the ganglion as a formation by degenerative processes secondary to injury to periarticular tissues. Similarly Payr (1898), Carp and Stout (1928), Ritschl (1895), and Thorn (1895) thought that connective tissue may be brought to degeneration and liquefaction by traumatic harm. Mayer (1950) arrived to the conclusion that a degenerative process underlies the formation of the ganglion.

Materials and Methods

In the course of 22 years 206 patients were examined. Of these, 184 patients were treated by the subsequently described s.c. discission; 14 other patients with a ganglion on the volar aspect of the wrist underwent primary excision of the ganglion, and 17 patients underwent excision of the ganglion either primarily because of its excessive size or secondarily because of recurrence after s.c. discission.

0344-8444/82/0099/0247/$ 1.20

Fig. 1. Ganglion on dorsum of the hand between extensor tendons

After gross examination of the lump of tissue (Fig. 1), usually excised in toto, portions of it most conspicuously displaying cystic changes were routinely fixed in 10% formaldehyde, and occasionally in Zenker's or Bouin's solution. The stain was hematoxylin-eosin (HE) and was supplemented whenever indicated with special stains by Mallory's phosphotungstic acid hematoxylin, Weigert-Van Gieson's dye, Masson's trichrome, and toluidine blue.

The transversal section provided information on the cystic character of the ganglion which was formed of a capsule of dense connective tissue enclosing a cavity. Rarely and only in the small ganglia were the cysts unilocular; more often a larger central cavity was surrounded by several smaller cavities, and very often a few larger cavities were interspersed between several smaller cavities; some of the latter merged with the larger cavities. The individual cavities were separated from each another by septa which were soft and tender in younger ganglia. In ganglia of longer duration they were dense and sometimes thinner or thicker. With expansion the cavities occupied the greater proportion of the volume of the ganglia than the solid septa. Accordingly, the ganglia had a spongy consistency with the interstitial tissue varying from parenchymatous over elastic to dense fibrous. Owing to increasing fibrosis the delimitation of the ganglion from the neighboring loose tissue became more distinct.

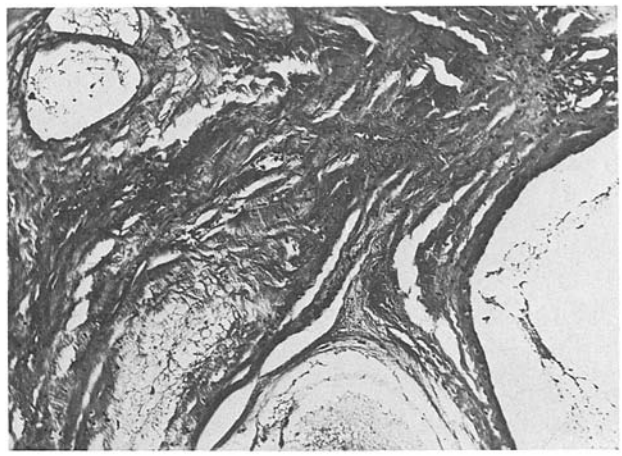


Fig. 2. In the left upper corner are two small cavities with myxoid degeneration of the neighboring tissue. Adjacent above and below are two areas with partly swollen and more disintegrating collagen fibers. At the mid-bottom is a cavity whose wall is in liquefaction. The wall of the cavity in the right lower corner is lined with fibrocytes

Fig. 3. Ganglion with a large cavity which is delimited by walls, and is subdivided by septa some of which display areas of myxoid loosening

The histopathological examination discloses not only in several ganglia of varying duration, but often in one ganglion the various phases of tissue changes leading to its formation. As introductory changes in areas of loose connective tissue, collagen fibers are swollen and broader, weakly stained and indistinctly structured until they loose their sharp demarcation (Fig. 2). The fibers become separated from each other and form a meshwork (Fig. 2) which comprises a liquid ground substance to which decomposing fibers gradually admix. In the process of disintegration

participate also the fibrocytes which swell and assume ovoid shape. Their cytoplasm is homogeneous and contains vacuoles filled with fluid. Their cytoplasmic processes become shorter and together with the cell bodies are finally incorporated into the process of liquefaction, where upon homogeneous areas intensely stained with hematoxylin appear which are separated from each other by septa of collagen bundles. In this way gaps develop that are filled with liquid material (Fig. 2), which by further disintegration of the interposed septa coalesce to larger cavities (Figs. 2 and 3) containing mucoid substance and being occasionally traversed by collagen fibers. These cavities are surrounded by rims and denser bundles of connective tissue (Fig. 3) which sometimes displays on its surface decreased staining capacity and progressive disintegration, but more often increased metachromasia on toluidine blue or acridine orange.

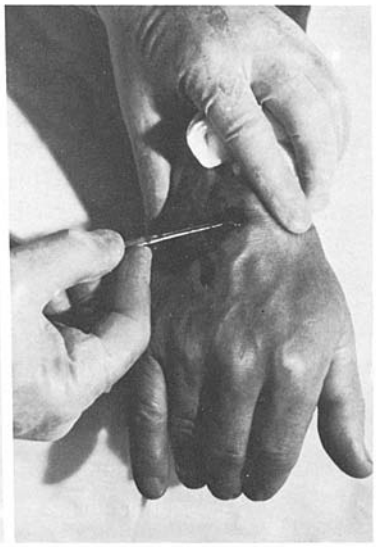
Gradually, the decomposition processes of the marginal border reach their end, and the surrounding capsule assumes a dense texture (Fig. 3). The latter change may be attributed to two factors: (1) by increase of the liquefied content the cavities expand, and by their tension the surrounding collagen bundles are compressed and convey a densified impression; (2) despite compression the collagen bundles are not thinner, but subsequently become thicker due to formation of additional collagen material in the course of fibrosis; this impression is confirmed by the increased number of fibrocytes which lie along and between the collagen bundles (Fig. 3). Corresponding with the increased intracystic tension the fibrocytes come to lie on the surface of the separating septa and delimiting capsule being positioned with their longitudinal diameter parallel to the cavities; they form a more or less coherent marginal lining of the cavities. Thus, whereas the central cavity or a few larger cavities have already attained the completion of their development, other areas display various stages in the development of the cyst from the beginning disintegration of a few collagen bundles to delimitation of a cystic cavity. The liquid content of the cysts stains like mucoid material azure blue with hematoxylin and contains desquamated cells involved in liquefaction with large indistinct nuclei, irregularly shaped homogeneous formations (apparently remnants of cells), and intensely stained fragments of nuclei (Fig. 3).

By the presence of a cavity filled with mucinous fluid, an endothelium-like inner lining, and a surrounding capsule of connective tissue the ganglion presents a structural similarity with a joint. Therefore, the ganglion was considered as a relict of arthrogenic tissue. However, the histopathologic examinations indicate that the formation of the ganglion is initiated independently from a joint by regressive mucoid degeneration of connective tissue, until by adaptation of the surrounding connective tissue the process of liquefaction reaches completion and delimitation. These observations support the opinions of Carp and Stout (1928), Mayer (1950), and Payr (1898) that degeneration of connective tissue is the basic process in the pathogenesis of the ganglion.

The primary cause for these changes has not yet been elucidated. Although direct traumata have been implicated, the past history does not reveal any trauma in the majority of cases, nor does the legion of traumatized people display a greater incidence of ganglia than those without trauma. On the other hand, one may assume with probability that frequent intensive strains of the limbs as in typists, musicians, sports people, and laborers are associated with disuse of connective tissue which undergoes regressive changes and local disintegration as a sign of excessive fatigue. That such changes and associated formations occur most frequently in the proximity of joints may be explained by the loose texture of the richly interstitial substance containing periarticular tissue. In addition, the factor of constitutional inferiority of the connective tissue system must be considered, because otherwise one could not explain why some individuals develop ganglia, whereas others with identical activity do not develop ganglia. The implication of constitutional inferiority finds its justification even more explicitly in some individuals who develop extensive ganglia in a few regions of the body, e.g., the dorsum of the hands and feet; one may designate this condition as gangliomatosis. In such situations the ganglia may attain plum size and extend diffusely into the vicinity where they are coherent with tendon sheets and/or joint capsule.

The ganglia of 4 months' to 3 years' duration had their most frequent location on the dorsum of the wrist (Figs. 1 and 4), on top of the carpal bones and between the tendons of the extensors of the fingers. Less often did the ganglia occur on the volar aspect of the wrist, where they were located either more distally between the tendons of the finger flexors and the transverse carpal ligament or somewhat less distally on the flexor tendons. The next most frequent location was the dorsum of the foot, where the ganglia lay on the tarsal bones and were often connected with the joint capsule, or the side of the ankle, where the ganglia were connected with the peritendinous tissue of the tibialis posterior and flexor hallucis longus or the peroneal tendons. On the anterior aspect of the distal part of the lower leg the ganglia were located between the peritendinous tissue of the anterior tibialis and extensor digitorum longus muscles and reached their largest size there. A less frequent location was the knee where the ganglia lay either on the

4



5

6

Fig. 4. Ganglion of 2 years' duration on dorsum of hand

Fig. 5. Subcutaneous discission of the ganglion by tenotome

Fig. 6. A year after s.c. discission of the ganglion, the dorsum of the hand displays normal configuration

medial aspect between the medial collateral ligament and the anserine bursa and the semimembranosus tendon or on the lateral aspect of the tibial condyle in front of the fibular head and origin of the peroneal mucles. In any location the ganglia were spherical or ovoid formations with the diameter from 1 cm to 6 cm.

The complaints elicited by a ganglion depend on its size, location, and relationship to the neighboring organs. The most distinct symptom appears to be the circumscribed swelling (Fig. 4) which comes even more into evidence as it occurs over distinctly shaped regions and is well delimited from the vicinity. The desire for removal of this cosmetically disturbing deformity primarily and usually leads the patients to seek medical treatment. The discomfort by an average size ganglion is minimal, and apart from some insecurity in the use of this joint most frequently no functional disturbances are noted. Sometimes a dull ache arises after intensive use of the joint. When the ganglion is adherent to the tendon sheaths of the hand, the gliding ability of tendons and with it the active motion of the fingers are impaired. In direct continuity of an expanding ganglion with nerves neurologic signs may arise. The ganglion on the volar aspect of the wrist may elicit by pressure paresthesias and motoric deficits in the distribution area of branches of the median or ulnar nerve. The ganglion situated close to the fibular head may cause compression signs in the distribution area of the peroneal nerve. On palpation the ganglion appears as a soft, elastic, or dense tumor which usually displays fluctuation. When the capsule is thick, a multiloculated composition is hardly ascertainable. But some conclusion on the age of the ganglion may be drawn from its consistency and the proportion in its composition between liquid content and firm connective tissue.

The treatment is applied accordingly, because a ganglion of shorter duration (1-3 months) may be brought to bursting by firm compression with the tip of the thumb. Sometimes such a ganglion may recur, especially if adjacent areas subsequently undergo disintegration and liquefaction; then another compression may be necessary. Such treatment is effective as long as the capsule is soft and encloses chiefly a solitary cyst, and the ganglion lies on a firm basis of bone. However, if several cavities have been formed, and the interposed septa and the surrounding capsule have acquired a dense texture or the ganglion communicates with a joint, then the attempt of compression fails.

As an alternative aspiration of the intraganglionic fluid, followed by injection of proteolytic (Ball 1940) or sclerosing solutions or steroid medications, is often practiced. Whereas these solutions elicit a strong inflammatory reaction followed by obliteration, their effect may spread beyond the confines of the ganglion and may affect neighboring tendon sheaths or joint capsule (Key 1942). On the other hand, the steroid medications are of little benefit, because their antiinflammatory effect is directed here against degenerative changes and therefore of little effect. However, most of all the prime requirement that all cavities be emptied of their mucinous content, so that the intraganglionically administered medication may exert its influence, cannot be fulfilled. If several smaller and larger cavities are present, it is difficult to visualize how the entire mucinous fluid could be aspirated from the ganglion, and without vacating all cavities the

Fig. 7. Collagen bundles and walls are sharply divided in several areas. The surrounding tissue contains hemosiderin droplets and thick-walled blood vessels

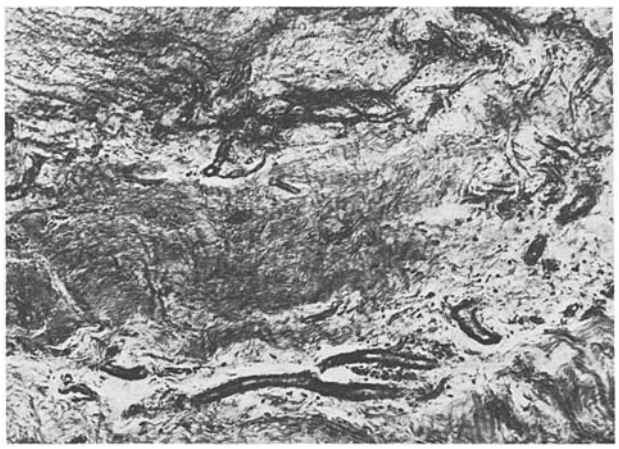


Fig. 8. The former cavity is obliterated by fibrous connective tissue. The surrounding wall contains numerous capillaries and smaller blood vessels

intraganglionically injected medication cannot develop its effect on the walls of the cyst.

The attitude of most physicians to treat the ganglion by excision appears reasonable. However, despite radical excision the ganglion recurs in 15%–40% of the operated cases (De Orsay et al. 1937; Hand and Patey 1952; Hvid-Hansen 1970; McEvedy 1954). This failure is easy to be explained because even with broad exposure not all degenerated, or in degeneration involved, tissue portions are perceived and removed; the remnants or buds of degenerated tissue progress to disintegrate and to liquefy, and form a ganglion afterward. The patient, in whom after excision of the ganglion even small remnants of degenerated connective tissue have been left, is removed from the operating room with the great probability of a recurrent ganglion. If additionally the fact is considered that the ganglion occurs on exposed regions of the body, where the resulting scar may be disturbing, then the endeavor to treat the ganglion by another procedure, rendering good results at lesser risk, appears well justified.

Such a procedure may be the s.c. discission which is well able to open all cavities of the ganglion and to remove the entire intraganglionic fluid. The technique of the s.c. discission is carried out in the following way. Local anesthesia with 1% Lidocaine solution is administered starting from the margin and proceeding into the interior of the ganglion. Then a s.c. tenotome of 3 mm width is inserted through the skin (Fig. 5), being held parallel to the skin whereby injury of the neighboring tendons is avoided. The tenotome is passed from the margin of the ganglion into the center of the ganglion and is continued so until it emerges through the opposite margin of the capsule. With the same attitude of the hand, the tenotome is partly withdrawn, and is turned forward and backward so that it circumferentially divides the capsule of the ganglion. Continuously parallel to the skin, the tenotome is passed a little more superficially and then a little deeper through the ganglion so that all cavities lying at various levels are opened. After the ganglion has been divided into a few planes, the tenotome is withdrawn. The effect of the s.c. discission may be visualized by the fact that the entire mucinous content of the ganglion is squeezed out through the discission opening, whereupon the ganglion collapses. A sterile compression dressing is applied, and the limb is immobilized with a splint for 10–14 days. Follow-up examination discloses at the site of the former ganglion a small thickening which gradually decreases by shrinking and scarification, so that eventually and usually no remnant of the ganglion may be perceived (Fig. 6).

The effect of the s.c. discission was evaluated by examination of tissue specimens obtained at the excision of nine recurrent ganglia and of five remaining thickenings at the site of the former ganglia. The ganglia were transformed into a dense, grayish-white plate which contained little or no mucinous fluid. Histologically, the specimens removed shortly after the procedure still displayed on distance small cavities whose walls were formed by transected bundles of loose connective tissue (Fig. 7). In the latter, residues of hemorrhages, hemosiderin-laden histiocytes, and thick-walled blood vessels were observed. In tissue sections of specimens removed 1 year after the discission, the cavities were completely obliterated, and were identifiable by being filled with younger and older granulation tissue (Fig. 8) which contained numerous small blood vessels, abundant collagen fibers, and many spindle-shaped fibrocytes with cytoplasmic processes. The previous inner borders of the

cavities had no more a cover of fibrocytes, and were connected with each other by masses of irregularly coursing collagen bundles (Fig. 8). This haphazard fashion in the arrangement of the collagen bundles extended over larger areas. An overall and conspicuous proliferation of connective tissue, composed less of fibrocytes and more of collagen fibers dominated the field; with this fibrosis scarification took place in areas of the former cavities and the presence of disintegration of the connective tissues was arrested.

By the above described technique of s.c. discission 184 patients with ganglia in various locations of extremities were treated within a lapse of more than 20 years; at the final follow-up examination, 151 patients displayed full scarification at the site of the former ganglion, whereas the other 33 patients displayed a recurrence of the ganglion. Of the latter group six patients underwent successful repetition of the s.c. discission, and nine patients underwent excision of the previously discissed ganglion; the remaining 18 patients rejected further treatment. Eight other patients with ganglia of excessive size underwent primary excision, and two of them had recurrences; 14 patients with smaller ganglia on the volar aspect of the wrist underwent primary excision because of the proximity to the radial artery and four of them had partial or complete recurrences.

References

Ball EJ (1940) A new method of treatment of ganglion. Am J Surg 50 : 722

Carp L, Stout AP (1928) A study of ganglion. Surg Gyn Obst 47 : 460

DeOrsay RH, McGray PM, Ferguson LK (1937) Pathology and treatment of ganglion. Am J Surg 36 : 313

Floderus B (1915) Studien in der Biologie der Skelettgewebe mit besonderer Berücksichtigung der Pathogenese der histioiden Gelenkgewebegeschwülste. Friedlander, Berlin

Hand BH, Patey DH (1952) The treatment of ganglion of the wrist. Practitioner 169 : 195

Herzog C (1940) Über die Pathogenese der meniskalen Ganglien. Arch Path Anat 307 : 27

Hippokrates (1927) On joints. (Translation by E. T. Withington), W. Heinemann, London

Hvid-Hansen O (1970) On the treatment of ganglia. Acta Chir Scand 136 : 471

Key A (1942) Treatment of ganglion by injection of caroid a dangerous procedure. J Am Med Assoc 118 : 516

Küttner H, Hertel E (1925) Die Lehre von den Ganglien. Ergeb Chir Orthop 18 : 377

Ledderhose V (1893) Die Ätiologie der carpalen Ganglien. Deut Z Chir 37 : 102

McEvedy BP (1954) The simple ganglion; a review of modes of treatment and an explanation of the frequent failures of surgery. Lancet 266 : 135

Mayer M (1950) Über das Ganglion. Helv Chir Acta 17 : 155

Ollerenshaw (1921) The development of cysts in connection with the external semilunar cartilage in the knee joint. Br J Surg 8 : 409

Payr E (1898) Beiträge zum feineren Bau und Entstehung der carpalen Ganglien. Deut Z Chir 49 : 329

Ritschl A (1895) Beiträge zur Pathogense der Ganglien. Beitr Klin Chir 14 : 557

Thorn J (1895) Über die Entstehung der Ganglien. Arch Klin Chir 52 : 557

Volkmann R (1882) Ganglion, Überbein. In: Pitha V, Billroth T (Hrsg.) Handbuch der Allgemeinen und Speziellen Chirurgie, Bd 2. Enke, Stuttgart, S 883

Received December 14, 1981