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## THE SURGICAL TREATMENT OF TOPHACEOUS GOUT\*

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GOUT is a chronic metabolic disorder associated with an increased concentration of uric acid in the blood. Early in its course it is characterized with few clinical manifestations except acute attacks of arthritis. As the disease progresses osseous and subcutaneous urate deposits appear and lead to physical deformity and persistence of low-grade symptoms. Patients with advanced changes may be seriously handicapped and suffer needlessly, due to the gradual increase in the size of the deposits. Since medicinal measures have been ineffective in treating these disabling tophi<sup>9</sup> recourse has been made to surgical treatment, with the expectation that considerable benefit would be obtained. The progressive course of the disease in no way has been affected but a lasting local benefit has been achieved that could not be produced by any other measures.

The surgical treatment of tophaceous gout in 11 patients constitutes the basis of this report. The operations were carried out at the Massachusetts General Hospital by the senior author (R. R. L.), or directly under his supervision. This was possible because of the medical study in a large group of gouty patients by the junior author (J. H. T.). In the group of patients treated surgically, there were ten males and one female. The ages ranged from 20 to 80 years. There were two in the third decade of life, one in the fifth, three in the sixth, two in the seventh, two in the eighth, and one in the ninth. Eight, or 73 per cent, were over 50 years of age. Seven patients had had gout for 20 years or more, two for 10 to 20 years, and two for seven years.

*Historical Review.*—Gout is a disease of great antiquity. Undoubtedly it is as ancient as civilization. Quoting from Garrod<sup>1</sup> (1858): "Gout . . . was probably one of the earliest diseases to which flesh became heir when man began to participate in the luxuries of civilized life: it is a disease, also, which can lay claim to having had among its victims some of the most renowned of the human race from their position, opulence, and intellect." The aphorisms of Hippocrates,<sup>2</sup> who lived about 350 B.C., indicate that he was well acquainted with the manifestations of gout. Writers on the

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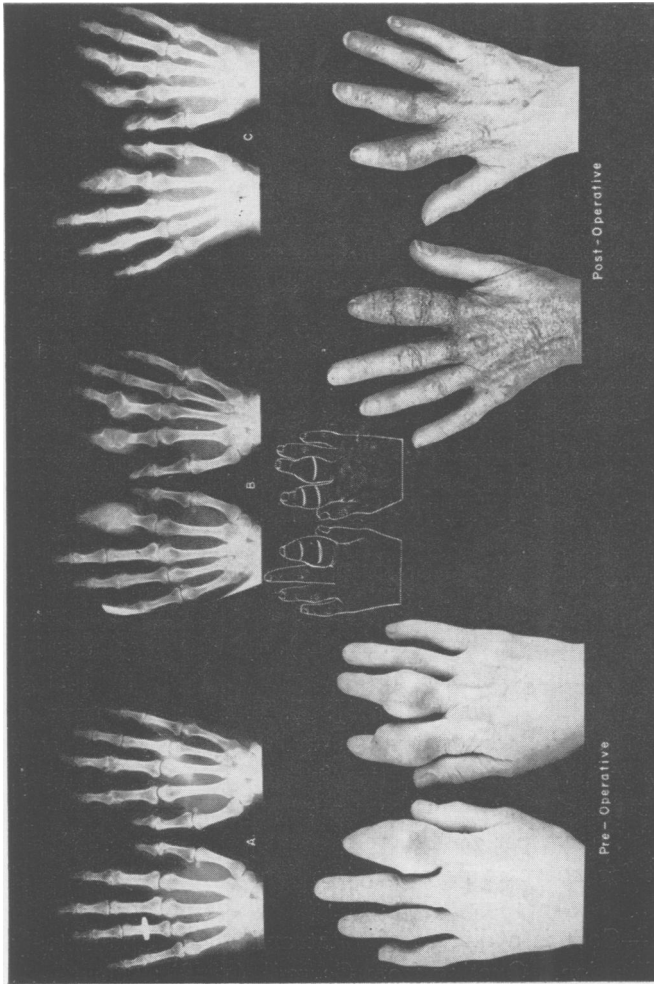


FIG. 1.—Extensive tophaceous deposits of the right and left index fingers and the middle right finger, which involved the phalanges and the extensor and flexor tendons. The patient, a female, age 49, had symptoms of gout for 32 years (The same patient as in Fig. 15). This case illustrates the rapidity with which tophaceous deposits may develop: (A) Roentgenograms, taken in 1933, show only slight evidence of osseous joint destruction. (B) Postoperative roentgenograms showing some regeneration of the phalanges. The periosteum was preserved as far as possible, which accounts for this new bone formation. The operations were performed under novocain block anesthesia at the base of the fingers. The postoperative photograph and roentgenogram were taken about six weeks after the operations. Some shortening of the fingers is to be noted and the cosmetic result was not as good as in some of the other cases, although this improved after months, but in view of the extensive involvement of the bones, extensor and flexor tendons, the result was satisfactory, especially since the patient received relief from pain, could again wear gloves, and did not have to hide her hands when in public. Note the transverse incisions which were made, and the excellent healing of them.

subject have been very prolific since that time. Most dissertations, however, have been clinical descriptions, and neither the etiology of the malady nor the pathogenesis of symptoms have been discovered as yet. The most important contribution regarding the treatment of acute gouty arthritis was described first by Alexander, of Tralles, quoting Garrod,<sup>1</sup> in the sixth century. On empiric grounds he recommended the use of hemodactyl, the plant from which colchicum is derived. Among the many interesting volumes on the treatment of gout is one written by Missaurus,<sup>6</sup> in 1735: "Demonstrating that the Gout is one of the greatest blessings which can befall Mortal Man: That all Gentlemen who weary of it, are their own Enemies; and that those Practitioners who offer it the cure, are the vainest and most mischievous Cheats in Nature."

In contradistinction to the voluminous writings on the medical aspects, little has been written on the surgical treatment. In 1641, Paré<sup>7</sup> opened painful areas about tophaceous joints with the cautery and rubbed them with hemodactyl, gentian, mercury, or alum. Hippocrates<sup>2</sup> resorted to actual burning of the painful areas. He says in his "Treatise of Diseases," speaking of gout: "The Disease is indeed long and grievous, but not mortal; but if the Pain remains in the toes, burn them above the joints with Crude Flax." This method, according to Hutchinson,<sup>3</sup> was revived in the seventeenth century by Hermon Busschof, a Minister at Batavia, in the services of the Dutch East India Company. The method described by Busschof consisted in placing a small piece of Indian moss over the painful tophus and then setting fire to it. This treatment apparently afforded relief, since Busschof, a victim of the malady, admitted extraordinary alleviation of pain. Another patient, Sir William Temple, reported: "That when the Pain in his Great Toe was very violent, and he, in five Days, had not been able to stir his foot, but as it was lifted, he was suddenly relieved by the Moxa (burning of it), and walked half a dozen turns about the Room without pain or Trouble to the Surprise of those that were about him, as well as his own."

Hutchinson,<sup>3</sup> in 1880, was the first to report the surgical removal of two toes on account of suppuration of tophaceous deposits. Riedel,<sup>8</sup> in 1904, stated that the removal of urate deposits could be accomplished if the gouty arthritis were localized to the metatarsophalangeal joint of the great toe. He performed two operations, one on a man, age 45, and the other on a woman, age 70. A preoperative diagnosis of suppurative arthritis was made in each instance, and not until he discovered urate crystals in the bursae and the synovial membranes at the time of operation did he appreciate that the patients were suffering from an acute attack of gout. In each case he simply opened the joint space and removed as much of the urate crystals as possible, then left the wound open to heal by secondary intention. The incisions healed in a few weeks, following which one patient was free of attacks for 14 years and the other for eight years, or until her death.

Lindsay,<sup>4</sup> in 1913, found that healing occurred naturally, provided the incision was made over the more healthy skin towards the base of the

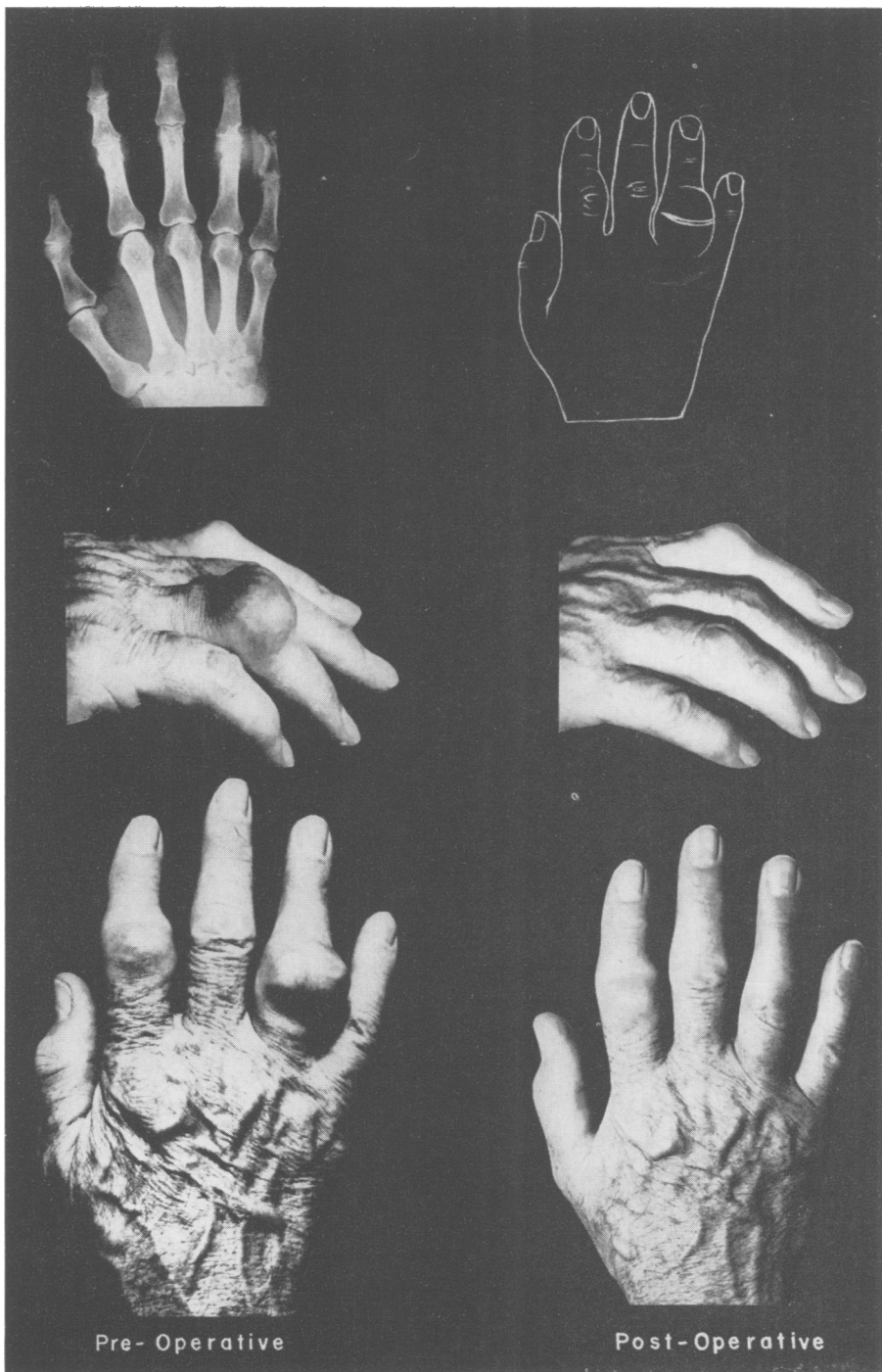


FIG. 2.—Tophaceous deposits involving the index and fourth fingers of the right hand. The patient, a male, age 69, had symptoms of gout for 15 years (The same patient as in Fig. 9). The roentgenogram shows moderate involvement of the bones. Only the tophus on the fourth finger was removed, at the patient's request, but since he obtained such a satisfactory result on this one he is planning to have the one on the index finger removed. The operation was performed under novocain block anesthesia at the base of the finger. The tophus was removed through a transverse incision. It involved the extensor tendon but it was possible to preserve a portion of it so it was only necessary to splint the finger until the wound healed. The interphalangeal joint capsule and the cartilages were involved. The patient was pleased with the cosmetic result, volunteering the information that he no longer tried to hide his hand while in public. The photographs show the hand before operation and four months later.

tophaceous swelling. Thomson, quoted by Llewellyn,<sup>5</sup> in 1920, reported two cases in which gouty deposits contiguous to tendon sheaths, bursae and skin were removed. The deposits in one man, age 30, had involved the extensor tendons over the fingers, and in the other, a man, age 37, large tophi were located about the left external malleolus, the left olecranon and the right malleolus. All were subcutaneous except the one about the left malleolus, where bone, ligaments, and peronei tendons were involved. The patients did well following the operations and no further gross tophaceous deposits developed.

A survey was made of the records at the Massachusetts General Hospital from 1835 to 1935, in order to determine how many patients with gout had been operated upon for the treatment of tophaceous deposits. Only seven cases could be found. The operative procedure consisted of evacuating the tophi in three patients, while amputations were carried out on four. The earliest operation was performed in 1878, by Dr. J. C. Warren. It seems difficult to understand why surgery was not performed more frequently in the treatment of deformed tophaceous joints and tophaceous deposits. Perhaps it was because an acute attack of gouty arthritis, with its classical insignia of "tumor, rubor, color, *et dolor*" was so frequently mistaken for an acute infection, and it still is by those not acquainted with the vagaries of gout. Furthermore, it was not realized that considerable relief of symptoms and rehabilitation of the patient could be obtained by surgery.

*Diagnosis.*—The diagnosis of gout in the tophaceous stage of the disease is not difficult.<sup>10</sup> A history of acute attacks of arthritis with complete relief from symptoms between attacks is usually obtained. If subcutaneous deposits of urate crystals have developed, roentgenograms of the extremities usually will show evidence of bony involvement. The characteristic roentgenologic appearance of a gouty joint includes "punched-out" areas, soft tissue swelling, diminution of joint space, and sometimes extensive destruction of the joint with ankylosis (Figs. 1, 6, 8 and 9). The concentration of uric acid in the blood serum (in contrast to whole blood) is above 6.0 mg. per 100 cc. The serum uric acid is increased between attacks as well as during attacks, and should always be determined in a suspected case of gout. If a sinus has formed in a subcutaneous tophus, the chalky exudate will reveal urate crystals on microscopic examination. A final confirmatory diagnostic procedure is the favorable response to full doses of colchicine if given during an acute attack.

The differential diagnosis between an acute attack of gouty arthritis and joint sepsis warrants *especial consideration*. Undoubtedly, many acute gouty joints have been operated upon because the surgeon considered the condition one of sepsis. This is not surprising, since there may be general as well as local manifestations of a severe infection in acute gout. These include fever, a leukocytosis of 15,000 to 20,000, and prostration. The absence of an ascending lymphangitis from the acutely inflamed gouty joint is a helpful differentiating sign. Fulminating sepsis involving a tophaceous

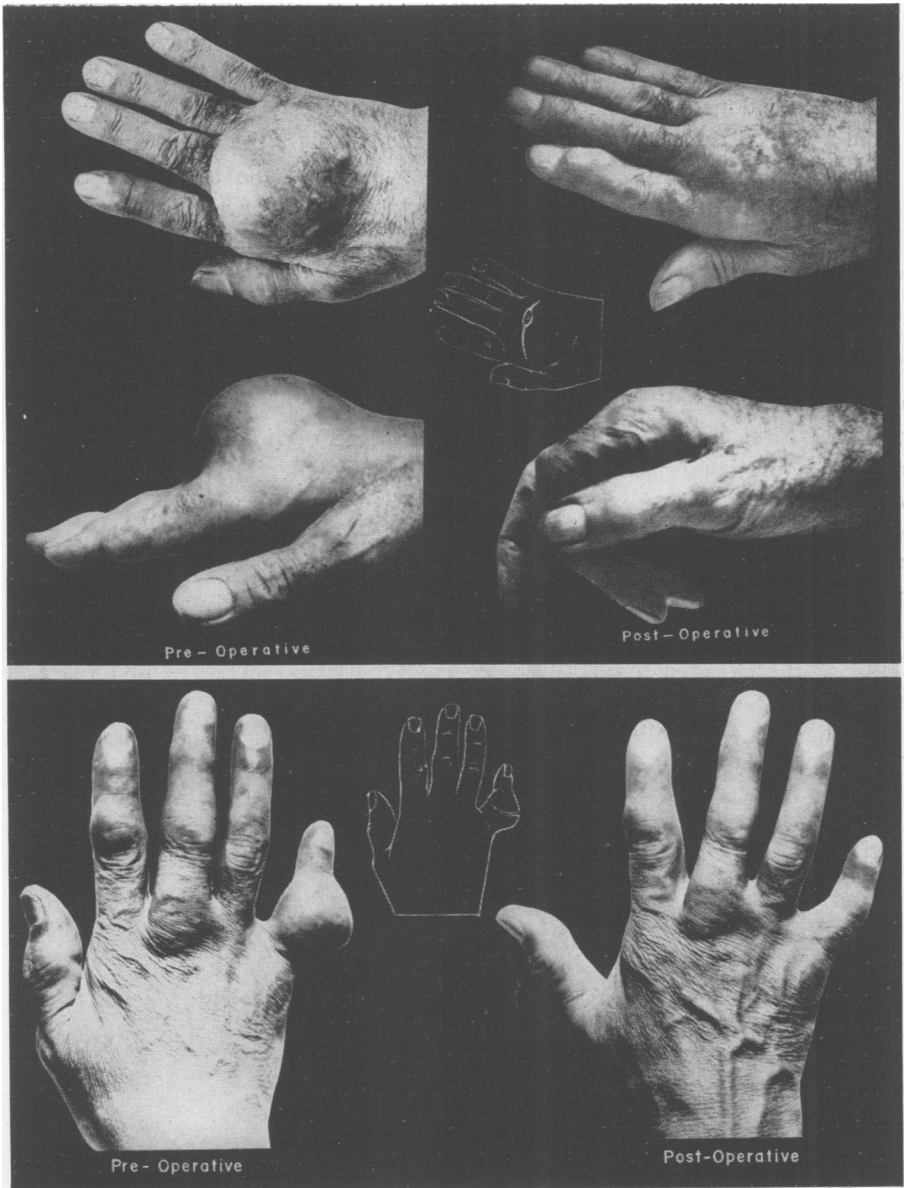


FIG. 3.—A large tophaceous deposit with a small draining sinus involving the dorsum of the hand. The patient, a male, age 80, had symptoms of gout for seven years. The operation was performed under ether anesthesia. The extensor tendons of the second, third and fourth fingers had to be excised with the tophus because they had been so infiltrated with urate crystals that they were unrecognizable. Despite this, a good functioning hand was obtained by splinting the fingers in extension for eight weeks, then commencing gentle massage and active motion. The drawing shows the incision. A portion of the skin sloughed because of the extensive dissection. This necessitated a secondary skin graft. The photographs show the hand before operation and two and one-half years later, with no evidence of recurrence.

FIG. 4.—A large tophaceous deposit involving the proximal interphalangeal joint of the fifth finger of the right hand and the extensor tendon of it. The patient, a male, age 59, had symptoms of gout for 36 years. The tophus was removed through a transverse incision under novocain block anesthesia at the base of the finger. There was destruction of the proximal end of the middle phalanx and the distal end of the proximal phalanx, with some shortening of the digit which is a little more marked in the postoperative view. The photographs show the hand before operation and one year later, with no evidence of recurrence.

joint is an extremely rare condition, so that immediate surgery in acute gout rarely ever is indicated. Tophaceous deposits about a joint not infrequently rupture through the skin and discharge urate crystals. This may leave an ulcerating lesion (Figs. 3, 5, 6, 7, 8 and 9). Cultures taken from these lesions, in our experience, have shown only the usual bacterial flora found on the normal skin, and in no instances has it been necessary to incise and drain such a lesion. The differentiation between acute gout and sepsis, therefore, should not rest on the local signs and systemic findings but upon a careful evaluation of all of the medical data. An accurate history, with particular reference to previous attacks of joint symptoms, is of utmost importance. An examination of the patient for evidence of tophi elsewhere on the body may give the true diagnosis. Roentgenologic examination of the affected part, and estimations of the blood serum uric acid level in doubtful cases are important diagnostic aids.

*Indications for Surgery.*—The surgical treatment of gout is applicable only to patients who have developed large tophaceous deposits. Less than ten per cent of all gouty patients studied by the junior author have needed surgical treatment. In the group of patients reported, surgery was limited to the removal of urate deposits which involved the bony and soft structures about the elbows, forearms, wrists, hands, and feet. Elsewhere in the body, especially about the knee joints where very large tophi appear, removal was not found necessary, but if the occasion should arise they could be similarly treated. The indications for surgical treatment are believed to be: (1) Cosmetic reasons when tophi have become large and unsightly, such as in the subcutaneous tissues of the fingers, the dorsum of the hand, forearm, or wrist (Figs. 1, 2, 3, 4 and 5). In this category may be included smaller tophi on the hands and feet which interfere with the wearing of gloves and shoes. (2) Pain in tophi because of their location over exposed areas of the body, such as those involving the olecranon bursae, knuckles, terminal ends of the fingers, toes and heels (Figs. 2, 4, 6, 8, 9 and 16). (3) Interference with the movements of tendons or adjacent joints by tophi that involve the extensor or flexor tendons of the hand (Figs. 5 and 11). (4) Any discharging sinus associated with a tophaceous deposit (Figs. 3, 5, 6, 7, 8, 9 and 16). (5) Extensive phalangeal involvement of the fingers or toes with urate deposits (Figs. 1 and 9).

*Surgical Pathology.*—The tophaceous deposits which were removed during this study may be divided into three anatomic types: (1) bursae and subcutaneous deposits which have involved only the tissues superficial to the deep fascia; (2) deposits which arise in tendons and which may or may not have involved adjacent tissues, such as fat, fascia, bursae, and skin; and (3) deposits which arise in joints with involvement of the bones, tendons, bursae, subcutaneous tissues, and skin.

All of the tophi involving the soft tissues had a definite fibrous capsule, which was thin and transparent but tough (Figs. 11, 12, 15 and 16). It is thought to be formed from connective tissue and is, therefore, not a

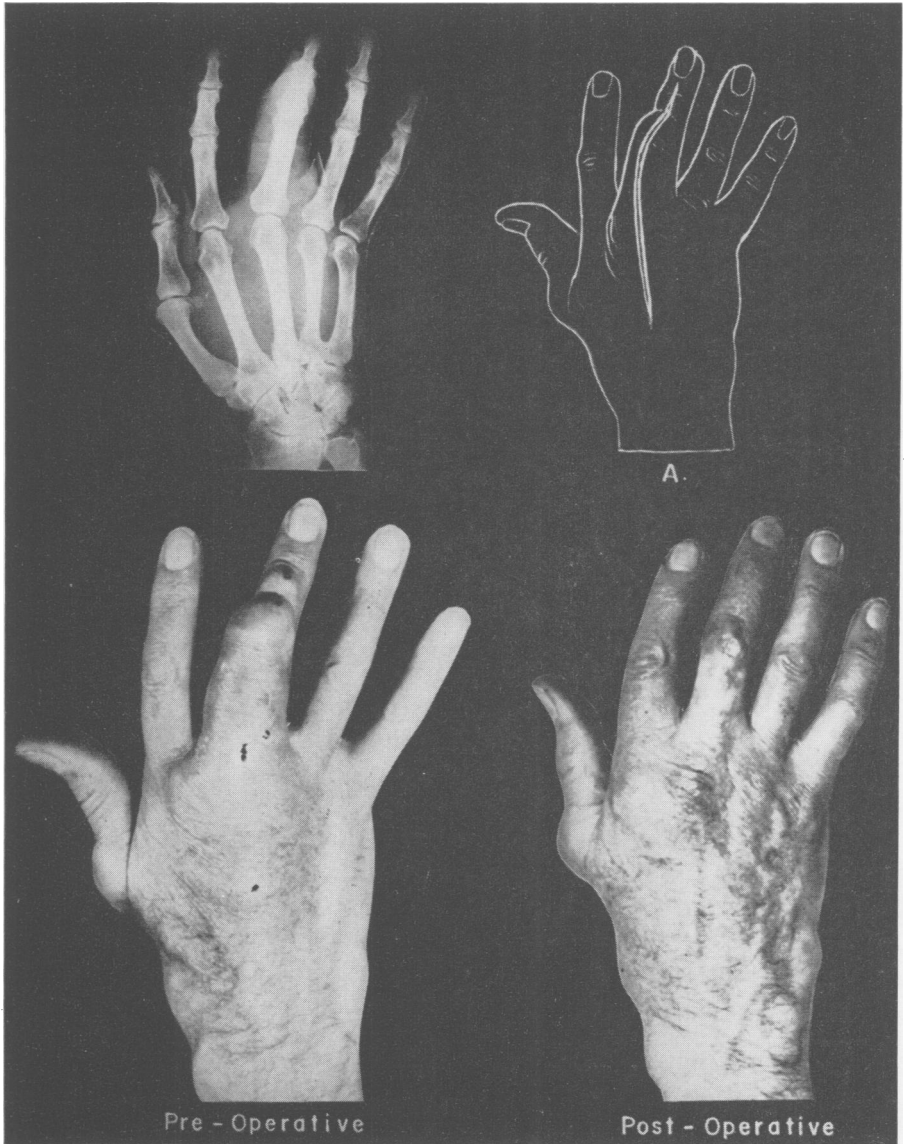


FIG. 5.—A large tophaceous deposit, with draining sinuses on the dorsum of the right hand. The patient, a male, age 65, had symptoms of gout for 20 years (The same patient as in Fig. 8). The roentgenogram shows ankylosis of the proximal interphalangeal joint, with little bone destruction. The operation was performed under ether anesthesia. The extensor tendon was so infiltrated with urate crystals that it was necessary to remove it from the base of the metacarpal bone to the base of the terminal phalanx. Despite this, excellent function was restored by splinting the finger in extension for eight weeks, then commencing gentle massage and active motion. This was one of the earliest cases operated upon using a longitudinal incision as shown in the drawing, which resulted in marked sloughing of the skin flaps necessitating a secondary skin graft. Multiple transverse incisions would have obviated this complication. The photographs show the hand before operation and two years later, with no evidence of recurrence.



true capsule. The formation of it is considered to take place with the deposition of urate crystals in the tissues. As the tophus gradually increases in size it replaces the subcutaneous fat and forces aside the fibrous connective tissue, thus forming a capsule. Some of the fibrous tissue may be infiltrated with urate crystals instead of being forced aside since on the cross-section of a tophus a stroma of interlacing fibers may be seen dividing it into numerous lobules (Fig. 12). The lobulated appearance is evident on the surface of all cleanly dissected tophi in which the capsule is intact (Figs. 11, 12, 15 and 16). The urate crystals rarely infiltrate through the subcutaneous tissues. When this occurred it was thought to have followed rupture of the capsule due to trauma or an acute attack of gout, when the contents of the tophus may be partially fluid and under considerable tension. When bones or tendons were involved a capsule was not encountered unless the urate crystals had pushed out into the soft tissues surrounding these structures. It is of interest to note that the urate crystals did not invade blood vessels or nerves, although they often surrounded them. Tendons, on the other hand, were very frequently infiltrated with urate crystals and in some instances so complete was the replacement with urate crystals that no tendinous structure could be recognized.

Tophaceous deposits of long standing were found to be very dry and chalk-like on cross-section (Fig. 12). If there had been a recent attack of acute gout, the urate crystals were suspended in a fluid which gave the appearance of pus. It is believed that the pain in a tophaceous deposit associated with an acute attack of gout may result from the tension produced by the rapid deposition of urate crystals in a semifluid state within the relatively nonyielding fibrous capsule of the tophus. Evidence in favor of this theory is the fact that when a tophus was decompressed by partial excision of the capsule and evacuation of the contents the patient was relieved of pain even though the urate crystals were not completely removed. The relief of pain following the spontaneous rupture of a tophus adds support to this theory.

*Analysis of Operations.*—The operations were carried out over a seven-year period, 1935 to 1941, inclusive. Forty-six operative procedures were undertaken on 11 patients. Several tophaceous deposits were removed at one operation in many instances. The number of operations per patient varied from one to ten. Six patients had five or more, three had one, one had three, and another two. The operations were divided equally between the hands and feet. There were 41 operations on the feet and toes, 40 on the hands and nine on the forearms and elbows. Local anesthesia, with one per cent novocain solution, was employed in 24, ether in nine, spinal anesthesia in 12, and no anesthesia in one.

An analysis of the lesions shows that there were 31 subcutaneous tophi, 36 involving tendons and adjacent structures, and 26 which arose from joints with bone and soft tissue invasion. Further analysis of the statistics shows that in the subcutaneous group there were eight on the fingers, most fre-

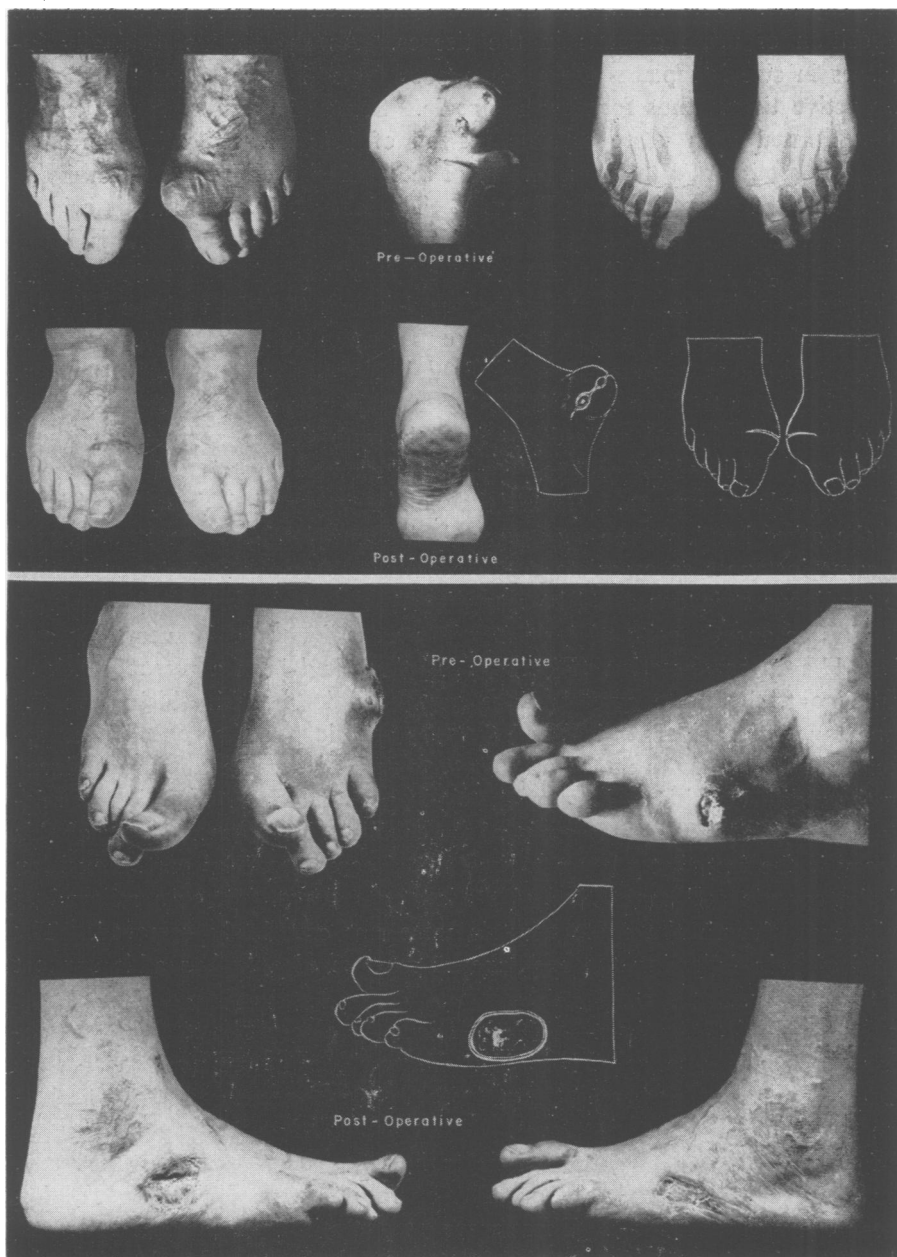


FIG. 6.—Tophaceous deposits involving the first metatarsophalangeal joints of both feet and the left heel. The patient, a male, age 55, had symptoms of gout for 26 years (The same patient as in Figs. 10 and 16). The operation was performed under spinal anesthesia. Note the draining sinuses in the tophus of the heel. Roentgenograms of the feet show some destruction of the proximal phalanges and the first metatarsal bones, but most of the articular surfaces were intact, so that the great toes were not amputated. The drawing shows the incisions employed. The photographs show the lesions before surgery and the left foot two years and the right foot and left heel one year later, with no evidence of recurrence.

FIG. 7.—Tophaceous deposits on the lateral side of the feet. On the right foot the skin was intact but on the left there was a large ulceration with urate crystals visible in the center. The patient, a male, age 70, had symptoms of gout for 30 years. The tophi involved the peronei tendons at their insertions into the tarsus. The operations were performed under spinal anesthesia. The deposits were excised with the overlying skin (see drawing). The tendinous structures were preserved by curettage of the urate crystals. Thiersch skin grafts were applied to the denuded areas, resulting in well healed wounds. The patient thereafter was able to wear his regular type of shoe without discomfort. The photographs show the feet before operation and two years later, with no evidence of recurrence.

quently on the flexor surface, three on the forearms, four involving the olecranon bursae, seven on the toes, eight on the heels, and one on the lateral side of the foot. There were 13 extensor tendons of the fingers and thumbs operated upon, 12 extensors of the toes, four extensors on the dorsum of the hands, two flexors of the fingers, one flexor in the palm of the hand, two triceps tendons, one tibialis anticus tendon, and two involving the peronei tendons at their insertion on the tarsus. The cases with joint, bone and soft tissue involvement included 12 fingers, some with metacarpal involvement, 14 toes, six of which had involvement of the metatarsophalangeal joints, five being of the great toe, the typical location for gout to manifest itself. It is of interest to note that of the 93 tophaceous deposits operated upon only approximately five per cent occurred at this latter site.

*Operative Technic.*—The successful operative results are attributed to meticulous surgical technic and the adherence to certain rules that evolved during the study. The incidence of arteriosclerosis among gouty patients both young and old is an important factor to be considered. Great care must be taken to maintain an adequate blood supply, particularly in the lower extremities. Incisions should be made so that when closed they will not be subjected to unnecessary tension lest sloughing of the skin occurs. Arterial tourniquets were employed on the finger operations, using a rubber band at the base, but they are contraindicated for operations carried out on the feet because they may damage an arteriosclerotic artery sufficiently to produce arterial thrombosis, with resulting gangrene of the foot. The carrying out of surgery by the most atraumatic method possible cannot be overemphasized.

A tophaceous deposit may be removed by one of two methods. Complete excision of the tophus with its surrounding capsule is preferable. This procedure was followed for all of the large tophi in the soft tissues, such as the olecranon bursa (Fig. 16), subcutaneous tissues of the forearm, hand, and foot where tendons were not involved. Curettage with a small bone curette was the second method. This procedure was used for the removal of the small subcutaneous tophi after making an incision through the overlying skin. If the tophaceous deposit involved the bones or tendinous structures, such as the triceps tendon or a flexor tendon, the major part of the tophus was excised and the remainder was removed by curettage in order not to destroy important structures (Figs. 11, 15 and 16).

The surgical procedures on the hands were, of necessity, more conservative than those on the feet. It is important to preserve the fingers in spite of extensive urate infiltration (Fig. 1). One badly involved finger was amputated early in the study, but as more cases were encountered it was found unnecessary to sacrifice these digits despite extensive urate deposits in the tendons and phalanges, since removal of the tophi resulted in relief of pain, improved cosmetic appearance and partial rehabilitation. The periosteum and bony shell of a phalanx was preserved insofar as was possible. The situation in many cases appeared hopeless when judged roentgenologically (Fig. 1), but a significant quantity of bony shell and periosteum

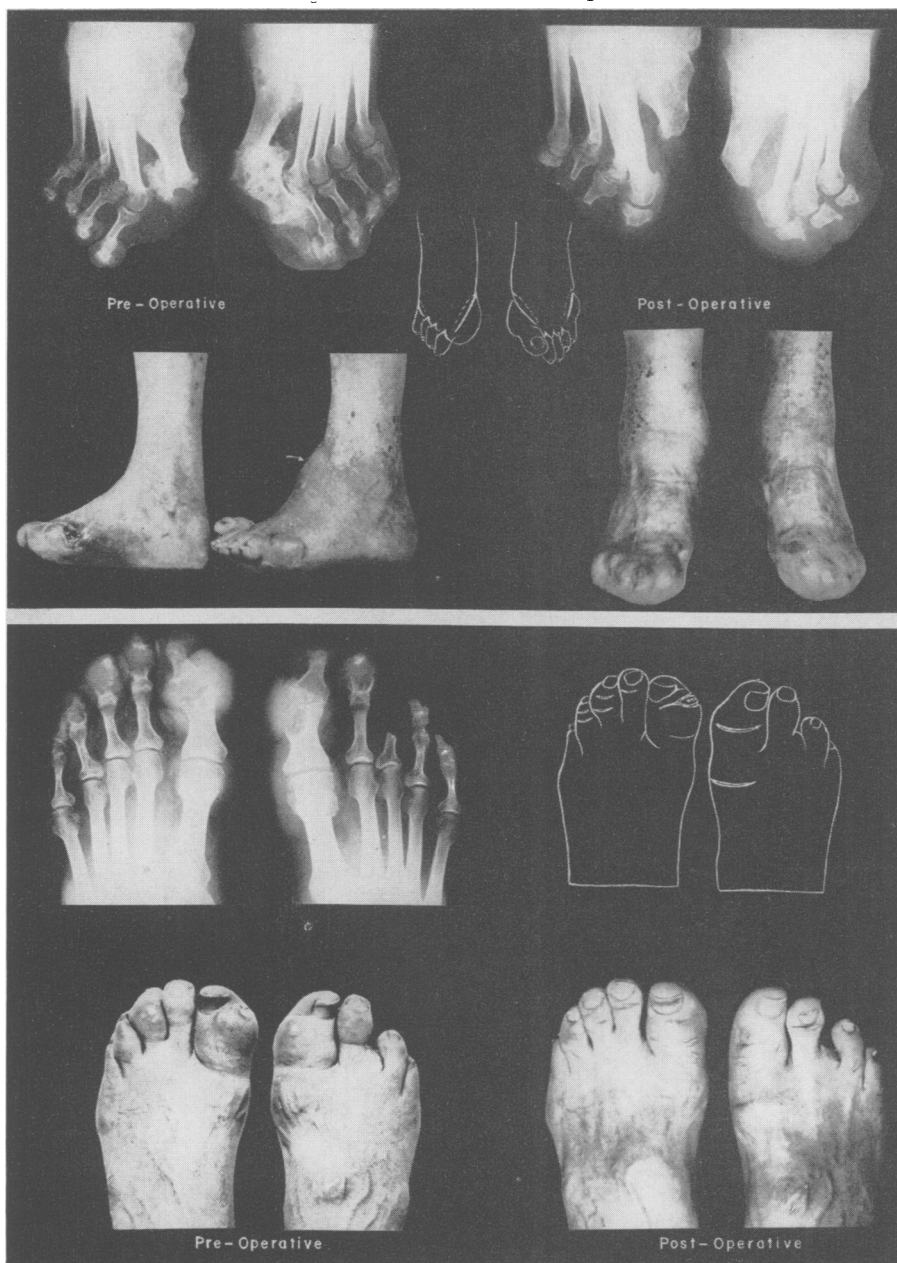


FIG. 8.—Extensive tophaceous deposits of all toes with marked involvement of the metatarsophalangeal joints of the great toes, the terminal phalanges of the other toes, and one in the tibialis anticus tendon of the left foot (marked by an arrow). The patient, a male, age 65, had symptoms of gout for 20 years (The same patient as in Fig. 5). The right great toe had been amputated several years previously at another hospital, but the wound had never healed because the removal of the disease was not sufficiently radical. The draining sinus is seen in the preoperative photograph. The operations were performed under ether anesthesia. The head of the right first metatarsal, the left great toe and the head of the first metatarsal, and the left fifth toe and the head of the fifth metatarsal were amputated through racquet-type incisions. The remaining toes were amputated through the base of the proximal phalanges using lateral skin flaps. This patient and one other were the only ones upon whom such radical surgery was carried out. Both patients obtained excellent results, as they were able to walk without pain. They used the specially constructed type of shoe shown in Figure 13, which permitted them to walk with a normal gait. The photographs show the feet before operation and two years later, with no evidence of recurrence.

would be found at operation. If this could be saved a useful finger was obtained despite the fact that the interphalangeal joints were destroyed.

Removal of the tophaceous deposits involving the toes without amputation also is recommended if roentgenologic examination reveals any of the joint surfaces of the phalanges or metatarsals to be intact (Figs. 6 and 9). When there was marked destruction of these bones (Fig. 8) the treatment of choice was amputation through the proximal phalanx, using lateral skin flaps. If the first or fifth toes were amputated the head of the metatarsal was removed with it, using a racquet-type of incision (Fig. 8). The end-results justified these procedures, since the patients were able to walk in comfort and with practically a normal gait, instead of being limited to a wheel-chair existence. All the toes were removed in a few patients, and despite such radical surgery the rehabilitation of the patient was very gratifying. A specially constructed shoe was developed for these patients which had a forked shank of steel incorporated in the layers of the sole (Fig. 13). The shank is almost as long as the foot before amputation of the toes. This type of shoe allows a spring to the patient's gait which otherwise would be lacking.

If a tophaceous deposit involved an important tendon, such as a flexor tendon of a finger (Fig. 11), the tibialis anticus (Fig 8), or a triceps tendon (Fig. 16), it was deemed important to remove the tophus leaving as much as possible of the tendon. When the extensor tendons of the fingers were involved, either over the digits themselves or the dorsum of the hand, it was impossible to recognize the tendons in many cases so that the remnants of them had to be sacrificed. Despite this, with careful postoperative splinting and rehabilitation, the majority recovered the use and function of fingers and hands. The extensor tendons of the second, third, and fourth fingers on the dorsum of the hand were removed in one patient. Nevertheless, he obtained a very serviceable hand (Fig. 3).

Every precaution was taken to prevent trauma to the parchment-thin skin which overlies many tophi. Sharp scalpel dissection was used to dissect it from the tophaceous deposit. The skin was retracted by means of sutures in the skin edges and as the dissection was carried toward the base of the tophus fine rake retractors were used. The incision was closed with vertical mattress sutures of silk to prevent infolding of the edges. A plaster splint was applied for immobilization whenever a tendon or a joint was involved. The first dressings were usually done in ten days to two weeks. The skin sutures were removed at that time.

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FIG. 9.—Tophaceous deposits involving the toes. The patient, a male, age 69, had symptoms of gout for 15 years (The same patient as in Fig. 2). The third toe on the right foot had been amputated two years previously by another surgeon because of a painful tophaceous deposit involving it. The roentgenograms show marked destruction of the terminal phalanges in the left and right first and second toes and the left third and fourth toes. There was also a large tophus involving the right metatarsophalangeal joint. The skin was ulcerated over the tophus on the left great toe, which had necessitated daily dressings for many months. The urate crystals can be seen in the base of the ulceration and through the parchment-thin skin over the other tophi. Through transverse incisions, as demonstrated in the drawing, all these deposits were removed under spinal anesthesia at one operation. The wounds healed *per primam*. Amputation of the toes was not considered necessary because the tophi were chiefly in the distal ends of the digits and the metatarsophalangeal joints were relatively uninvolved. The photographs show the feet before operation and four months later.

The types of incisions which were used are of extreme importance, especially on the fingers and toes. The first operation for the removal of a tophaceous deposit on a finger was undertaken through lateral incisions, one on either side of the finger. This gave an adequate exposure and it was possible to remove the urate crystals without difficulty. The skin between the two incisions sloughed, unfortunately, and the wound healed by secondary

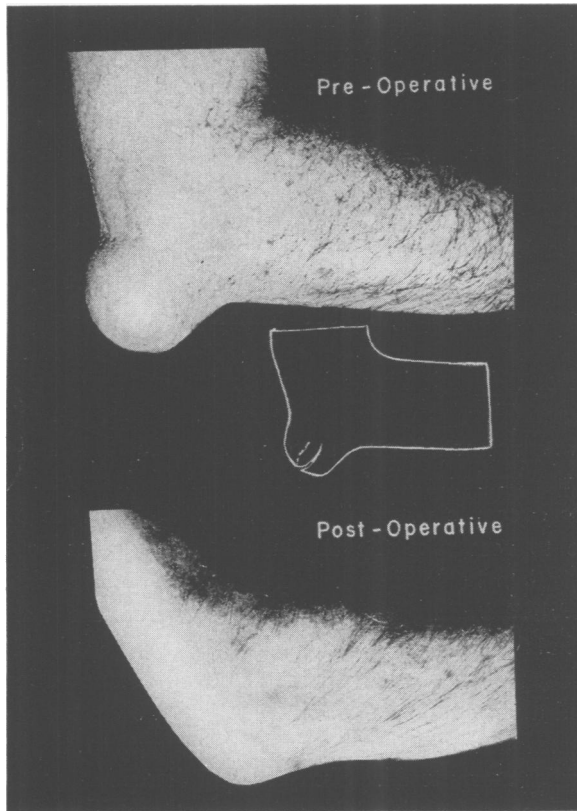


FIG. 10.—A large tophus of the elbow involving the olecranon bursa and the insertion of the triceps tendon. The patient, a male, age 55, had symptoms of gout for 26 years (The same patient as in Figs. 6 and 16). The operation was performed under ether anesthesia. The urate crystals were curetted from the tendon in order to preserve the attachment of this important structure. The drawing shows the incision. The photographs show the elbow before operation and one year later, with no evidence of recurrence.

intention. Early in the series another large tophaceous deposit, which extended from the base of the third metacarpal to the base of the terminal phalanx on the dorsum of the hand (Fig. 5), was removed through a long incision extending over the entire length of the tophus. It was necessary to remove the extensor tendon with the tophaceous deposit because it had been practically destroyed by infiltration with urate crystals. Once again, the skin edges of the wound sloughed and it was necessary to do a secondary

skin graft in order to heal the wound. A satisfactory result was obtained but it required several additional weeks (Fig. 5).

Following this incident all tophaceous deposits on the fingers, hands, toes and feet were removed through single or multiple transverse incisions. Care was taken to avoid severing the digital arteries. Sloughing of the skin edges was never a factor after this type of incision was adopted. Similar

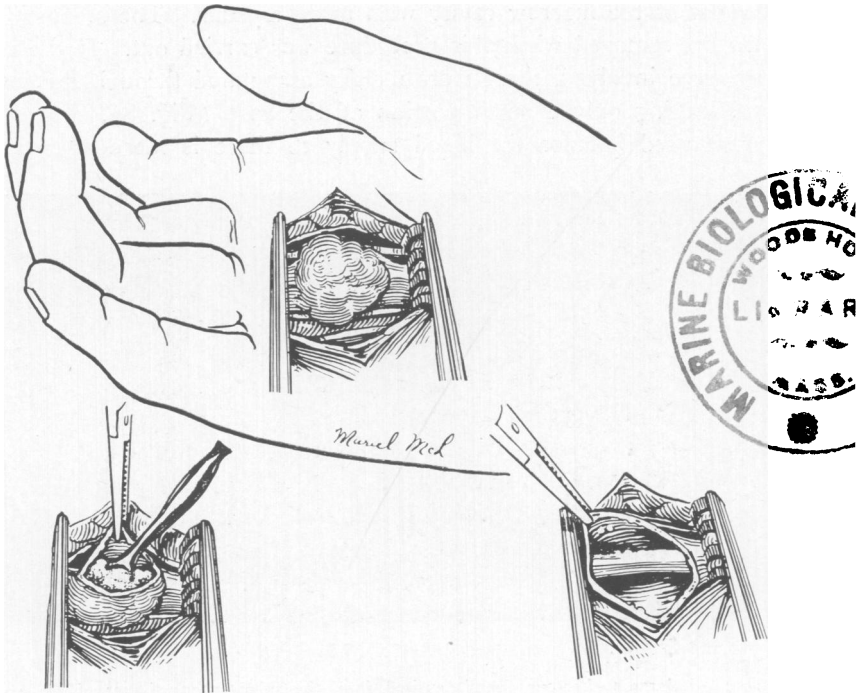


FIG. 11.—A drawing showing a tophaceous deposit in the flexor profundus tendon of the left fourth finger in the palm of the hand. The patient, a male, age 28, had symptoms of gout for seven years. The tophus prevented complete extension of the finger. The operation was performed under local anesthesia, through a transverse incision. The tophus was limited to the tendon. It was lobulated and covered with a thin capsule. The removal was accomplished mainly with a curette in order to avoid excising too much of the tendon. Since so much of the tendon was involved complete removal was impossible for fear the tendon would rupture. As a result, the tophus recurred and a second operation was performed two years later, at which time a more radical removal was attempted. Again, three years later there is only slight evidence of recurrence but no interference with flexion of the finger. The patient is one of the youngest in the group and has the most marked and disabling tophaceous deposits involving practically all of his joints.

transverse incisions in the cleavage planes of the skin were used for the removal of the olecranon bursae or tophaceous deposits in the forearms, wrists and heels. It was found most satisfactory to incise the skin directly over the tophaceous deposits (Figs. 15 and 16) rather than to make the incision at the base of them in sound skin, as advised by Lindsay.<sup>4</sup>

The treatment of ulcerating tophaceous deposits which involved the first or fifth metatarsophalangeal joint of the foot was most satisfactory by amputation of the toe through the body of the metatarsal bone. The in-

cision was a racquet-type which extended around the base of the toe and up along the inner or outer side of the foot in order to expose the metatarsal bone (Fig. 8). It was possible to circumvent any ulcerated lesion on the side of the joint with this type of incision and when closure was made there was adequate skin to close the wound without tension. The metatarsal was divided either at the middle or junction of the middle and distal thirds in most instances (Fig. 8). This was necessary usually because of extensive involvement of the marrow cavity with urate crystals. The sesamoid bones were always removed when this procedure was carried out. If the remaining toes were involved, these were usually amputated through the proximal phalanx, leaving only a small portion of the base (Fig. 8). Lateral skin flaps were used because the blood supply to these is more adequate than

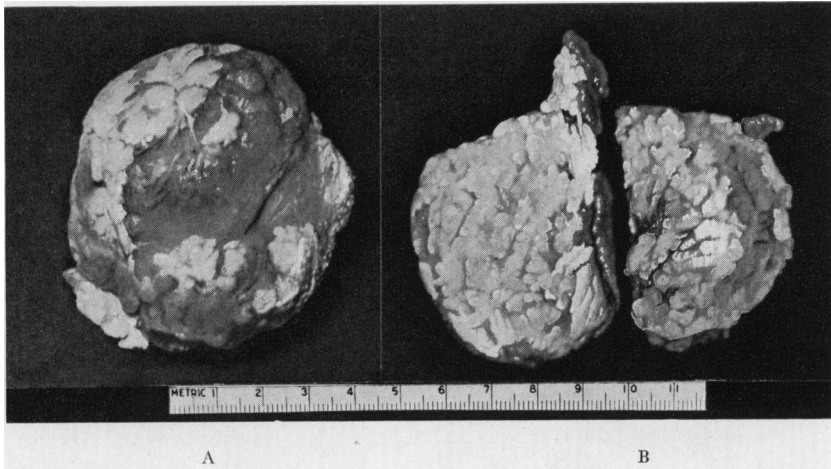


FIG. 12.—A large tophaceous deposit excised from the subcutaneous tissues of the heel. The patient, a male, age 55, had symptoms of gout 26 years (The same patient as in Figs. 6, 10 and 16). A. Note the lobulated appearance of the tophus which is covered with a thin transparent capsule. B. The cross-section of the tophus shows the chalk-like appearance and the stroma of interlacing fibers of connective tissue dividing it up into numerous lobules.

the anterior or posterior flaps. The involvement of the first metatarsophalangeal joint with destruction of the proximal phalanx and the first metatarsal bone was less extensive in some of the cases. When there was no ulceration of the overlying skin the tophus was exposed through a transverse incision (Fig. 16). The greater part of it was cut away with a scalpel and the remainder removed by curettage. It was possible by this means to remove practically all of the tophaceous deposit without sacrificing the great toe although it had destroyed the major part of the joint and completely surrounded it pushing aside tendons, nerves and blood vessels. The results obtained in these cases were very gratifying (Figs. 6 and 9).

A large residual cavity was unavoidable following the removal of a tophaceous deposit that had destroyed a joint. This always filled with blood (Fig. 15) which either organized eventually to form a fibrous union between the bones, or ossified and ankylosed. If the bony destruction was



marked there was considerable shortening of the digit after healing (Figs. 1 and 4). Postoperative drainage was unnecessary and even is considered contraindicated in these cases.

Ulcerating tophaceous lesions were encountered on the lateral side of the foot in some patients (Fig. 7). The method of handling this type of lesion was different than the others. Since it was impossible to remove the tophus without interfering with the blood supply of the overlying skin this was excised with the tophaceous deposit. The urate crystals in such cases had usually invaded the tendinous structures of the foot so that it was necessary to complete the removal by curettage. A large raw surface several centimeters in diameter remained which would have taken many weeks to epithelialize. Healing was hastened by suturing a Thiersch skin graft over the raw surface. A very satisfactory "take" followed each instance this was

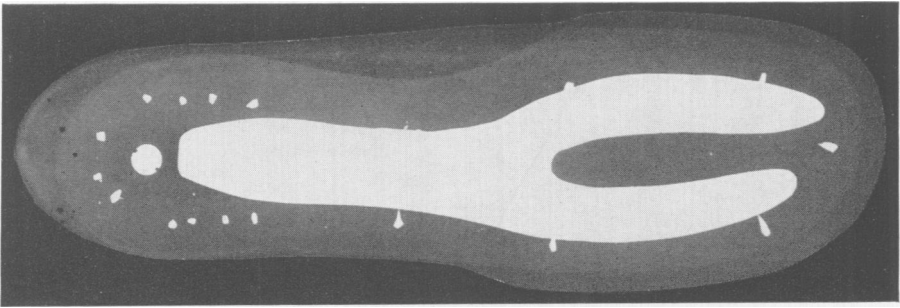


FIG. 13.—An anteroposterior roentgenographic view of the specially constructed shoe worn by the patients who had all their toes amputated for extensive tophaceous deposits. Note the forked shank of steel which is incorporated in the sole of the shoe. The shank is almost as long as the foot before amputation of the toes. This permits a spring to the patients' gait which otherwise would be lacking.

attempted. The cosmetic result (Fig. 7) was excellent and the patient received complete relief from the troublesome deposits and ulcerated lesions.

*Wound Healing in Gout.*—Surgical wounds in gouty patients heal exceptionally well. Ninety-three separate incisions were made in 46 operative procedures that were carried out on the 11 patients. Sepsis developed in three wounds only, and in each of them preoperative ulceration was present. The tophi had ulcerated through the skin so that operations of necessity had to be performed in the presence of infection. The sepsis was only superficial and followed removal of a tophaceous deposit involving the extensor tendons of the fingers. Two of the cases were among the earliest ones done in the period in which longitudinal skin incisions were used. It is believed that this played a part in the wound breaking down. In the third case the largest tophus of the series was removed from the dorsum of the hand, which involved all of the extensor tendons of the fingers with the exception of the thumb and fifth finger. The tophus was open and had established a sinus through the skin (Fig. 3). The removal of it necessitated such an extensive dissection of the skin overlying the tophus that its blood supply was impaired. This led to a partial slough which later required

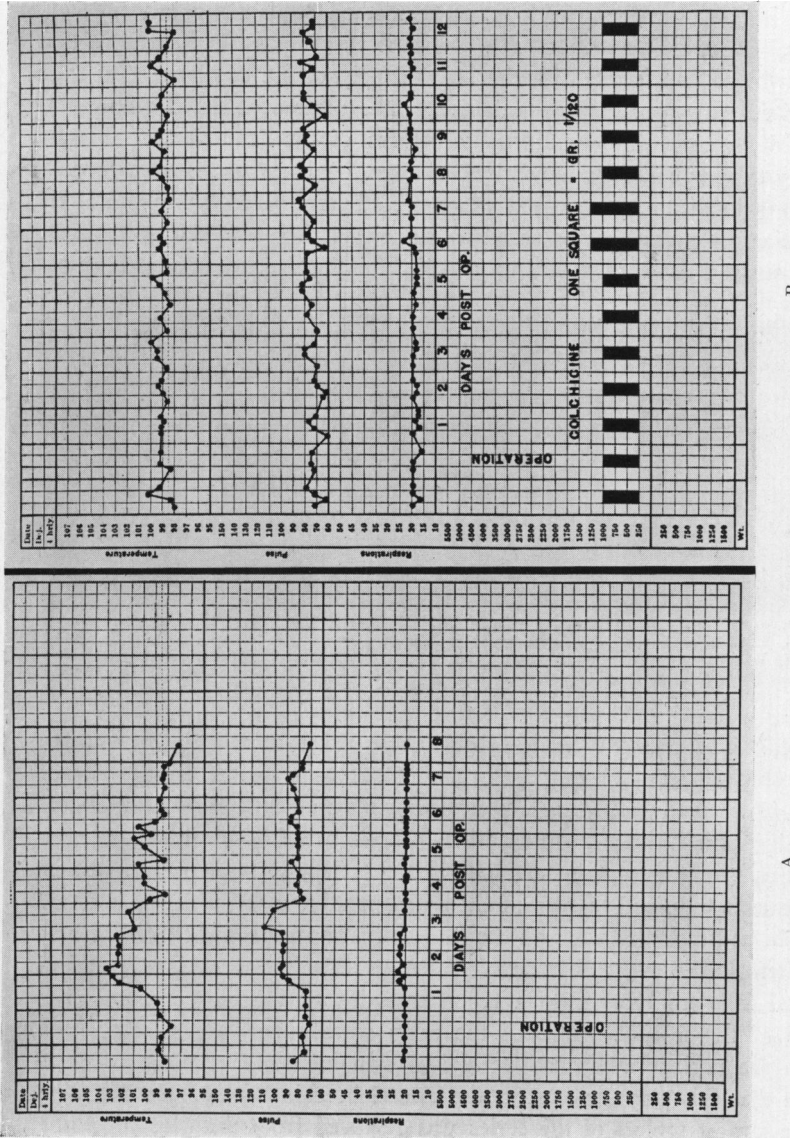


Fig. 14.—A. The temperature, pulse and respiration chart before and after the excision of a small tophaceous deposit on the foot, under spinal anesthesia, without administration of colchicine either preoperatively or postoperatively. The patient, a male, age 62, had symptoms of gout for 20 years. Note the marked rise in temperature beginning on the first postoperative day. This was accompanied with acute joint symptoms characteristic of an acute attack of gout. The operative wound healed *per primam*, with no evidence of sepsis. B. The temperature, pulse and respiration chart before and after the removal of extensive tophaceous deposits in two fingers, under local anesthesia. The patient, a female, age 49, had symptoms of gout for 32 years. She received colchicine 1/120 grain three times a day preoperatively and postoperatively. Note the absence of any postoperative febrile reaction and, clinically, there were no signs of acute gout.

a skin graft. In two of the cases with postoperative sepsis there was bony involvement, yet no serious consequences resulted. It is worthy of note that five other cases were operated upon with open lesions, all of which healed *per primam*. The local application of sulfanilamide in the operative wounds was not used in this series of operations, but it is felt that its use would be an additional safeguard especially in cases with draining sinuses. The excellent wound healing in this group of cases suggests that sodium biurate crystals may have a bacteriostatic action since it was impossible to remove all of them from the operative wounds except in well encapsulated subcutaneous tophi. These good results do not mean that a surgeon can operate upon gouty patients as if they were normal healthy individuals but the above statistics show that one is justified in attempting to relieve patients with painful tophi without any great risk of serious infection. The only serious case of sepsis developed in the finger of one of the patients following an incision and drainage of the tophus by his local doctor, who misdiagnosed an attack of acute gout as sepsis. Neither the physician nor the patient recognized the acute attack and the incised wound was left open. This became infected subsequently and an open amputation of the finger through the proximal phalanx was required.

*Postoperative Gouty Attacks.*—An interesting complication may confuse the postoperative course of a gouty patient. It is not unusual on examining the clinical records of patients either with recognized or unrecognized gout to note that an unexplained fever and leukocytosis (Fig. 14) appeared on the second or third postoperative day. If the operation involved joints or was adjacent to articular structures, acute joint symptoms were prone to be attributed to the operation. If the operation was unrelated to gouty deposits the acute joint symptoms were apt to be overlooked. It is not widely appreciated that an acute attack of gout may follow any operative procedure in a gouty patient. Articular or nonarticular structures may be the site of operation. The attack may appear within 24 hours after operation or it may follow an interval of as long as a week. The attack may be monarticular or polyarticular and indistinguishable from an acute attack of gouty arthritis not related to an operative procedure.

In reviewing the records of 100 patients with gout, there were 22 operations in which no attempt was made to avert the development of postoperative gouty arthritis. The operations included a dissection of the neck for carcinoma of the esophagus, partial colectomy, radical excision of a myosarcoma of the thigh, and a Thiersch graft of the skin. The incidence of postoperative gout following this series of operations was 86 per cent. In an attempt to reduce this percentage, the ingestion of a few colchicine tablets immediately following operation was practiced. This proved successful in many instances, but eventually was extended to include preoperative as well as postoperative ingestion. At present, the routine procedure is to give three colchicine tablets ( $\frac{3}{120}$  gr. each) a day for two days before operation and a similar quantity for three or more days following operation (Fig. 14).

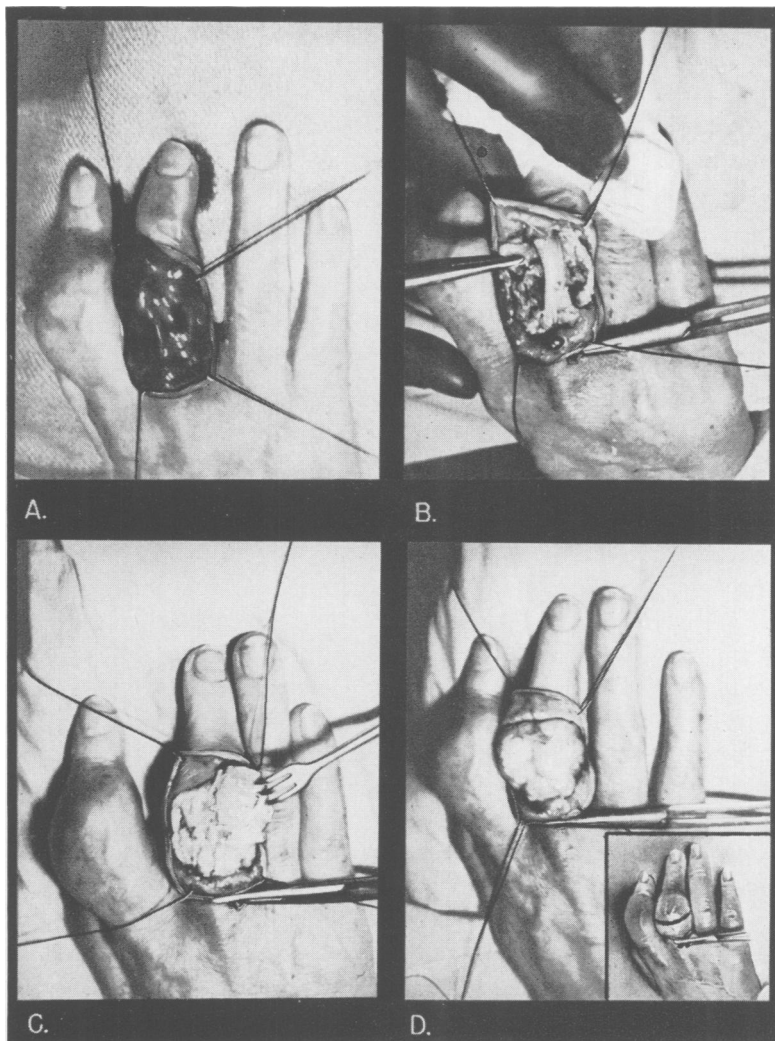


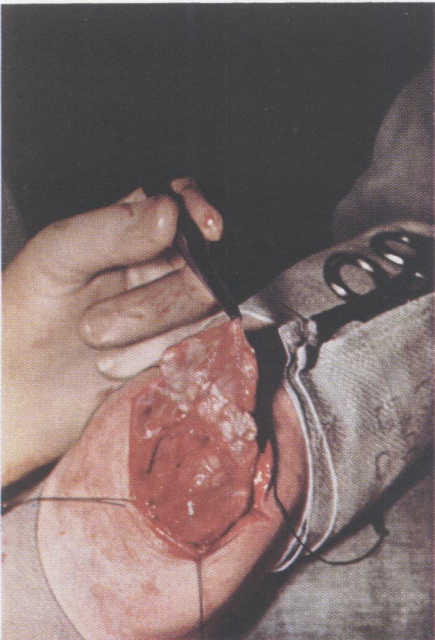
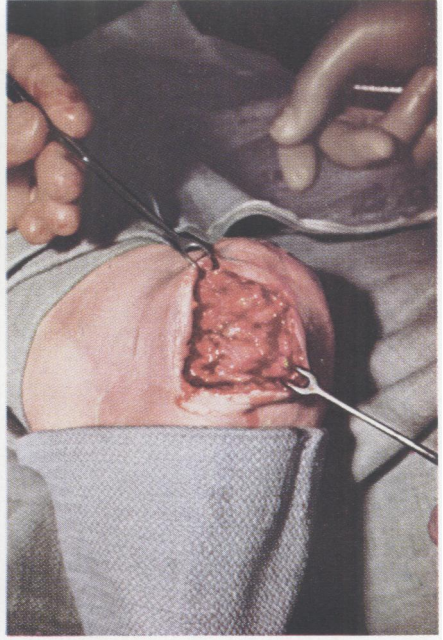
FIG. 15.—Photographs of the operative removal of an extensive tophaceous deposit involving the phalanges and tendons of the middle finger of the right hand. The patient, a female, age 49, had symptoms of gout 32 years (The same patient as in Fig. 1). The operation was performed under novocain block anesthesia at the base of the finger. (A) The skin over the tophaceous deposit has been incised, employing a transverse incision. A rubber tourniquet at the base of the finger, held with the hemostat, prevented bleeding and permitted a careful dissection. Note the thin capsule of the tophus and its lobulated appearance. (B) The main mass of the tophaceous deposit has been partly freed up and pulled aside with the rake retractor. (C) More of the tophaceous deposit has been removed exposing the extensor tendon which was infiltrated with urate crystals and buried beneath the main mass of the tophus. The portion shown was preserved. The cavity beneath it represents the joint space. A considerable portion of the adjacent phalanges have been destroyed by the tophaceous deposit, leaving a large dead space after removal of the urate crystals. (D) The tourniquet has been removed. Note the free bleeding which has occurred. The skin was closed with interrupted vertical mattress sutures of silk.



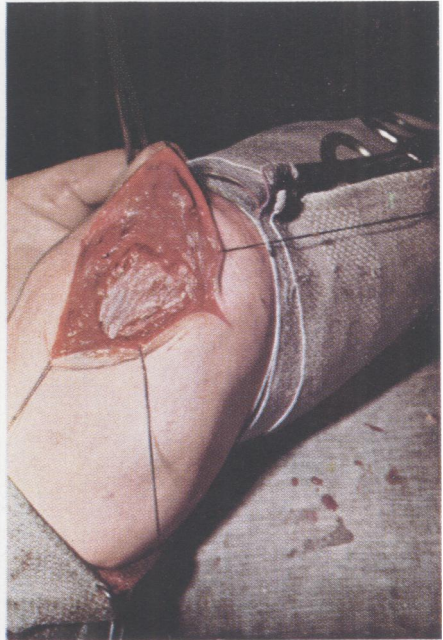
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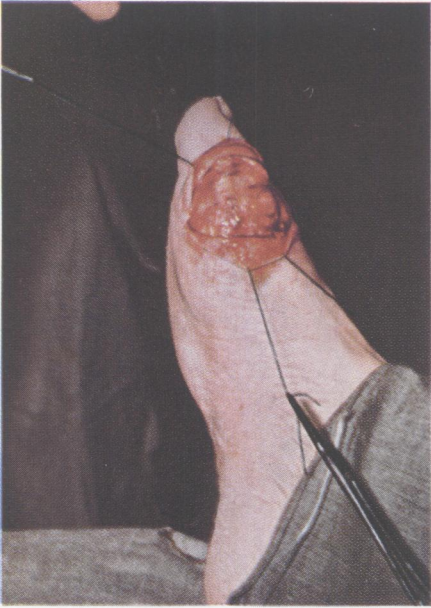


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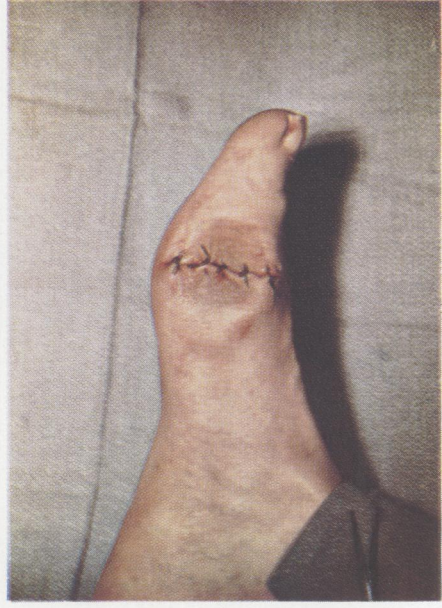
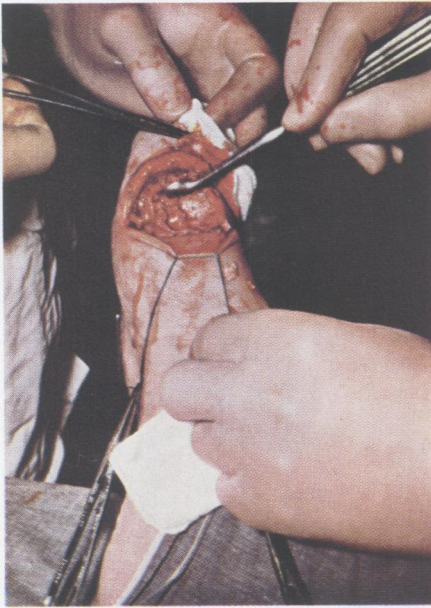
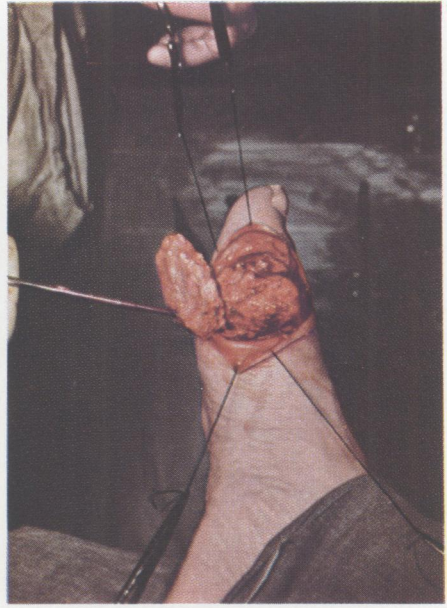
FIG. 16.—The excision of large tophaceous deposits involving the left heel, the right elbow and the right first metatarsophalangeal joint. The patient, a male, age 55, had symptoms of gout for 26 years (The same patient as in Figs. 6 and 10). A. A lateral view of the heel to show the tophaceous deposit. A large piece of desquamating epidermis has been peeled downward, showing the large subcutaneous tophaceous deposit. Note the lobulated appearance of the mass and the urate crystals showing at the base of the ulcerated areas. B. The main mass of the tophus has been resected through a transverse incision, excising the ulcerated areas in the skin. The base of the wound shows normal appearing subcutaneous tissues. This tophaceous deposit did not involve a tendon or bone but lay in the subcutaneous tissues of the heel. The wound was closed with interrupted silk sutures, without drainage. The foot was immobilized in a posterior plaster shell for two weeks. The wound healed *per primam*. An excellent result was obtained (see Fig. 6). C. The skin over the olecranon has been opened through a transverse incision. The tophaceous deposit filling the olecranon bursa has been dissected from the overlying skin and the tissues beneath it and retracted downward with forceps. Note the separate deposit involving the triceps tendon in the lower portion of the wound.



E



F



G

H

D. The dissection has been carried down to the triceps tendon from which most of the tophus has been dissected away with the scalpel and curette. Some urate crystals are to be seen in the tendon. It was necessary to leave these because they had infiltrated the tendinous structure to such a degree that complete removal of them would have destroyed the attachment of the triceps tendon. The wound was closed with interrupted sutures without drainage. The elbow was immobilized with a posterior plaster splint for ten days. The wound healed *per primam*. An excellent result was obtained (see Fig. 10). E. The skin directly over the tophaceous deposit of the first metatarsophalangeal joint has been opened through a transverse incision exposing the capsule of the tophus. The skin was dissected free with a scalpel, and silk sutures in the edges were introduced for retraction to prevent undue trauma to the parchment-thin skin. The lobulations of the tophus can be seen through the capsule. F. A large section of the deposit has been cut away with a scalpel, which still left a large amount of urate crystals about the bones and joint. G. The remainder of the tophus involving the base of the phalanx and the head of the metatarsal bone, and an extension of it over the dorsum of the joint to the outer side of the toe, was removed with a bone curette. The capsule of the joint was markedly infiltrated with the urate crystals, so that removal of it opened the joint space. Most of the joint cartilage and the articular ends of the bones had been destroyed but sufficient of them were intact, so that it was not felt necessary to amputate the toe. H. The wound was thoroughly flushed with normal saline solution and the skin approximated with interrupted vertical mattress sutures of fine silk, without drainage. Note the depression where the tophus had been. This cavity filled with blood clot, which became organized, resulting in a normal contour to the foot when healed (see Fig. 6). The foot and ankle were immobilized in a padded posterior plaster shell for two weeks. The wound healed *per primam*.

For this reason it was found advantageous to use local anesthesia wherever possible. Thirty-three operations in all have been performed using colchicine in prophylactic doses. The incidence of postoperative gout, in contrast to the 86 per cent among untreated patients, was only ten per cent. Gout developed in one patient who had had preoperative colchicine but not postoperatively; one had it postoperatively but not preoperatively; and one had it both preoperatively and postoperatively. It is obvious from these data that the adequate use of colchicine not only gives peace of mind to the surgeon, but comfort to the patient in the postoperative period. If a patient suddenly develops a fever in the first week following an operation, it is important to know that such a reaction not uncommonly may occur in patients with gout. More important is the recognition of the fact that it is possible to prevent attacks of postoperative gouty arthritis with adequate amounts of colchicine.

The type of anesthesia seemed to have little if any effect on the postoperative attack of gout. In this series local anesthesia with one per cent novocain infiltration was used in 24, ether in nine, spinal anesthesia in 12, and no anesthesia in one. Six of the 13 postoperative attacks of acute gout followed local anesthesia, three followed spinal anesthesia, and four followed ether anesthesia. The preponderance of cases following local anesthesia is explained by the fact that the majority of the patients received local anesthesia for their operation.

*Follow-up Studies.*—The follow-up studies carried out in June, 1942, or up to the death of the patients, showed that in only three out of the 93 tophaceous deposits were recurrences of any size observed. One of these was in the finger of a woman with very extensive deposits in which an inadequate removal was done at the first operation. In the second case a tophus recurred in the flexor tendon in the palm of the hand because removal had been incomplete from fear of destroying the tendon. The third case had a recurrence in the finger and was one of the earlier operations in which complete removal of the tophaceous deposit had not been obtained. The explanation of why tophi do not recur after simply removing the urate acid crystals is not offered.

Relief from pain was obtained by the surgical removal of the tophaceous deposits in all of the 11 patients. Four patients with extensive involvement of the feet, who were unable to walk without extreme pain or not at all, were rehabilitated so that they could get about without pain. Eight of the patients had painful tophi removed from the hands and fingers with marked relief of symptoms and in some with considerable restoration of function. In addition the improvement in the appearance of hands was very marked.

It is hoped that the results published in this paper will encourage others to undertake surgery in similarly afflicted gouty patients. Since this series of cases show that good results are possible by the surgical removal of tophaceous deposits, even late in life, it is recommended that surgery be done earlier in the course of the disease than usually is considered desirable.

## CONCLUSIONS

1. The surgical removal of tophaceous deposits in 11 patients with gout is reported.
2. Tophaceous deposits, as a rule, primarily involve joints and secondarily tendons, bones and soft tissues, but also they may occur primarily in tendons and subcutaneous tissues.
3. Carefully planned and staged-operations may be carried out on patients with gout which result in the relief of pain, restoration of function, rehabilitation of the patient, improved cosmetic appearance, and in many instances permanent eradication of the tophaceous deposits.
4. Adequate preoperative and postoperative treatment of the patient with colchicine is essential.
5. Close cooperation between the surgeon and the internist in the selection and care of these patients is vital.

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