FROM THE ORTHOPAEDIC HANDCLINIC, COPENHAGEN.

TREATMENT OF UNUNITED FRACTURES OF THE CARPAL SCAPHOID BY BENTZON'S OPERATION

By

OLAF AGNER

According to the recent literature on fractures of the scaphoid bone, most authors now prefer conservative treatment of recent fractures in plaster cast. The results are somewhat varied, union being obtained in from about 70 % to about 95 % of the cases within 8–12 weeks. These results have been obtained where the treatment is centralized, where interest is devoted to this particular fracture, and where a routine technique of applying the plaster cast is employed. The results must be assumed to be less favourable in departments where fewer cases are treated, so that sufficient experience cannot always be presumed to have been gained.

Thus, a certain number of scaphoid fractures do not unite despite treatment—and to these are added primarily untreated cases, either because the patient has not consulted a doctor or because the fracture has been overlooked in the course of the examination. A number of these cases are diagnosed accidentally, or when the patient presents himself with persistent pain, possibly after a second injury years after the occurrence of the fracture.

Numerous methods have been suggested in the treatment of ununited fractures of the carpal scaphoid. "A study of the extensive literature on the subject is not conducive to peace of mind for the surgeon—there are too many alternatives" as stated by *Lyman Smith,* Illinois, in 1956. I shall not try to discuss every single method, but shall merely enumerate them: excision of one or both fragments, excision of the proximal carpal row, insertion of a prosthesis, prolonged immobilization, internal

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screw fixation, drilling of fragments, intercarpal or radiocarpal arthrodesis, bone grafting, radial styloidectomy.

To this long list may be added yet another method which is worth considering: Bentzon's operation. It does not pretend to be the final solution in the treatment of ununited fractures of the carpal scaphoid. However, as fairly good results have been reported in 3 series followed up for a long time, there seems reason to submit the method for discussion.

In the event of nun-union of scaphoid fractures, Bentzon makes a distinction between 3 types: (1) Necrosis of a small, usually proximal, fragment presenting itself on the X-ray film with distinct sclerosis, (2) absorptive lesions (traumatic cysts) around the fracture line, and (3) actual pseudarthrosis, usually dividing the bone into two almost equally large parts. According to Bentzon, a small necrotic fragment should be excised, while in cases of traumatic cysts immobilization should be tried. An actual pseudarthrosis is the indication for this operation. Bertelsen prefers exstirpation when dealing with proximal fragments less than 1/5 of the bone, but Bentzon's method in wider fissures through the waist.

Many patients with pseudarthrosis of the scaphoid bone have no pain and little limitation of motion. Therefore, it was Bentzon's idea that in patients with painful pseudarthrosis the condition might be altered to a painless one by an operation interposing a fat-fascia flap between the fragments.

In 1939 he started using this method in long-standing cases of pseudarthrosis at the Aarhus Orthopaedic Hospital, Denmark, in collaboration with Randløv. The procedure is as follows.

OPERATION

A fairly large, curved incision is made over the anatomical snuff-box and the adjoining distal area. The incision should be convex in the dorsoulnar direction. The skin flap is retracted, and from subcutaneous fatty tissue, connective tissue and possibly some tendon sheath, a fairly large flap is made. Its attachment is proximal, just above the styloid process of the radius. In this type of scaphoid fracture, the fracture line is located just distal to the tip of the styloid process. At this site, the joint capsule is opened and the fracture line exposed. If the appearances are not quite clear, a probe is inserted and the site is X-rayed. After debridement, the fracture will gape wide and now the fat-connective tissue flap should be interposed and accurately fixed between the fragments. To

this end, a nylon suture is applied to the tip of the flap, and by quite straight needles both ends of the suture are pulled down through the gap and through the skin on the volar aspect of the carpus. At this site, the suture is tied over a small gauze tampon, thereby pulling the flap right to the bottom of the fracture line. In the course of this manoeuvre, it is of course important not pierce the median nerve or the radial artery. Tying the suture on the volar aspect fixes the flap in the fracture gap and makes it fit snugly. The fascia and skin are now sutured. The wrist is fixed in a plaster cast in slight dorsal and ulnar flexion. At the end of 2 weeks the plaster and sutures are removed, and of course the suture which has fixed the interposed flap. The patient is then encouraged to use and train his hand immediately.

In Bentzon's opinion it is important not to put off the operation too long, and under no circumstances so long that osteoarthritic changes have appeared. The final therapy has to be decided upon if immobilization for 8–10 weeks has failed to give satisfactory union.

Bentzon & Randløv published their preliminary results in 1944 and 1945. In 1954 *Randløv* reported on a series of 20 patients treated by the interposition method and followed up for periods of from 1 to 15 years. Sixteen were "completely all right", working in their usual occupation to a full extent without any complaints. In 4 the results was "good", i.e. they had returned to their former work, but suffered pain upon severe exertions. None had poor results.

Perey, also in 1954, conducted a follow-up study on 15 out of 17 patients treated at the Orthopaedic Clinic of the Karolinska Institutet, Stockholm, during the period 1940–1950. All had strenuous work. The average period elapsing from the accident to the operation was 4 years and from the operation to follow-up 2–9 years, avering 5 years. The results were: 10 "completely all right", 4 had slight pain, and 1 had "improved". All but one had been able to return to their former work after the operation.

In the majority of cases, the mobility in the wrist was reduced, but this did not bother any of the patients. Moreover, the strength of the hand was reduced, but this was not of practical importance except in 3 cases. Radiological evidence of mild osteoarthritis in the radiocarpal joint was found in 11 cases.

At the Orthopaedic Hospital, Copenhagen, 25 patients were treated by the Bentzon operation during the years 1951–1958 inclusive. During the same period, a total of 245 patients were referred with fracture of the carpal scaphoid.

The operative indication was in all cases painful pseudarthrosis, in most cases accompanied by restricted mobility in the wrist and reduced strength. Twelve patients were unable to do their jobs, while the others were working with difficulty.

Two patients had radial styloidectomy at the same time.

Two patients were females, 23 males. At the time of the operation they ranged in age from 15 to 49 years, average 27.2 years.

Eighteen patients had heavy work, the remaining 7 lighter work.

Sixteen fractures were left-sided, 9 right-sided.

The majority of the fractures were near the middle of the scaphoid bone, 1 in the proximal third, and one in the distal third.

In 19 instances, the fracture had not been diagnosed primarily. Five of these patients had been X-rayed immediately, but without the fracture being detected. In 6 cases the diagnosis was made immediately, but nevertheless one of them was not treated.

Twelve had been treated previously by plaster cast from 5 weeks to 9 months. This treatment had been instituted immediately after the injury in only 4 cases in whom it had been continued for 4 months, 5 months, 6 weeks, and 8 weeks respectively. In the other patients the treatment has not been started until 4 weeks to 10 years after the accident.

One year after the injury 1 patient had been treated, because of pain, with a plaster cast for 6 weeks, but unsuccessfully. Two years after the injury, drilling by the method of Beck was tried, and since the fracture still failed to unite, the Bentzon operation was carried out 3 years after the accident.

For the sake of completeness, it must be mentioned that 2 patients had been treated by massage and X-ray therapy.

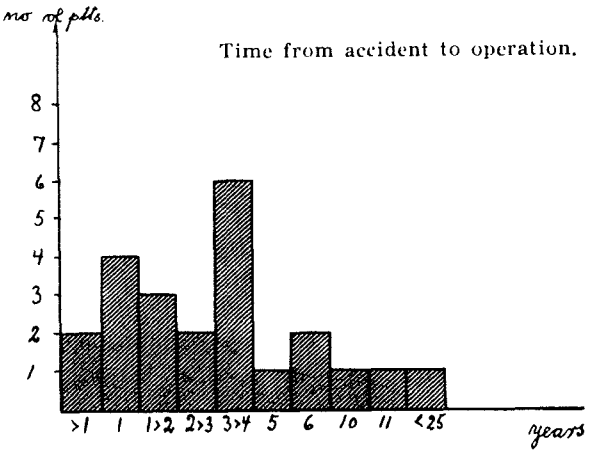
FOLLOW-UP

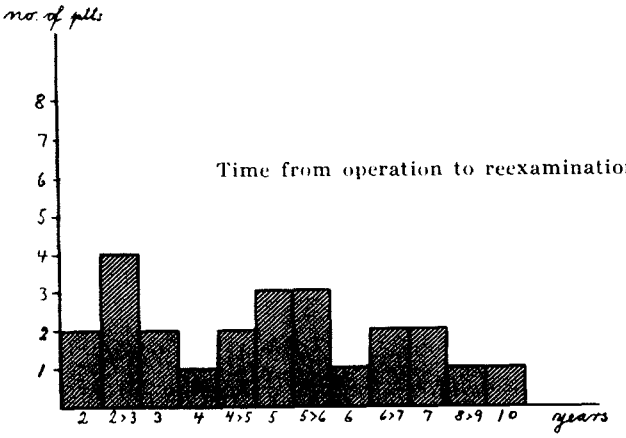
One patient died 6 years after the operation for pseudarthrosis of the scaphoid. He was last seen in hospital 7 months after the operation. At that time he had been working fulltime as a labourer for 4 months. Only heavy impacts would cause mild pain at the site of the scaphoid. There was some limitation of the volar, less of the dorsal flexion, but the mobility was far better than prior to the operation.

Twenty-four patients were re-examined in the period November 1960 to March 1961, after follow-up periods of from 2 to 10 years, average 5 years (4 years 11 months).

25 *patients.*

23 men ..... 18 heavy workers
2 women .....
24 ptts. followed up
(1pt. died 6 years after operation).





At follow-up, 17 patients reported that they were fully satisfied with the result. They could perform any kind of work without pain in the hand. All had returned to their former work.

Four had slight pain after prolonged, strenuous work. The pain was of brief duration and never so severe as to induce them to interrupt their work. All four had returned to their former work.

Three still had complaints, but stated that the condition was better than before the operation. A boiler maker with pseudarthrosis in the right carpal scaphoid developed pain in the wrist after using the hammer for a long time. Now, he was working as a chaffeur and had no complaints. A grocer developed brief pain in the wrist when lifting heavy weights, but unlike the previous occasion he could write without discomfort. The third one was a labourer who had been treated previously by immobilization in plaster, but not until one year after the accident, as the fracture had not been diagnosed. Two years after the accident, drilling of the fragments was tried, and not until 3 years after the accident did he have a Bentzon operation. He has now been working in his old job for 6 years. He often has to lift heavy weights, and this gives rise to pain. During the past few months, the condition has become aggravated. At follow-up this patient, like the one just mentioned, was found to have a long styloid process and osteoarthritis in the wrist. One month ago, therefore, he had radial styloidectomy.

Treatment before operation. Immobilisation (plaster cast) 12 cases.

primarily	later (the fracture not diagnosed primarily)
1 pt. plaster cast 5 months	1 pt. after 5 months plaster cast 6 months
1 pt. plaster cast 4 months	1 pt. after 10 years plaster cast 1½ months
1 pt. plaster cast 1½ month	1 pt. after 1¼ month plaster cast 4 months
after ½ year plaster 8 months	1 pt. after 1 year plaster cast 1½ months
1 pt. plaster cast 2 months	1 pt. after 1 month plaster cast 7 months
after 1 year plaster 4 months	1 pt. after 3 years plaster cast 1½ months
	1 pt. after 1 month plaster cast 4 months
	1 pt. after 3 months plaster cast 1¼ months

massage: 2 cases.

In most of the cases there was some limitation of motion in the wrist. Only a few of the records gave accurate data regarding the mobility prior to the operation, but in these cases it was found to be improved. Radial flexion was more often restricted than ulnar flexion and volar flexion more often than dorsal. On the average, the limitation of motion was as follows: dorsal 10°, volar 15°, ulnar 10°, radial 15°.

Strength was reduced in 8 cases, but this was not of practical importance except in one.

All the 24 patients included in the follow-up were X-rayed. In 13 this revealed osteoarthritic changes involving the radial part of the wrist, and only that part.

13 out of 24 cases had radiologic visible arthritis at reexamination.

	age of pt. at op.	time from accident to op. years	time from op. to reexamination years	arthritis before op.	arthritis at reexmination
h	29	6	4.6	++	++
	19	1	6.3	+	+ ×
h	19	3.3	5.6	+	++
	41	ca. 30	2	++ :	++ :
h	34	11	5.6	++	++ : ×
h	46	1	5	+	++ : ×
	22	?	10	+	++
	21	1.6	7	+	++ : ×
h	20	3	6	+	++ : ×
h	25	2.3	2.8	++	++ :
h	20	1.6	4	--	+ : ×
h	21	6	2.9	—	+ :
h	26	5	4.6	+	+ :
average	26.5	5.9	5.1 (5.4)	with arthritis	
average	27.5	2.3	4.5	without arthritis	

++ sinking of cartilage and sharp. of styloid. × exostosis of dist. fragm.
+ sharpening of styloid. : proliferation of trapezium.
h heavy workers.

All the 13 patients showed "sharpening" of the styloid process of the radius. 9 also had a narrowed joint space between the radius and scaphoid bone.

6 had exostoses on the radial aspect of the distal scaphoid fragment. 9 had mild proliferation of the articular margin of the trapezium bone.

Close scrutiny of the preoperative X-rays, however, revealed osteoarthritis in 11 out of these 13 patients. In 2 there had been no changes in the degree of osteoarthritis, while in 9 it had progressed. Only 2 had no visible osteoarthritis prior to the operation, but slight arthritis after.

There was no correlation between he presence of osteoarthritis and the patients' ages or type of work.

In the 13 cases with osteoarthritis, the average period from the accident to operation was 5.9 years as compared with 4.4 years for the total series and 2.3 years for patients who did not develop osteoarthritis.

The average period from operation to follow-up was for cases with arthritis 5.1 years –and apart from those in whom the arthritis was unchanged 5.4 years—as compared with 4.5 years for cases without arthritis.

excellent: back in earlier employment, no pains no complaints.
good: back in earlier employment, slight pains after heavy work.
improved: pains and stiffness of the wrist when working but less than before operation.
bad: unaltered or worse than before operation.

results.	
excellent	17 patients
good	4 patients
improved	3 patients
bad	0 patients
	24 patients

Bentzon's operation is a simple procedure requiring only a short treatment period. The patient can soon return to his work. As already mentioned, the results of this operation have now been reported in 3 series, comprising a total of 60 cases, followed up for several years after the operation. The subjective as well as clinical results are good. Osteoarthritis was found by X-rays in about half the cases, but most of these patients had incipient osteoarthritis before the operation. The incidence of osteoarthritis must be a decisive factor in selecting the method of treatment. From numerous investigations, it is known that osteoarthritis is a common finding in cases with long-standing pseudarthrosis in the carpal scaphoid (*Kjeld Andersen & Therkelsen* at the University Hospital in Copenhagen found 36 %, but 50 % among operated cases).

In the literature, we have not been able to find reports of follow-up studies for osteoarthritis in patients treated by other surgical techniques Pending such reports, we feel justified in continuing to use the Bentzon operation on the named indications.

SUMMARY

At the Orthopaedic Hospital, Copenhagen 25 patients were treated according to Bentzon's method for pseudarthrosis of the carpal scaphoid in the years 1951–1958. During the same period 245 patients were referred for fractures of the carpal scaphoid. The aim of the operation is to alter a painful pseudarthrosis to a painless one by interposing between the fragments a fat fascia flap from the subcutaneous tissue of the anatomical snuffbox. The wrist is fixed in a plaster cast for two weeks after the operation, then the patient is encouraged to use and train his hand immediately.

24 patients were followed up from 2–10 years after the operation. (One patient had died). 17 had excellent results. 4 got slight pain after

prolonged, strenuous work, but never so severe as to induce them to interrupt their work. 3 still had complaints, but stated that the condition was better than before the operation. At follow-up all the 24 patients were X-rayed—in 13 osteoarthritic changes were seen, but in 11 preoperative X-rays revealed osteoarthritic changes,—in 9 they had progressed. In two only no osteoarthritis was seen prior to the operation, but slight osteoarthritic changes afterwards.

RESUME

A Hôpital Orthopédique de Copenhague, la méthode de Bentzon a été appliquée au tritement de 25 cas de pseudarthroses du scaphoïde carpien pendant les années 1951 à 1958. Durant cette même période 245 malades ont été traités pour des fractures du scaphoïde carpien. Par l'opération, on vise à transformer une pseudarthrose douloureuse en une maladie sans douleur, en interposant entre les fragments un bout de fascia gras prélevé dans le tissu sous-cutané de la tabatière anatomique. Le poignet est fixé dans le plâtre pendant deux semaines après l'opération, puis on recommande au malade d'utiliser et d'entraîner sa main immédiatement.

24 malades ont été réexaminés entre 2 et 10 ans après l'opération. (Un malade était décédé). Chez 17 les résultats étaient excellents; chex 4, il y avait eu de légères douleurs à la suite d'un travail pénible prolongé, mais les douleurs n'avaient cependant jamais été assez fortes pour les amener à cesser leur travail. 3 continuent à se plaindre, tout en reconnaissant que leur état est meilleur qu'avant l'operation. A l'examen, tous les 24 malades ont été passés aux rayons C. On a constaté des modifications ostéoarthritiques chez 13, mais chez 11 la radiographie préopératoire avait déjà révélé des modifications ostéoarthritiques — chez 9 malades, elles avaient progressé. Dans deux cas seulement aucune modification ostéoarthritique n'a été observée avant l'operation, mais il y avait de légères modifications après l'intervention.

ZUSAMMENFASSUNG

Am orthopedischen Krankenhaus in Kopenhagen wurden in den Jahren 1951–1958 25 patienten nach Bentzons Methode zur Behandlung der Pseudarthrose des os naviculare der Hand operiert. Während des gleichen Zeitraumes wurden 245 Patienten mit Brüchen des Kahnbeines der Hand gesehen. Man beabsichtigt mittels der Operation eine schmerz-

volle Pseudarthrose mittels Einlegung eines gestielten Fett-Faszienlappens von dem subkutanen Gewebe der Tabatiere zwischen die Fragmente in eine schmerzlose zu verwandeln. Die Hand wird für zwei Wochen nach der Operation im Gipsverband ruhiggestellt und nachher wird der Patient aufgefordert seine Hand ohne weiters zu gebrauchen und zu üben.

24 Patienten wurden 2 bis 4 Jahre nach der Operation nachuntersucht. (Ein Patient war gestorben). 17 zeigten ein ausgezeichnetes Ergebnis. 4 bekamen leichte Schmerzen nach langer, anstrengender Arbeit die jedoch u.s.w. unterbrechen mussten. 3 Patienten hatten fortgesetzt Schmerzen, aber gaben an, dass ihr Zustand besser als vor der Operation war. Anlässlich der Nachuntersuchung wurden alle Patienten röntgenuntersucht – bei 13 wurden osteoarthritische Veränderungen gesehen, aber bei 11 von ihnen zeigten die vor der Operation vorgenommen Röntgenbilder bereits osteoarthritische Veränderungen, – die in 9 Fällen zugenommen hatten. Nu in zwei Fällen wurde keine Osteoarthritis vor der Operation besehen, entwickelte sich aber in leichtem Grade nachher.

REFERENCES

Andersen, K. & Therkelsen, F.: Acta Radiologica, *31*: 343–357, 1949.
Bentzon, P. G. K. & Randløv-Madsen, Å.: Nord. Med., *21*: 524–527, 1944.
Bentzon, P. G. K. & Randløv-Madsen, Å.: Acta Orthop. Scandinav., *16*: 30–39, 1945.
Bertelsen, A.: Acta Orthop. Scandinav., *24*: 343, 1954.
Perey, O.: Acta Orthop. Scandinav., 23: 26–33, 1954.
Randløv, Å.: Acta Orthop. Scandinav., *24*: 341–343, 1954.
Smith, L. & Barry, F.: J. Bone and Joint Surg., *38 A*: 368–375, 1956.