FROM THE ORTHOPAEDIC CLINIC OF THE KAROLINSKA INSTITUTE, STOCKHOLM. CHIEF: PROF. S. FRIBERG

ON ARTHRODESIS OF THE ANKLE JOINT IN POSTTRAUMATIC CONDITIONS

BY

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Fractures occur frequently in the region of the ankle joint, and the majority have a very satisfactory end result. Yet, a certain number of cases recalcitrant to conservative treatment, are continuously encountered. They include the cases in which, in spite of accurate reposition, previous cartilage damage gives rise to secondary arthrosis deformans.

The conservative aftertreatment of these fractures requires the use of various forms of innersoles, foot splints and special shoes, besides physiotherapy and training. Every bandage treatment, however, causes considerable discomfort and women are particularly often unwilling to wear big unsightly supports.

In order to abandon them, we decided, as we had done earlier for sequels of poliomyelitis, to stiffen the ankle-joint. In fact postoperative discomfort seems to be rather minimal in patients afflicted by the latter disease. Posttraumatic conditions are however not entirely analogus. This must be attributed mostly to the inelasticity of the tissue following prolonged fixation in the primary treatment and to subsequent faulty position with secondary changes in the joint resulting from nalunion.

Stiffening the ankle joint has been generally agreed to be a difficult procedure, since chondrectomy will result in reduced and incongruous contact surfaces between the bone ends. The final results obtained by the first operations upon sequels of

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poliomyelitis in which exclusive intraarticular arthrodesis was carried out, tend to confirm this to a certain extent.

At the Orthopaedic Clinic of the Karolinska Institutet in Stockholm, a total of 24 arthrodeses of the talocrural joint, all presenting bone injuries, were performed from 1936 to 1946.

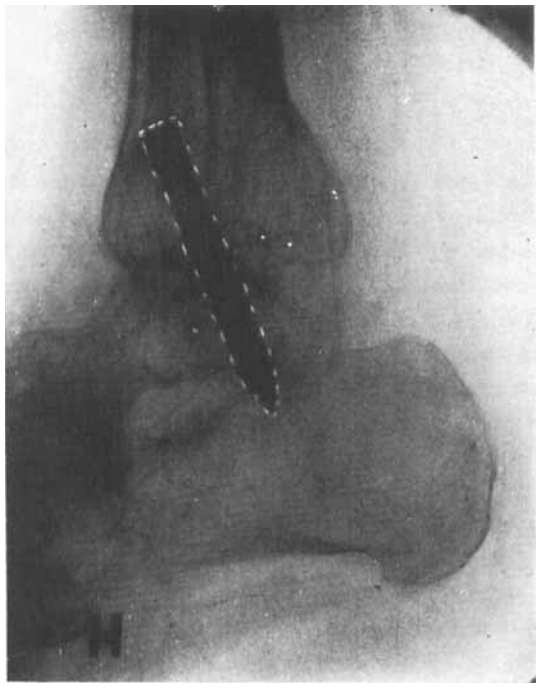

Fig. 1.
Panastragaloid arthrodesis achieved by means of a transarticular graft driven through the posterior talocalcanean joint.

The great majority of them were performed in cases of fractures of both malleoli or of trimalleolar fractures. Exclusive intra-articular arthrodesis has been practised as the earliest operative procedure. Gradually, insertion of one, later of two, transarticular bone grafts completed the surgical interference (fig. 1, 2, 3, 4).

The end results obtained by the operations appear from Table

1, which gives also records of *Hallock*'s and *Berntsen*'s final results.

The argument that ankylosis of the talocrural joint is difficult to obtain, seems to be refuted by the average duration of the ankylosing phase, amounting to 3.1 months, all reported

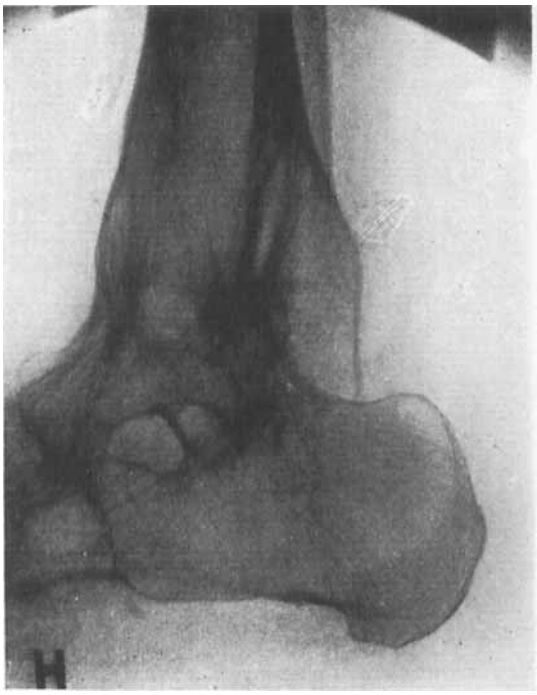

Fig. 2.
Same case as illustrated by Fig. 1, demonstrating total bony ankylosis of the talocrural, talonavicular, talocalcanean and calcaneocuboid joints.

cases being considered. Table 2 presents an analysis of the cases according to the different operations, and indicates the average duration of the ankylosing phase for each.

The cases are not numerous enough to secure definite evidence. However, it may be pointed out that the shortest phases occur after intraarticular arthrodesis combined with fixation of

two grafts across the articulation. As a matter of fact, this result is to be expected, since a satisfactory fixation of the mutual surfaces to arthrodese is more adequately obtained, both immediately after the operation and during the following weeks.

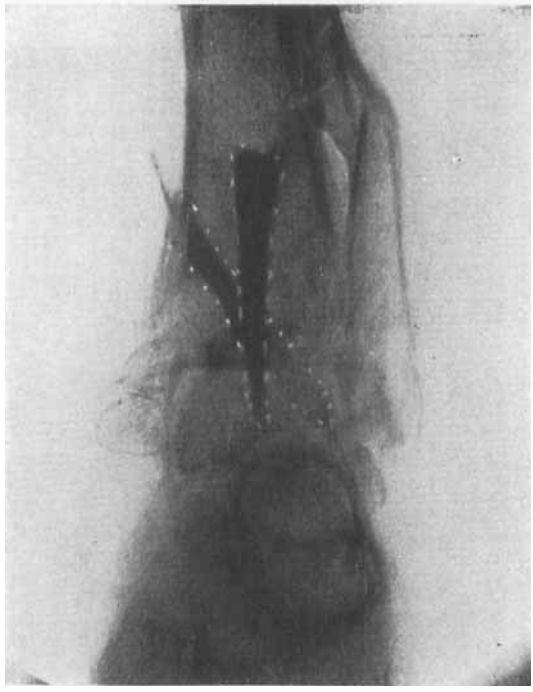

Fig. 3.
Talocrural arthrodesis by means of two grafts fixed across the articulation.

It further facilitates maintenance of the position of the foot, obtained when encasing it in postoperative plaster cast. The necessarily prolonged operative course, should not be considered as of practical importance.

The functional result may be estimated partly from the occupational point of view, partly from the postoperative support required. Of the 24 cases, 20 have full ability to work, while

2 have returned to lighter activities. One of the latter was unable to carry on his original occupation, on account of a postthrombotic condition which had followed the primary treatment of a trimalleolar fracture. One of the two remaining

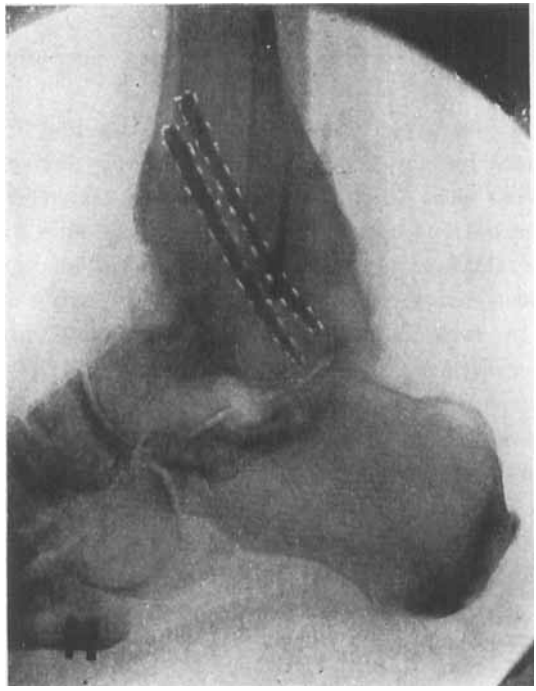

Fig. 4.
Talocrural arthrodesis with two parallel transarticular grafts. A metallic peg ensures accurate fixation of the lateral malleolus, that shows temporary avulsion.

patients is disabled until a prosthesis for the other leg, which had to be amputated on account of extensive deep lacerations, can be secured. The second is at present under supervision for an additional subastragaloid arthrosis. In this case, a faulty varus position of the foot had followed the original arthrodesis of the ankle joint, and occasioned such considerable pain from

TABLE 1

End Result of Ankylosis in Talocrural Arthrodeses.

	Number of Cases	Incidence of Ankylosis		Per cent Osseous Ankylosis
		Osseous	Non-osseous	
Hallock, H.	38	29	9	77
Berntsen, Aa.	15	14	1	93.3
Orthop. Clinic, Stockholm	24	24	—	100

the subtaloid joints, that fusion had to be considered advisable. If the amputation case may be rated among patients able to work, 21 cases were fully capable of work, 2 partially capable and only one patient incapacitated. This represents an excellent result, if we take into account that, prior to operation, all the patients had been entirely disabled or could work only with greatest difficulty. In regard to the postoperative need for appliances the end result may be evaluated as good, if the patients either discarded all supports or if only ordinary foot-pieces or Lange-soles were used. A less favourable result occurs when orthopaedic boots or shoes, leg braces or foot bandages are required. Apart from the patient recently submitted to subtaloid arthrodesis, 18 cases may be rated as "good", while in 5 cases a less favourable final result is obtained. Arthrodesis of the ankle joint seems to be followed by a certain discomfort in these latter 5 cases. Ortho-

TABLE 2

Incidence of Ankylosis and Duration of the Ankylosing Phase in Different Types of Talocrural Arthrodesis.

Operative Procedure	Number of Cases	Result in Ankylosis	Ankylosing Period	
			No. of Reliable Cases	Average Duration in Months
Intra-articular arthrodesis ...	11	All osseous ankylosis.	9	3.1
Intra-articular arthrodesis + 2 transarticular grafts	8	—„—	8	2.9
Intra-articular arthrodesis + 1 transarticular graft	5	—„—	5	3.4

TABLE 3
Postoperative Arthrosis in the Subtalo- or Talonavicular Articulations.

	Number of Cases	Postoperative Arthrosis
Hallock, H.	38	4
Berntsen, Aa.	15	3
Orthop. Clinic, Stockholm ...	24	3
	77	10 (13 per cent)

paedic shoes have been prescribed in 2 of them, partly on account of pain located to the dorsum of the foot, partly as a preliminary first measure after operation. Unarticulated foot splints were provided for adjustment in the 3 remaining cases, in order to alleviate pain arising either from *Chopart's* joint or from the subtaloid joints. Immobilization of the ankle joint imposes increased strain particularly on *Chopart's* joint. Evidence of this condition is given by high increased-range of movement (to 30 degrees), that subsequently appears in that joint. Also the subtaloid joints may be considered as being exposed to increased, abnormal strain, which is either due to decreased rate of pronation and supination, or at least, to a certain elasticity in the ankle joint. Secondary arthrosis deformans involving the exposed joints may be expected and referable to these increased strains.

Table 3 records *Hallock's* similar statement in 4 cases in a series of 38 patients. *Berntsen's* review indicates one case with arthrosis of the foot, one other where arthrosis was involving *Chopart's* joint and one case complaining of pain in the posterior region of the ankle joint, most probably referable to the posterior talocalcanean joint. 3 of our 24 cases show changes due to arthrosis. The talonavicular joint is involved in one case, while in both other cases the changes are located to the talocalcanean joint. Table 3 summarizes the above-mentioned cases, presenting 77 cases of which 10, i.e. 13 per cent disclose secondary arthritic manifestations in the contiguous joints. Besides the 3 above-recorded cases, 3 other patients suffered from pain

in the midfoot (without secondary arthrosis deformans showing on the X-rays).

How can such discomfort be avoided? Justified surgical effort should consist in simultaneous triarticular subtaloid arthrodesis with the talocrural arthrodesis, i.e. panastragalar arthrodesis. This interference has been carried out in 10 cases which have been excluded from the group of cases described above. In one of the panastragalar cases, confluent skin necrosis, with secondary osteitis developed and necessitated amputation of the leg. Apart from this case which can not be assessed there remain 9 cases. Only one of them complained of pain in the foot. In fact, the method had prevailed in that case as a less injuring interference, because amputation of the leg had been declined by the patient. Pain arising from the mid-foot was absent in the 8 other cases in spite of increased movement at the tarsometatarsal articulation. Needless to say, the small number of cases does not imply definite evidence. *Hallgrimson* has demonstrated in his communication 15 cases of poliomyelitis followed-up after panastragalar arthrodesis. In 6 of them, there was a more or less increased range of movement in *Lisfranc*'s joint, never however exceeding 20 degrees. 2 cases complained of subsequent slight pain.

It thus becomes evident that pain after performed panastragalar arthrodesis is almost negligible. Yet, the method must be considered as a more severe operative procedure than simple talocrural fusion. As a matter of fact, the duration of the operation is longer, and injuries sustained by the soft tissues cause complications (necrosis of the skin involving the area of operation was noted in 5 cases, while infection occurred in 3 cases). Besides, the postoperative follow-up period shows no absolute guarantee of a painless mid-foot. Panastragalar arthrodesis should therefore not be expected to become a generally used procedure.

A study of these facts seems to substantiate the following statement:

1) In serious deteriorations, talo-crural arthrodesis provides a

suitable complement to surgical treatment of fractures in the ankle joint region.

2) When performed lege artis, it gives as a rule a gratifying end result (bony ankylosis) within a relatively brief interval.
3) At operation careful manipulation of the foot into an absolutely accurate position must be done, i.e. into 10 degrees of equinus and neutral pronation and supination, in order as far as possible to prevent pain, originating from adjacent joints.
4) Should that failure not have been advoidable, complementary triarticular subtaloid arthrodesis (i.e. fusion of the talocalcanean, talonavicular and calcaneocuboid joints), may be employed after talocrural arthrodesis.
5) Primary panastragalar arthrodesis is recommended as an attempt to remedy cases in which changes prior to operation have involved either the subtaloid articulation or *Chopart*'s joint.

SUMMARY

The author reports the results of 24 cases of tibio-tarsal arthrodesis for post-traumatic conditions. Bony ankylosis was obtained in all cases. 21 patients are fully able to work, 2 have light work and 1 is still under treatment (supplementary subastragular arthrodesis). 3 cases have a secondary osteo-arthritis of the neighbouring joints.

The following conclusions can be drawn:

1) After fractures in the region of the ankle-joint tibiotarsal arthrodesis is a good addition to the treatment of severe post-traumatic disabilities.
2) Correctly performed it gives a certain result (bony ankylosis) within a relatively short period of time.
3) At operation the foot must be placed in the correct position, that is, 10 degrees of equinus, and neutral position as regards pronation and supination, in order to avoid as far as possible painful complications in the neighbouring joints.
4) When these complications occur the tibio-tarsal arthrodesis

is supplemented with a sub-astragalar (tri-articular) arthrodesis, that is to say arthrodesis of the astragalo-calacaneo, astragalo-scaphoid and calacaneo-cuboid joints.

5) Tibio-tarsal arthrodesis combined initially with subastragalar (tri-articular) arthrodesis is confined to cases which have already, before operation, developed osteoarthritis in the subastragalar and mid-tarsal joints.

RESUME

L'auteur rend compte des résultats obtenus dans 24 cas d'arthrodèses tibio-tarsiennes exécutées lors d'états posttraumatiques. Une ankylose osseuse fut obtenue dans tous les cas. 21 malades sont entièrement capables de travailler, 2 sont occupés dans des emplois peu pénibles, alors qu'un malade se trouve actuellement en traitement, (arthrodèse sous-astragalienne complémentaire). Dans 3 cas une arthrose déformante secondaire des articulations adjacentes put être constatée.

En résumé, on peut tirer les conclusions suivantes de cette étude :

1) Après fracture dans la région du cou-de-pied, l'arthrodèse tibio-tarsienne constitue un bon complément dans le traitement d'états posttraumatiques graves.
2) Exécutée lege artis elle permet un résultat sûr (ankylose osseuse) dans un laps de temps relativement court.
3) Lors de l'opération il est nécessaire de prendre garde à ce que le pied vienne se placer en position absolument exacte, c.à.d. en 10 degrés d'équinisme et en une position moyenne quant à la pro- et supination ; cela afin d'éviter, autant que faire se peut, des troubles douleureux provenant des articulations adjacentes.
4) Au cas où ces derniers se produisent, on complètera l'arthrodèse tibio-tarsienne plus tard par une arthrodèse sous-astragalienne tri-articulaire, c.à.d. arthrodèse dans les articulations astragalo-calcanéenne, astragalo-scaphoïdienne et calcanéo-cuboïdienne.
5) On réservera l'arthrodèse tibio-tarsienne + l'arthrodèse sous-

astragalienne tri-articulaire primaire aux cas qui déjà avant l'opération présentent des altérations d'une sorte ou d'une autre, affectant les articulations sous-astragaliennes ou l'articulation médio-tarsienne.

ZUSAMMENFASSUNG

Verfasser berichtet über die Ergebnisse von 24 Fällen von talo-cruraler Arthrodesis wegen posttraumatischer Zustände. In allen Fällen wurde eine knöcherne Ankylose erzielt. 21 Patienten sind vollständig arbeitsfähig, 2 haben leichte Arbeit, und 1 ist noch in Behandlung (supplierende Subtalo-Arthrodesis). 3 Fälle zeigen eine sekundäre Osteo-Arthritis der benachbarten Gelenke.

Es lassen sich folgende Schlüsse ziehen:

1) Nach Frakturen in der Fussgelenk-Region ist eine talo-crurale Arthrodese eine gute Ergänzung der Behandlung schwerer posttraumatischer Funktionsstörungen.
2) Bei korrekter Ausführung gibt sie in relativ kurzer Zeit ein sicheres Resultat.
3) Bei der Operation muss der Fuss in die korrekte Lage gebracht werden, d.h. 10° Spitzfuss-Stellung und neutrale Stellung hinsichtlich Pronation und Supination, um schmerzhafte Komplikationen in den benachbarten Gelenken so weit wie möglich zu vermeiden.
4) Wenn solche Komplikationen eintreten, ist die talo-crurale Arthrodese mit einer Subtalo-Arthrodese zu supplieren, d.h. einer Arthrodese der Articulationes talo-calcanea, talo-navicularis und calcaneo-cuboidea.
5) Die talo-crurale Arthrodese gleich zu Anfang kombiniert mit einer Subtalo-Arthrodese wird nur in Fällen angewendet, die bereite vor der Operation Veränderungen des Subtalo- und Tarsalgelenks aufweisen.