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THE GRICE OPERATION FOR PARALYTIC FLAT FEET IN CHILDREN

By

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INTRODUCTION

Arthrodesis of the ankle joint and subastragalar joint is a procedure which has been used for a long time for the purpose of correcting and stabilizing feet paralyzed and deformed by poliomyelitis.

As early as 1879 *Albert* of Vienna performed an arthrodesis of the ankle joint in order to stabilize a paralyzed foot, and in 1905 *Nieny* did a subastragalar arthrodesis. Since then, numerous reports on arthrodeses of paralytic feet have been published, and a number of different techniques have been employed. Subastragalar arthrodesis, as generally performed, often requires resection of a good deal of bony tissue, especially when performed on flat feet. In children it has been used only with some hesitation for fear of disturbing growth.

In 1952, however, *Grice* described a procedure for subastragalar fixation of paralytic flat feet in children consisting in extra-articular fixation inserting a bone graft into the sinus tarsi. In his first paper he reported favourable results, but the follow-up period did not exceed 2 years. In 1955 *Grice* reported his further experience, now after 1–5 years' follow-up, and the results were still satisfactory.

At the Orthopaedic Hospital, Copenhagen, we have used the Grice operation for paralytic flat feet in a number of cases from the great polio epidemic in 1952. By now, the follow-up period is sufficiently long for assessing the results. The present report deals with the follow-up findings and the conclusions which they seem to warrant.

M A T E R I A L

Sixty-six children with paralysis of the feet after poliomyelitis were submitted to a total of 69 Grice operations at the Orthopaedic Hospital, Copenhagen, during the period 1955-57.

TABLE 1

Sex and age distribution of 66 children who had the Grice operation for paralytic flat feet.

No. of children	29	No. of feet: 69
	37	
<i>Age at operation:</i>		
	4-6 years: 22 feet	
	7-9 years: 28 feet	
	10-12 years: 19 feet	

In all cases the deformity was plano-valgus or calcaneo-valgus; Table I giving the sex and age at operation, shows that the age ranged from 4 to 12 years, the majority being from 4 to 9 years; 29 were girls and 37 boys.

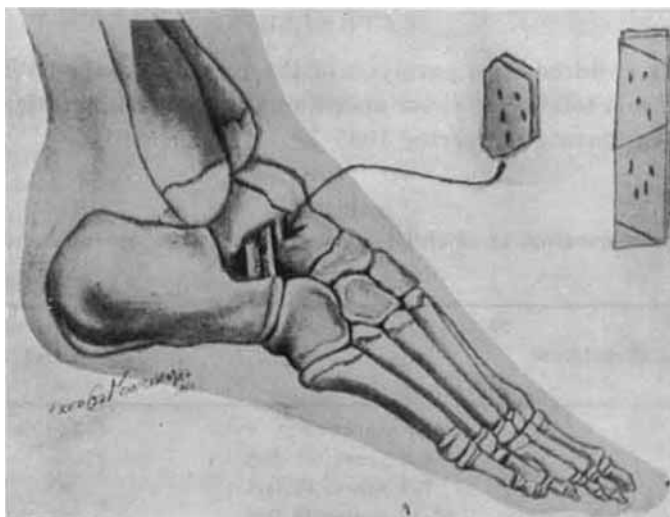
All the patients had been infected with polio in 1952, and the operations were carried out from 2 to 5 years, in most cases about 3 years, after the acute illness. This gives a follow-up period of from 4 to 6 years.

All the patients were after-examined by the author in early 1961. The examination included subjective and objective clinical assessment and X-ray investigations.

M E T H O D

The procedure was that described by *Grice* (1952), inserting 2 auto-genous bone grafts from the tibia into the sinus tarsi (Figs. I, II, III, IV).

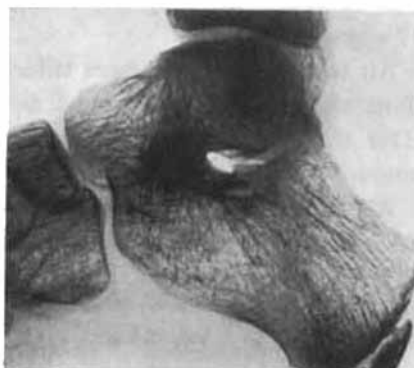
After-treatment consisted in a plaster cast for a total of 12 weeks, without weight-bearing for 4 weeks and with weight-bearing for 8 weeks. Thereupon orthopaedic footwear, arch supports or in a few cases foot capsule according to the shape of the foot and paralyses in other muscles of the leg were utilized. In several cases tendon transplantations were carried out to stabilize the position; lengthening of the heel cord was done where it seemed necessary.

*Fig. 1.*

Grice's original technique of inserting a bone graft into the sinus tarsi (from J. Bone & Joint Surg. (Am.) 34 A: 927, 1952).

*Fig. 2.*

Paralytic flat foot in plaster cast immediately after the Grice operation.

*Fig. 3.*

The same foot one year later. The grafts have healed.

RESULTS

At follow-up the cases were grouped only into good and poor results, as a more detailed grading was deemed unnecessary.

A *good result* is taken to mean a stable, well-balanced foot with satisfactory gait and without subjective complaints. Normal or near-normal

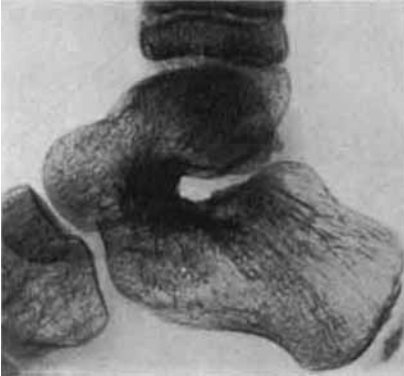


Fig. 4.

The same foot three years later. The grafts are now completely incorporated.



Fig. 5.

Paralytic flat foot 3 months after the Grice operation.

shape is intended, but allowing for negligible valgus or cavo-varus position, providing that the function is good.

Drop foot was not included in the evaluation.

A *poor result* is taken to mean either an unchanged or an increasing valgus deformity or over-correction in varus position.

TABLE 2
Results of the Grice operation at follow-up on 69 paralytic flat feet.

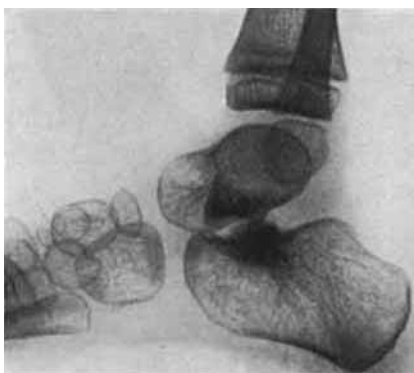
No. of operated feet	69	
Good results	46	(66.7 %)
Poor results	23	(33.3 %) < valgus: 20 varus: 3

The total results are given in Table II which shows that two-thirds were good and one-third poor. In most cases the poor result was due to deficient correction, only in 3 to over-correction.

ANALYSIS OF POOR RESULTS

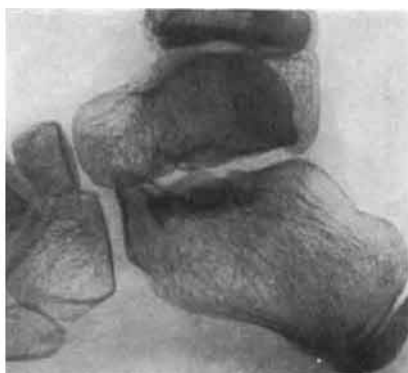
The first condition for a satisfactory result is a solid subastragalar fixation.

From Table III it will be seen that subastragalar instability was found clinically in only 5 cases, all of whom belonged to the poor group. X-ray examination, on the other hand, revealed deficient healing in 18 cases, 8 of whom belonged to the good group. In these 8 cases, therefore,

*Fig. 6.*

The same foot as Fig. 5. 2½ years later.

Incipient absorption of the grafts.

*Fig. 7.*

The same foot as Fig. 5. 5 years later.

The grafts have been completely absorbed.

the fixation must be due to fibrous adhesions in the sinus tarsi. In 2 instances there was a question of incorrect technique, the grafts having been inserted into the wrong place and having been completely absorbed (Figs. V, VI, and VII). In the other cases with deficient healing of the grafts, perusal of the case records did not afford any explanation. It must be mentioned that in our cases where healing was deficient, this was always at the astragalus.

TABLE 3

Clinical and radiological fixation at follow-up on 69 paralytic flat feet treated by the Grice procedure.

	Subastragalar fixation at follow-up	
	Clinical	X-ray
Fixation:	64	51
No fixation:	5	18
Total No.:	69	69

In assessing the X-ray appearances, it is important to note the relationship of the astragalus to the calcaneus. It is impossible to decide to what extent the A-C angle has been corrected by the operation, since regrettably no preoperative films were available for a large proportion of the patients. However, since the operation was carried out to correct flat foot, the A-C angle has presumably been increased in the great ma-

*Fig. 8.*

A large A-C angle in paralytic flat foot.

*Fig. 9.*

The same foot approx. 5 years after a successful Grice operation. Now, the A-C angle is smaller than normal.

jority of cases. In those cases where preoperative X-rays were available, there had been a distinct diminution of this angle (Figs. VII–IX).

Follow-up showed a normal A-C angle in 22 cases. In 17 cases it was 10° – 30° , in 20 cases it was $< 10^{\circ}$, and in 6 cases 0° . Only 4 had an abnormally wide A-C angle.

The explanation why so many patients showed clinically uncorrected or increased valgus deformity at follow-up, despite a normal or even reduced A-C angle and subastragalar fixation, must be that a large proportion of them had instability of the ankle joint and Chopart's joint. Even in clinically satisfactory cases, some patients may show a trace of instability of the ankle joint.

Out of 23 patients with poor results, 18 had marked instability of the ankle joint and a varying degree of instability of Chopart's joint. Out of the 46 cases with a good result 8 had slight instability of the ankle joint which may be feared to progress in the years to come. Thus, out of the total series of 39 feet, 26—or 38 %—had more or less tendency to instability of the ankle joint and often also of Chopart's joint.

In 11 patients, mainly those with poor results and instability of the ankle joint, follow-up revealed tightening of the heel cord. Eighteen of

the total series had lengthening of the heel cord performed, either at the time of the Grice operation or somewhat later.

TENDON TRANSPLANTATIONS

About two-thirds of the patients had tendon transplantations, in addition to the Grice operation, for the purpose of correcting the muscular imbalance and thereby preventing a recurrence of the deformity. Table IV shows the type of transplantation.

TABLE 4
Different types of tendon transplantation done in connection with the Grice operation.

Results in cases with and without tendon transplantation			
Type of transplantation	Total no.	Good	Bad
Strengthening of heel cord	7	6	1
Strengthening of ant. and/or post. tib.	18	12	6
Peron. long. or brev. to dorsum ped.	15	6	9
Others	4	4	0
Total No. with tendon transplant.	44	28 (63.6 %)	16
Without tendon transplantation	25	16 (64 %)	9

It will be seen that the result of the operation is the same in both groups and therefore gives no indication of the value of supplementary tendon transplantation.

TABLE 5
Analysis of instability in the ankle joint following the Grice operation in relation to tendon transplantations.

Tendon transplantation in relation to stability of the ankle joint			
	Stable	Unstable	Total
With transplant.	30 (68 %)	14	44
Without transplant.	13 (52 %)	12	25
Total No.	43 (62 %)	26	69

Tendon transplantation must in all cases affect the lateral and medial muscles, whether the transplantation is posterior, anterior, or contralateral. It is of importance, therefore, to ascertain whether tendon transplantation is of any significance to secondary instability of the ankle joint. This is shown in Table V which reveals a far larger number

of unstable cases without tendon transplantation than with tendon transplantation. A possible explanation is that it has been predominantly in cases of severe paralysis that tendon transplantation has not been performed.

MUSCLE POWER IN RELATION TO RESULTS

From what has been stated above it will be understood that an important cause of the poor results was secondary instability in the ankle joint. The following figures set out the relation of this sign to muscle power, assessed at follow-up. In other words, the assessment includes tendon transplantations, if performed.

Table VI gives the results in cases of sufficient and insufficient triceps. There is no difference.

TABLE 6

Analysis of results following the Grice operation in relation to the strength of the triceps.

Muscle power in relation to results. (According to the international grading into five)			
	Good	Poor	Total
Triceps 3 or more:	33	15	48
Triceps below 3:	13	8	21
Total No.:	46	24	69

Table VII shows the significance of the lateral and medial muscles. Clearly, the strength of these muscles is of the utmost importance to the results, there being only one poor result out of 17 where they were sufficient on both sides, while two-thirds were poor, where these muscles were insufficient.

TABLE 7

Analysis of the results following the Grice operation in relation to strength of peronei and ant. and posttibialis respectively.

Muscle power in relation to results. (According to the international grading into five)			
	Good	Poor	Total
Peronei 3 or more ant. et post. tib. below 3: ...	23	9	32
Peronei below 3 ant. et post. tib. 3 or more: ...	1	1	2
Both 3 or more:	16	1	17
Both below 3:	6	12	18
Total:	46	23	69

DISCUSSION

From this analysis it is evident that the Grice operation in our hands, with a follow-up period of 5 years, has given good results in two-thirds of the cases.

When deducting cases in which there were technical errors at the operation or deficient healing of the graft for other reasons, the main cause of the poor results was instability of the ankle joint and of Chopart's joint. Furthermore, a number of the feet which are satisfactory at present may be expected to develop instability in the course of the next few years.

In his first paper *Grice* mentioned only one case in which the result was compromised by instability of the ankle joint. The follow-up period was then only 2 years. In his second paper, with follow-up periods up to 5 years, he had 3 cases. In his opinion, the explanation was tightening of the heel cord. This accords well with the present author's findings as 11 of the poor results had tightening of the heel cord at follow-up.

Westin (1957), in a series of 31 cases, had no unstable ankle joint. However, he had 3 with plano-valgus deformity and tightening of the heel cord, so that possibly the deformity was in actual fact due to instability of the ankle joint.

It is a common opinion that arthrodesis often leads to excessive strain and consequent instability, and possibly oseoarthritis, in neighbouring joints. *Robins* (1959), however, found instability of the ankle joint in only 15 % of cases submitted to subastragalar arthrodesis for the sequelae of poliomyelitis in young persons, and *Lindholm* (1960) reported instability of the ankle joint in only 2 out of 36 adult polio feet after subastragalar arthrodesis. In the present series, however, the operations were performed on younger children, and this perhaps accounts for the difference in the results.

That muscle power *per se* is of great importance is beyond doubt. Where the lateral and medial muscles were sufficient, nearly all the results were good, while with insufficient lateral and medial muscles practically all were poor.

Primarily, there is imbalance between the posterior and anterior tibialis on the one hand and the peronei on the other, as this is what makes the deformity develop, and the sufficiency—or more correctly—the balance has been created by tendon transplantations, primarily activation of the anterior or posterior tibialis. An active posterior tibialis

may be obtained by transplanting the peroneus brevis to this tendon. This procedure, however, very often yields poor results, either in the form of over-correction or lacking effect, while activation of the anterior tibialis by all the toe extensors generally gives good results (*Zachariae* 1961) and is to be recommended.

Whether the Grice operation is to be considered a final procedure or has to be followed by subastragalar arthrodesis or panarthrodesis about the age of 14, is difficult to say at present. The latter is indicated by many findings, int. al. instability of Chopart's joint and the ankle joint. In that case, it must be seriously considered whether the same result might not have been obtained by tendon transplantation alone and whether in that case the secondary instability of the ankle joint might have been avoided.

S U M M A R Y

A follow-up study on 69 paralytic flat feet treated by the Grice operation is reported. All the patients were from the 1952 polio epidemic, underwent operation 2–5 years after the acute illness, and were followed up 4–6 years after the operation. Good results were found in two-thirds, but a large proportion had secondary instability of the ankle joint, possibly due to tightening of the heel cord. Tendon transplantation had been carried out in two-thirds. The various types of this procedure are discussed, and transplantation of all toe extensors to the anterior tibialis is recommended. The muscle power in the lateral and medial muscles is of great importance to the results, and it is suggested that in a number of cases the surgery might presumably have been restricted to tendon transplantation alone.

R E S U M E

Compte rendu de l'examen complémentaire de 69 cas de pieds plats paralytiques traités par l'opération Grice. Tous ces malades avaient été atteints par l'épidémie de poliomyélite de 1952. L'opération fut pratiquée 2 à 5 ans après le stade aigu de la maladie et les malades furent réexaminés 4 à 6 ans après l'opération. Chez les deux tiers, on trouva des résultats satisfaisants, mais avec une large proportion d'instabilité secondaire de l'articulation de la cheville, peut-être due à l'épaississement des tendons du talon. Une transplantation de tendons a été pratiquée chez les deux tiers de ces malades.

Il est discuté des différents types de procédés et la transplantation

de tous les extenseurs des orteils au tibia antérieur est recommandée. La force musculaire du muscle latéral et médial est d'une grande importance pour le résultat et il est suggéré que l'on aurait pu se limiter à la seule transplantation des tendons dans un certain nombre de ces cas.

ZUSAMMENFASSUNG

Über eine Nachuntersuchung von 69 Lähmungsplattfüßen, die mittels der Operation nach Grice behandelt wurden, wird berichtet. Alle Patienten kamen von der Poliomyelitisepidemie 1952, wurden 2–5 Jahre nach Ablauf der akuten Erkrankung operiert und wurden 4–6 Jahre nach der Operation kontrolliert. Gute Ergebnisse wurden in zwei Dritteln gefunden, aber eine grosse Anzahl hatte eine sekundäre Instabilität des Knöchelgelenkes, möglicherweise wegen Anstrammung der Achillessehne. Sehnenverpflanzung wurde in zwei Dritteln vorgenommen. Die verschiedenen Arten des Vorgehens werden besprochen und die Verpflanzung aller Zehenstrecker zum m. tibialis anterior wird anbefohlen. Die Muskelkraft der lateralen und medialen Muskeln ist von grosser Wichtigkeit und man nimmt an, dass man sich in einer Anzahl von Fällen mit Sehnenverpflanzung allein hätte begnügen können.

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