SUB-TALOID EXTRA-ARTICULAR ARTHRODESIS

A REVIEW OF NEARLY A HUNDRED CASES—PRELIMINARY REPORT OF ITS USE IN PARALYTIC VARUS FEET.

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Sub-taloid extra-articular arthrodesis conceived by Green and developed by Grice (1952) and henceforth referred to in this paper as Grice's operation has been one of the most significant advances in the field of surgical correction and stabilisation of the immature feet of young children afflicted with poliomyelitis, to whom prior to the development of this operation triple arthrodesis at a much later age was offered. It is an operation of wide scope and potentiality and one which has come to stay. It is particularly suited to the young children of our regions, where before surgical treatment the fitting of braces is a task well nigh impossible due to inadequate health education, poor economy, varied social customs and difficulty in obtaining orthopaedic appliances.

In this paper is presented certain observations regarding the scope, complications and problems of this operation on the basis of the reports in the surgical literature and our own series of 104 operations in 96 patients. Apart from this the scope of Grice's operation combined with osteotomy of the calcaneus in the surgical treatment of paralytic varus feet of young children is presented as a preliminary report on the basis of the follow-up of a short series of 8 cases.

AGE GROUP

Table 1, shows the age group of the patients on whom Grice's operation was carried out. It is to be noticed that in 8 cases the operation was performed in the age group 10 – 13 years. Some of these cases were suitable for the conventional triple arthrodesis, viz., those with pure valgus feet without any secondary deformities. The operation was given a trial in these cases, and 4 to 5 year follow-up showed excellent results. Table 2 shows the types of deformities and the number of cases in each type.

TABLE 1

Age Group 3½ to 13 years.

Age	3½ to 5 years	5 to 7 years	7 to 10 years	10 to 13 years
No.	25	29	32	8

There were two traumatic Valgus cases ages 16 and 35 years.

TABLE 2

Type of deformity		Number of cases
Paralytic Valgus 56 cases		
Calcaneo-valgus		18
Equino-valgus		30
Plain valgus		8
Paralytic Varus 21 cases		
Cavo-varus		8
Eqinocavo-varus		7
Plain varus		6
Flail or Partially Flail		20
Congenital Flat Feet		2
Failure of previous Tendon Transfers		2
Painful Feet after Fracture of Calcaneum		2
	Total	103

THE PARALYTIC VALGUS FOOT

The essential pathology in this condition is the total or partial weakness of the Tibialis Anterior or the Posterior or both. There is an unequal pull of the Peronei, helped perhaps by the Extensors of the toes and the Peroneus tertius. As the result of this muscle imbalance the heel is everted. Since the os calcis is everted, its anterior portion is displaced laterally and posteriorly. There is loss of normal support beneath the head of the talus which drops into equinus and projects further anteriorly. With continued weight bearing the ligamentous supports on the medial side of the talus give way and it assumes a more equinus position. In order to accomplish take-off, the foot has to be rotated out so as to permit the great toe of the pronated foot to touch the ground. The forefoot thus becomes abducted. There-after contracture of the tendo-achilles and secondary adaptive changes take place in the joints.

In the surgical treatment of this condition:—

1. The calcaneus needs to be replaced beneath the talus and maintained there.
2. The talus has to be brought out of the equinus.
3. The muscle balance must be restored by appropriate tendon transfers and the everting force of the Peronei be abolished.
4. The operation must be done early before secondary adaptive changes take place and the deformities get fixed.
5. The height of the foot should be restored.

Apart from the factor of muscle transfer, Grice's operation done early does all this and more. It produces a more normal looking foot than a triple arthrodesis and it does not interfere with growth. Being an extra-articular operation it does not damage the endochondral plate which underlies the articular cartilage in children.

Figure 1, is an example of a case whose X-ray shows that the graft is fully incorporated after 5 years. Figure 2 is the picture of the same case showing good correction after appropriate tendon transfer

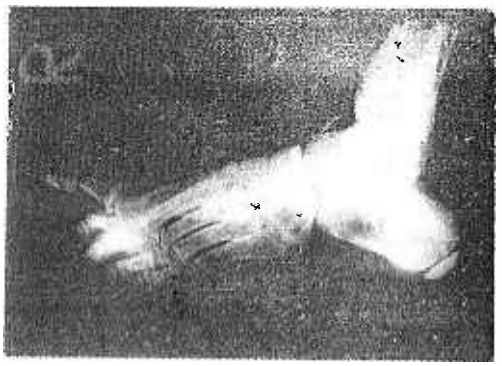

Fig. 1. X-ray of a paralytic valgus foot to show incorporation of the graft five years after Grice's operation.

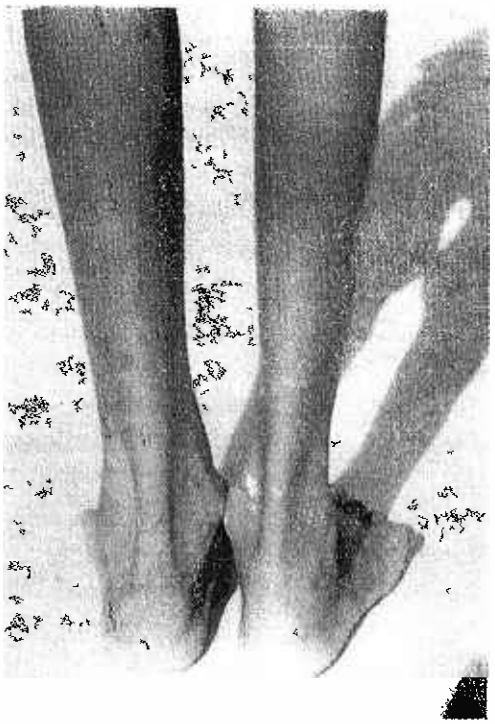

Fig. 2. Clinical photograph of the patient whose X-ray of the right foot was seen in Fig. 1. There is good correction of the deformity after Grice's operation and transfer of the peroneous longus tendon.

In paralytic equino-valgus there is a tightening of the heel cord which needs to be corrected along with the arthrodesis. We have routinely lengthened the tendo-achilles when doing the Grice's operation. We consider the wedge plaster correction as time consuming, uncertain in its results and likely to give a higher recurrence rate.

PARALYTIC CALCANEO-VALGUS

In paralytic calcaneo-valgus in addition to the basic pathology of the valgus foot there

are the superadded deformities which result from the paralysis or weakness of the Gastrosoleus group. The patient cannot stabilise his calcaneus which rotates inferiorly when he attempts to bear weight on walking, and further cavus of the foot develops due to the contracture of the muscles and fasciae on the plantar surface. He becomes a heel walker. The take-off is not possible, with the result that the foot is rotated strongly outwards, pressing the big toe firmly to the ground and flexing the knee. In severe cases there is considerable external tibial tortion and genu valgun. By performing Grice's operation early the valgus of the foot is corrected and further undesireable deformities are prevented and the foot is aligned. This is followed by adequate tendon transfers to the os calcis through the tendo-achilles.

Rotation osteotomy after the technique of O'Donoghue (1940) has been done on two occasions in severe tibial torsion with satisfactory results.

Figure 3 shows good incorporation of the graft after a follow-up of 5 years, and figure 4 shows the picture of the same patient rising on the toes after Grice's operation and transfer of the Tibialis Anterior and the long and the short Peronei to the os calcis through the tendo-achilles. This is a representative result in calcaneo-valgus.

Fig. 3. X-ray of a paralytic calcaneo-valgus foot showing good incorporation of the graft five years after operation.

FLAIL OR PARTIALLY FLAIL FOOT

In these cases the role of Grice's operation is naturally limited. However, it gives a better aligned and a more stable foot and prevents further deformities.

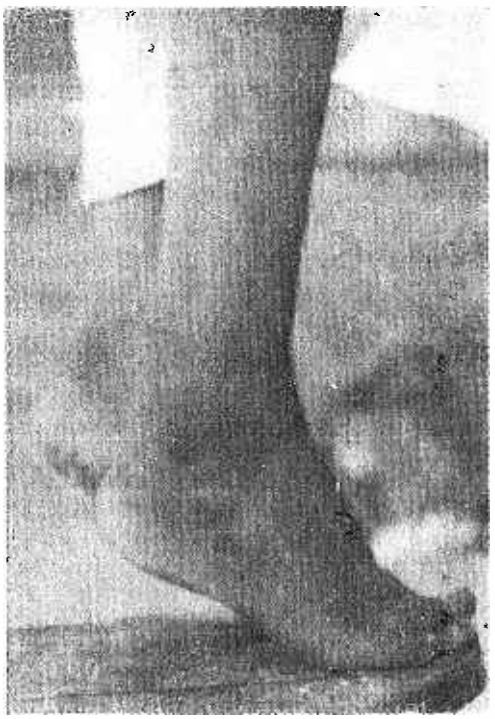

Fig. 4. Clinical photograph of the patient whose X-ray of the right foot was seen in Fig. 3. There is good plantar flexion after Grice's operation and transfer of the tibialis anterior and peronei into the tendo-achillis.

PARALYTIC VARUS FOOT

This is the most disabling deformity that follows poliomyelitis. The role of Grice's operation in the management of the valgus foot has now been well established. In the varus foot on the other hand there seems to be a general feeling that this operation has nothing to commend it, because, although the subtaloid joint may be fused, it does not correct the deformity.

In our earlier attempts to correct the paralytic varus foot we carried out Grice's operation alone or followed it with the transfer of either the Tibialis Posterior to the mid-line on the dorsum of the foot through the interosseous membrane or of the Tibialis Anterior to the cuboid. This

1. took away the deforming forces of the Tibialis Posterior and/or of the Tibialis Anterior,
2. gave a fused stable sub-taloid joint, and
3. resulted in good dorsiflexion or its supplementation when poor.

The immediate results of Grice's operation seemed to be fairly satisfactory, but on weight

bearing there was a tendency for the heel to go into inversion and with it the forefoot into adduction and supination. In some of the other cases in which Grice's operation was combined with transfer of appropriate tendons, the heel did not remain corrected for long. After a time the forefoot started to relapse into supination and adduction. The main deforming element in paralytic feet was the varus of the heel. As pointed out by Dwyer (1959) if this could be corrected the forefoot deformity would correct itself on continued weight bearing. He developed Calcaneal osteotomy for Pes Cavus, in the paralytic variety of which the varus of the heel ultimately became a constituent part of the deformity. In those cases in which the paralytic varus was associated with a contracted tendo-achilles, the equinus was mostly confined to the forefoot. Here again continued weight bearing on the outer side of the foot increased the varus of the heel.

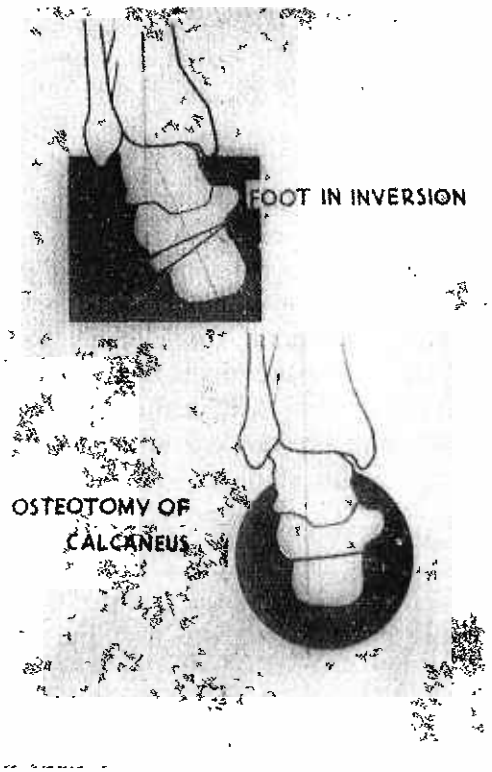

Fig. 5.
Upper: Heel in inversion and a wedge has been marked out for removal. **Lower:** Heel in neutral after the closing in of the space following removal of the wedge.

With this background of the problem, we started two years ago combining Grice's operation with osteotomy of the calcaneus. The technique of the osteotomy was as described by Dwyer (1959). Figure 5 (upper) shows a schematic representation of a heel in inversion with a wedge having been marked out for removal from the outer side of the calcaneus. The lower sketch represents a neutral heel after the closing in of the space following removal of the wedge. Osteotomy of the heel shifts it into a neutral or even slightly valgus position. Weight bearing is then allowed to produce correction of the forefoot and the foot thus becomes plantigrade.

Even after a calcaneal osteotomy alone, Dwyer (1959) has reported several cases in which recurrence of the heel varus has occurred in pes cavus, particularly in the paralytic types. This in our opinion has been due to:—

1. failure to correct the varus fully,
2. failure to stabilise the sub-taloid joint by arthrodesis, and
3. failure to correct the deforming forces which produce the varus of the heel, namely an overactive Tibialis Posterior or Anterior in the presence of paralytic Peronei.

Table 3 shows the various types of muscle transfers done to balance the feet in our cases. In the paralytic varus there were 15 cases of Tibialis posterior and 2 cases of Tibialis anterior transfers. The further break-up of the 15 cases of Tibialis Posterior transfers is shown in Table 4. There were seven cases in which we combined Grice's operation with transfer of the Tibialis Posterior to the dorsum through the interosseous membrane.

In all these the varus deformity recurred after a varying period in spite of effective muscle re-education and support in the post operative period with proper shoes. In one of our earlier reports (Kathju 1961), we had mentioned division of the tendon of the overactive Tibialis Posterior in order to prevent recurrence of the deformity. Pollock and Carrell (1964) reported only transient improvement after sectioning the Tibialis Posterior tendon in a number of cases. Even though the heel remains corrected for some time, the forefoot is not corrected. The uncorrected forefoot tends to reproduce the heel varus at the sub-taloid joint.

TABLE 3

Muscle transfers to balance the feet in our cases.

Type of Deformity	Type of Muscle transfers	No. of cases
Paralytic Varus		
	Tibialis Anterior	2
	Tibialis Posterior	15
	Tendo Achilles Lengthening	6
Paralytic Valgus		
	Tendo Achilles Lengthening	22
	Tendo Achilles Lengthening plus Posterior Capsulotomy	8

TABLE 4

Operations done for Varus Feet.

1. Calcaneal Osteotomy plus Grice's operation plus Tibialis Posterior Transfer to the Dorsum of the foot 8 cases
2. Grice's operation plus transfer of Tibialis Posterior to the Dorsum of the Foot 7 cases
3. Grice's operation alone ... ... 4 cases
4. Grice's operation plus transfer of Tibialis Anterior to the Cuboid ... ... 2 cases

Figure 6 shows a schematic representation of the heel going into varus in spite of the deforming muscle forces having been taken away, and in spite of a calcaneal osteotomy to correct the heel varus. This could be eliminated if we fused the sub-taloid joint by Grice's technique, as represented by the lower drawing in Figure 6.

Therefore, it is our opinion that if the talus and the calcaneus are fused by Grice's technique and then an osteotomy of the calcaneus is carried out, we form a single talo-calcaneus bone in a neutral position in the ankle mortice. If this is followed with appropriate tendon transfers to restore muscle balance, then the chances of recurrence would be minimised. With this physiological basis we have planned this combination in eight cases in our series (Table 4). The follow-ups vary from 6 months to 2 years. The results in all our eight cases have been uniformly good without any recurrence. The series is too small and therefore it is presented as a preliminary report deserving further trail.

Figures 7 and 8 show representative X-rays of a case in which calcaneal osteotomy has been done.

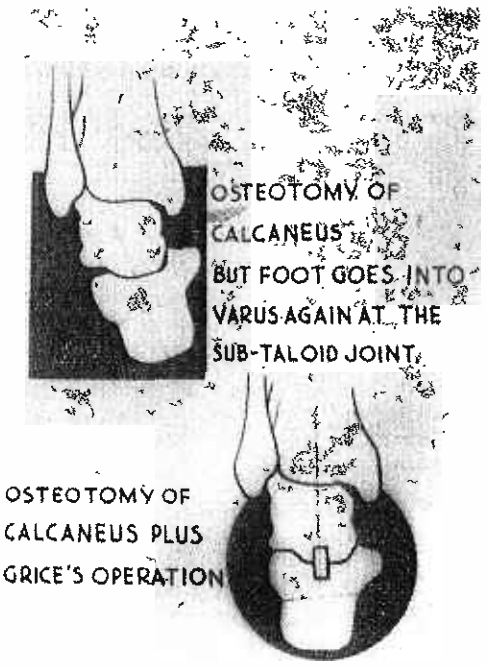

Fig. 6.
Upper: Heel going into varus again in spite of the deforming muscle forces having been taken away, and in spite of Calcaneal osteotomy to correct the heel varus.
Lower: Calcaneal osteotomy plus Grice's operation would give a neutral heel and a stable foot with minimal chances of a recurrence.

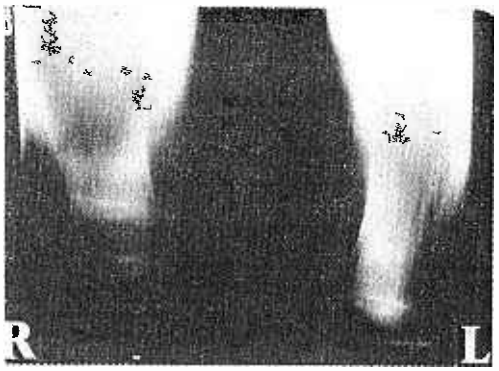

Fig. 7.

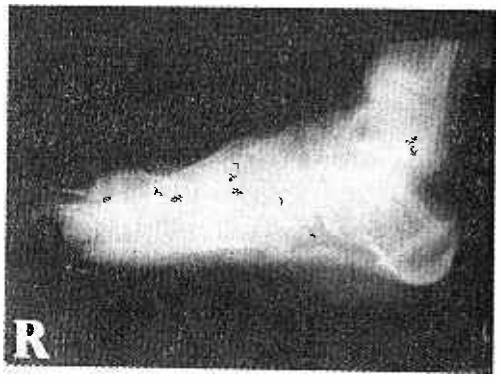

Fig. 8.

Figs. 7 & 8. X-rays of a case in which a Calcaneal osteotomy has been done on the right side (A.P. and Lat. views).

Fig. 9. Photograph to show correction of a paralytic varus foot (right) by a combination of Grice's operation, Calcaneal osteotomy and transfer of the tibialis posterior through the interosseus membrane to the dorsum of the foot.

Figure 9 is a picture of a case of paralytic varus foot corrected by a combination of Grice's operation, Calcaneal osteotomy and transfer of the Tibialis Posterior tendon to the dorsum of the foot through the interosseous membrane.

COMPLICATIONS AFTER GRICE'S OPERATION

1. Over correction of the valgus deformity.

This occurred in 4 of our cases. In only one did we think the reverse deformity to be incapacitating enough to warrant a revision operation. We have made our assessment on clinical judgement only and not on routine post-operative X-rays. Unlike Grice, we keep the graft ends pointed, so that we can manipulate the foot into neutral position before a final plaster cast is applied after two weeks.

2. Absorption of the Graft.

This occurred in 15 of our cases, which we consider a high figure although McMurray (1962) stated that in his experience 50% of the grafts absorbed within five years. The

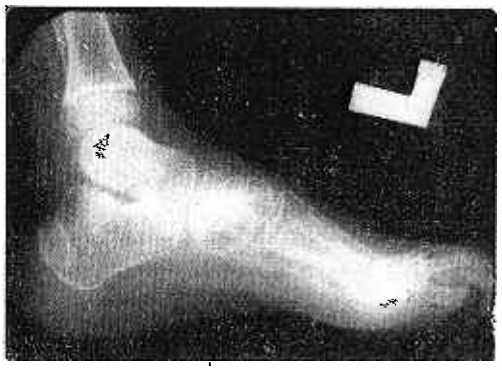

Fig. 10. To show absorption of the graft following Grice's operation.

Fig. 11. The graft has not taken and is being cast off.

graft was placed in a faulty position in six cases. In another six cases the children came walking on broken plaster casts before sound fusion could be expected. In the other three no obvious cause could be held responsible. Figures 10 and 11 show two examples in which the graft has not taken.

3. Late development of varus deformity.

This has occurred in 13 out of the total of 21 cases of paralytic varus in our series. In the last eight cases in which we did the combined Grice's operation with Calcaneal osteotomy and muscle transfers we had no delayed recurrence in a two year follow-up.

We had eight cases of delayed varus deformity in 56 operations for valgus feet. We did revision operations in 4 cases, and Calcaneal osteotomy in one case. The rest of the three cases did not turn up for further treatment.

We agree with Pollock and Carrell (1964) that this delayed varus deformity is not due to sub-taloid extra-articular arthrodesis. These authors suggest that the simultaneous transfer of both the peronei to the midline in front may be responsible for such cases and recommend the transfer of only one of the peronei, preferrably the brevis.

CERTAIN PARTLY SOLVED PROBLEMS

Answers to some of these problems would be forthcoming as longer follow-ups result in more experience and the filling up of some of the lacunae in our knowledge. These have been dealt with by various authors and are reviewed below.

1. Degenerative changes.

Such changes do not occur in the sub-taloid and calcaneo-cuboid joints, because the sub-taloid joint is not resected, the normal alignment of the foot is restored as also is the muscle balance.

2. Predisposition to Peroneal muscle spasm.

In Grice's operation we are producing a talo-calcaneal fusion after restoring the foot to normal alignment. If the fusion occurs with the foot still in valgus, there may be peroneal spasm but not otherwise.

3. Would a triple arthrodesis be needed.

Longer follow-ups would be needed before a final answer is forthcoming. Of the nineteen cases in our series which we followed up over the last five years on to maturity we have not noticed any loss of function or return of deformity. Fusion of the talus and the calcaneous in correct alignment is we believe a prerequisite to a lasting good result.

4. How early to operate.

The dictum is to operate early.

The earliest in our series has been 3½ years, but it has been difficult to carry out subsequent tendon transfers at earlier ages due to poor osseous development of the tarsus. It is also a problem to give these children proper instructions in muscle re-education. Out of a total of 18 tendon revision operations necessary in our series, sixteen were in the age group of under 5 years.

5. Cases with fixed deformities.

In long standing cases with fixed valgus deformity it may be difficult to restore the calcaneus under the talus. In some such cases we were helped by carrying out extensive capsulotomies of the talo-calcaneal, talo-navicular and the calcaneo-cuboid joints.

6. Late Osteo-arthritis and instability of the ankle.

It is well-known that in spite of an unstable ankle joint the association of poliomyelitis and osteo-arthritis is not the rule. It may be due, as observed by many, that muscular forces apart from abnormal weight bearing are essentially responsible for the causation of osteo-arthritis. With the fusion of the sub-taloid, joint, if it is possible to achieve muscle balance, delayed osteo-arthritis is unlikely.

Robins (1959) has pointed out that after triple fusion there was a striking absence of late osteo-arthritis of the ankle. Depending, also on the achievement of muscle balance, gross ankle instability is not the rule.

CONCLUSIONS AND SUMMARY

In this series, 104 sub-taloid extra-articular arthrodeses done from March 1959 to March 1964 have been analysed. The operation has been done on children from three and a half years to thirteen years, except two cases of traumatic valgus feet whose ages were sixteen and thirty-five years. The operation produced painless feet in both the traumatic cases. In the older age group in our cases, that is, roundabout 12 years the results were excellent. We are putting forward a plea for the use of Calcaneal osteotomy in combination with Grice's operation and subsequent transfer of the Tibialis Posterior to the dorsum in the correction and stabilisation of the varus foot in young children. In submitting a preliminary report on eight cases the results clinically and radiologically have been encouraging. The physiological basis of this suggested combination has been discussed.

The three complications met with in our cases, namely over-correction of the valgus deformity, absorption of the bone graft and development of late varus deformity have been mentioned, giving the figures, and the reasons for and the method of avoiding them have been briefly discussed. Finally certain difficulties and problems met with in the follow-up studies of our cases and those published in the literature are briefly mentioned and discussed.

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