

Department of Diagnostic Radiology and Orthopaedic Surgery, University Hospital,
Uppsala, Sweden.

THE RESULTS OF EXTRA-ARTICULAR SUBTALAR ARTHRODESIS ACCORDING TO THE GREEN-GRICE METHOD IN CEREBRAL PALSY

A. ENGSTRÖM, U. ERIKSON & Å. HJELMSTEDT

Accepted 5.viii.74

Foot deformities reduce the possibility of proper gait training in children with cerebral palsy, and therefore early correction of these deformities is advisable. Unfortunately many cases are first seen by the orthopaedic surgeon when the deformity is pronounced as was the case in many patients in the present material.

Green & Grice presented in 1950, in a preliminary report, their method of extra-articular subtalar arthrodesis for cases of paralytic flat foot. Later the method was also tried for correction of valgus deformity in cerebral palsy often in conjunction with lengthening of the Achilles tendon to correct the concomitant equinus deformity. Malvarez (1957), Baker & Dodelin (1958), Picard & Mimran (1961), Stagnara & Desbrosses (1961), Baker & Hill (1964), Chigot & Sananes (1965), Kenig (1966) and many others have achieved relatively good results with this method in cerebral palsy, but have also shown that recurrences and complications are not uncommon. Keats (1970), however, demonstrated excellent results in a large series.

This method has been in use at the University Hospital of Uppsala, but since the results have not been fully satisfactory, it is of interest to analyse the causes of the failures.

MATERIAL

The present series reviews 27 feet operated upon on 16 children with cerebral palsy. The age at operation varied between 3 and 12 years with an average of 6 years 10 months. Eight cases had neurological di- or hemiplegia without hypotonia, and

four had slight to moderate hypotonia, one child had a post-traumatic spastic tetraplegia and the remaining three had a complex neurological status with spastic paresis in the lower extremities. The main indication for operation was the dominant valgus deformity often in combination with a concomitant equinus deformity, resulting in balance and gait difficulties. In many cases an abduction deformity of the forefoot was also present.

METHODS

Subtalar arthrodesis was performed according to the method described by Grice in 1952, and for the present series the operations were performed by seven different surgeons. In 21 operations an autologous tibial bone graft was used, in three of these combined with a heterologous, de-fatted and de-proteinized transplant (Kieler Knochen). In six operations only heterologous transplants were used. Lengthening of the Achilles tendon had either been performed previously or was done during the same procedure in 19 cases. The period of postoperative plaster fixation was about 12 weeks.

The present review was undertaken 1 to 8 years after operation, the average being 3 years and 3 months. In the survey the following factors were noted in particular—the clinical stability at the arthrodesis, the movement in the ankle joint and the function of the foot during weightbearing.

Radiological examination of the feet with and without weightbearing was also made in order to evaluate the healing at the arthrodesis, the position of the talus relative to the tibia, fibula and calcaneus and finally the stability of the foot in weightbearing. Besides antero-posterior and lateral projections, oblique projections were used to visualize the tarsal sinus for study of the consolidation of the bone transplant. If in doubt tomograms were performed.

RESULTS

Radiologic results

The arthrodesis was established in 18 of the 27 feet in the study. Of the nine cases of non-union one had healed primarily but the transplant fractured later (Figure 1) and the reoperation was unsuccessful. In two cases the transplant united only to the talus or the calcaneus, and as the transplant remained intact the functional result was that of an arthrorisis. In the remaining six cases we found that no union had occurred and that the transplant was either fully or partially absorbed. In two of these six cases heterologous transplants had been used as also in the two cases above which developed arthrorisis.

All the cases with non-union were in the age range of 3–7 years at operation.

Figure 1. Lateral projection of the subtalar joint. The bone transplant is fractured and the talus has slipped forward and is in an abnormal rather vertical position.



Table 1. Comparison between clinical and roentgenological findings.

Clinical findings	Roentgenological findings		
	Union	Arthrorisis	Non-union (Graft resorbed)
Fully corrected and with subtalar stability	11	1	—
Corrected equinus or valgus but residual abduction < 15°. Subtalar stability	3	1	—
Corrected equinus, valgus insignificant or none at all. Abduction > 15°. Subtalar stability	2	—	—
No equinus or valgus. Abduction > 15° without weightbearing. Subtalar stability	2	—	—
Subtalar instability	—	—	6
Insignificant varus. No other deformity. Subtalar mobility. Improved gait	—	—	1
Total	18	2	7

Clinical results (Table 1)

- 1) Subtalar stability and full correction of the deformity in 12 of the operated feet.
- 2) Subtalar stability and full correction of the valgus and equinus deformity but a residual abduction deformity of the forefoot of 15° maximum in four of the operated feet.
- 3) Subtalar stability, none or insignificant valgus or equinus deformity of the foot but a residual abduction deformity of the forefoot of more than 15° in two operated feet.
- 4) Subtalar stability and residual abduction in two feet of a patient with a post-traumatic spasticity and tetraplegia whose condition had progressed to a stage not allowing weight-bearing.
- 5) Subtalar mobility and recurrence of the deformity in six cases.
- 6) Subtalar mobility, insignificant varus in weightbearing and despite non-union a functional improvement in one case.

Summarizing, the clinical assessment showed full or satisfactory correction in 16 cases, recurrence in six, and unsatisfactory results consisting mainly of residual abduction of the forefoot in two. Finally in two cases the results were functionally indeterminable and in one case there was functional improvement despite non-union of the arthrodesis.

DISCUSSION

The reasons for unsatisfactory results, as mentioned in the literature, are non-union of the arthrodesis, over- or undercorrection of the valgus deformity, residual abduction deformity of the forefoot as sequelae to hypermobility or dysplasia of the bones and the small joints in the forefoot, and incomplete correction of the muscular imbalance.

The best results have been reported by Keats (1970) in whose series with 112 cerebral palsy cases not a single case of non-union was reported. Lahdenranta & Pylkkänen (1972) reported non-union in approx. 10 per cent of cases with valgus deformity and approx. 3.5 per cent with varus deformity in a material composed mainly of paralytic foot deformities. Zachariae (1963) reported non-union in 25 per cent in a series with paralytic flat feet, and Kenig (1966) reported a 27 per cent recurrence in cases of spastic deformities. In our present series union could be demonstrated in only 18 of 27 arthrodesis operations.

There is no doubt that non-union is often due to faulty technique.

Keats (1970) and Baumann (1970) point out that "the key to success" is that the head of the talus is properly supported by the sustentaculum.

Reposition can be facilitated by incising the capsule and ligaments of the talo-navicular joint, and stabilization can be improved by a screw, Kirschner wire (Grice 1959) or staples. Judging from the early post-operative radiographs incomplete reposition does not seem to be the cause of non-union in our series.

A suitable length of bone transplant and correct insertion is a necessary prerequisite to union, otherwise a dislocation of the bone graft may occur, as in one of our cases. The operations in our study had been performed by seven different surgeons. This can hardly be considered satisfactory. The preoperative assessment and the operation of neuro-orthopaedic cases ought to be performed by an experienced surgeon specializing in this field.

Chigot & Sananes (1965) have pointed out that autologous tibia grafts often do not have the stability to withstand the forces generated by the peroneal muscles in spastic flatfeet. According to their report the use of fibula grafts gave significantly better results than tibia grafts. Keats (1970) has used mainly homologous grafts and his success may depend on the better stability of such grafts.

Fracture of the graft has been previously reported not only in cases of extra-articular arthrodesis according to Grice but also in cases treated by Batchelor's method (Brown 1968, Seymor & Evans 1968). Internal fixation with a screw or staples could provide a suitable preventive measure. In our series heterologous bone grafts were used in six cases. In two of these the consolidation was proportionately delayed, in two cases we found pseudarthrosis 3.5 and 4 years after operation, with the final result an arthrorisis instead of an arthrodesis. In the remaining two cases the bone grafts were almost completely resorbed. Thus heterologous bone grafts are not suitable for these operations.

In the cases with good union of the arthrodesis we found no over-correction of the preoperative valgus deformity, neither undercorrection, but correction of the preoperative abduction deformity of the forefoot has not always occurred. In five feet the abduction deformity was corrected, in another five feet the abduction deformity had decreased substantially to less than 15° , and in four feet the residual abduction deformity remained between $15-30^\circ$ giving unsatisfactory weightbearing and some instability of the foot.

Thus to some degree, specially in younger children, one can achieve satisfactory correction of the abduction deformity by correcting the

valgus deformity, but in older children with more pronounced pre-operative abduction deformity a triple arthrodesis seems to be a better alternative as already pointed out by Grice in 1959. An analysis of the abduction deformity including radiological examination ought to be undertaken before the operative procedure is decided upon.

The analysis of our unsuccessful cases shows that the major cause was non-union. This was related to the fact that heterologous grafts were unsuitable for these operations and that autologous tibia grafts in the younger children lacked the required strength. In the future we intend to use a fibula graft, and also to use internal fixation—either screw or staple—to ensure a proper fixation and to minimize the risk of fracture of the graft. Only experienced surgeons will be allowed to handle the neuro-orthopaedic cases. When healing occurs this method gives good or satisfactory clinical results. As it ought to be possible to improve the frequency of healing taking into account the suggestions given above, we will keep to the extra-articular subtalar arthrodesis in carefully selected cases. However, in cases with a more pronounced abduction deformity other methods ought to be applied; alternatively complementary surgical corrections performed.

CONCLUSIONS

The main reason for our failures was non-union. This seems to have been caused mainly by the use of heterologous or osteoporotic autologous grafts and less by faults in the operative technique. Better autologous grafts, e.g. fibula, ought to give a higher frequency of union. Complementary internal fixation with a screw or staples may be needed. If valgus deformity is combined with severe abduction deformity of the forefoot satisfactory correction is not always possible with extra-articular arthrodesis. Thus complementary surgical correction of abduction deformity may be necessary. Alternatively a triple arthrodesis can be used.

SUMMARY

Results from 27 extra-articular subtalar arthrodeses in 16 children with spastic planovalgus or equinovalgus foot deformities are presented. The clinical results are good in cases where union has occurred, except in cases with a pronounced preoperative abduction deformity. The main cause of failure is non-union. The clinical results and the frequency of union ought to be greatly improved by the use of more

suitable bone grafts and internal fixation, and by careful selection of the patients.

REFERENCES

- Baker, L. D. & Dodelin, R. A. (1958) Extra-articular arthrodesis of the subtalar joint (Grice procedure). Results in 17 patients with cerebral palsy. *J. Amer. med. Ass.* **168**, 1005-1008.
- Baker, L. D. & Hill, L. M. (1964) Foot alignment in the cerebral palsy patient. *J. Bone Jt Surg.* **46-A**, 1-15.
- Baumann, J. U. (1970) *Operative Behandlung der infantilen Zerebralpareesen*, p.p. 28-29, Georg Thieme, Stuttgart.
- Brown, A. (1968) A simple method of fusion of the subtalar joint in children. *J. Bone Jt Surg.* **50-B**, 369-371.
- Chigot, P. L. & Sananes, P. (1965) Arthrodèse de Grice. Indications nouvelles et variante technique. *Rev. Chir. orthop.* **51**, 53-65.
- Green, W. T. & Grice, D. S. (1953) The surgical correction of the paralytic foot. In: *Instructional course lectures, American Academy of Orthopaedic Surgeons*, vol. 10, pp. 343-363. J. W. Edwards, Ann Arbor.
- Grice, D. S. (1952) An extra-articular arthrodesis of the subastragalar joint for correction of paralytic flat feet in children. *J. Bone Jt Surg.* **34-A**, 927-940.
- Grice, D. S. (1959) The role of subtalar fusion in treatment of valgus deformities of the feet. *Instructional course lectures. The American Academy of Orthopaedic Surgeons*, vol. 16, p. 127-150. C. V. Mosby Co., St. Louis.
- Keats, S. (1970) *Operative orthopaedics in cerebral palsy*, pp. 205-218, Charles C Thomas, Springfield, Illinois.
- Kenig, I. (1966) Traitement chirurgical du pied spastique. *Xe Congrès International de Chirurgie Orthopedique*, p. 1163-1167.
- Lahdenranta, U. & Pyllkänen, P. (1972) Subtalar extra-articular fusion in the treatment of valgus and varus deformities in children. *Acta orthop. scand.* **43**, 438-460.
- Malvarez, O. (1957) Arthrodesis subastragalina en el pie valgo pronado paralítico. Artrodesis minima. Estudio de 87 casos. *Rev. Ortop. Traum. (B. Aires)* **2**, 251-259.
- Picard, J. J. & Mimran, R. (1961) Opération de Grice. *Rev. Chir. orthop.* **47**, 590-597.
- Seymour, N. & Evans, D. K. (1968) A modification of the Grice subtalar arthrodesis. *J. Bone Jt Surg.* **50-B**, 372-375.
- Stagnara, P. & Desbrosses, J. (1961) Arthrodèse sous-astragalienne pur le traitement des pieds plats valgus paralytiques (flasques ou spastiques). Procédé de Grice. *Rev. Chir. orthop.* **47**, 641-653.
- Zachariae, L. (1963) The Grice operation for paralytic flat feet in children. *Acta orthop. scand.* **33**, 80-90.

Correspondence to:

Ake Hjelmstedt, M.D. or Axel Engström, M.D.
 Department of Orthopaedic Surgery
 University Hospital
 S-750 14 Uppsala
 Sweden