RELAPSED CLUB FOOT

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“ The literature on the treatment of club feet is, as a general rule, that of unvarying success. It is often as brilliant as an advertising sheet and yet in practice there is no lack of half-cured or relapsed cases, sufficient evidence that methods of cure are not universally understood.”—E. H. Bradford at a meeting of the American Orthopaedic Association in 1889.

Congenital club foot is a variable three-dimensional deformity of a complex system of joints. Secondary and adaptive structural changes involving skeletal and soft tissues are already well established at birth and radiography is unhelpful in the first year of life. Our understanding of the subject is still incomplete, and when one reflects that it has to be based on dissections of rare post-mortem specimens, on radiological appearances in older children and on what can be seen through limited surgical incisions, it is not surprising that the literature is confusing and that inadequate observations gleaned from inadequate sources have led different observers to widely differing conclusions. After reading some of the literature one can only murmur with Sir Robert Jones when he was trying to summarise a vigorous discussion of the subject: “ it only goes to show how many-sided the question is.” It even seems probable that when, in the course of time, our knowledge does become complete we shall find that there is more than one explanation for congenital equino-varus and that “ club foot ” is a generic term covering several pathological entities.

This paper is not primarily concerned with the morbid anatomy of club foot. Its main purpose is to describe an operation which yields an adequate and stable correction of relapsed club feet. Experience of the operation suggests that it may have some theoretical as well as practical significance, for it is based on assumptions which appear to be justified by the results. The assumptions are that the essential deformity in club foot is in the mid-tarsal joint; that the other elements of the deformity, including varus deformity of the heel, are secondary and adaptive; and that full correction of the primary deformity combined with adequate release of all contracted soft tissues will yield a reasonably normal foot. The operation is simple and effective; in essence it merely adds wedge-resection of the calcaneocuboid joint to the already familiar procedure of medial and posterior release of contracted soft tissues. It appears to me to be a logical procedure, but before trying to establish the logic it is necessary to review the development of the hypothesis that the primary deformity is in the mid-tarsal joint—a hypothesis which is widely but by no means universally accepted.

PATHOLOGICAL ANATOMY

In 1803 Scarpa (Wishart 1818) pointed out that the deformity is essentially a dislocation of the tarsus on the talus and that “ in infants . . . obliquity of the body of the astragalus is very trifling when compared with the other bones of the foot,” and he predicted, correctly, that “ descriptions of bones of the tarsus in congenital club foot will always differ from one another according to the degree of the deformity and the ages from which the descriptions are taken.” In 1866 Adams, in a Jacksonian Prize Essay, noted that exposed parts of the articular surfaces of the talus which remain unengaged by the ankle and navicular bone were nevertheless covered by cartilage.

Thus Scarpa and Adams were clearly of the opinion that the talus was not at fault in this deformity, and although this view has since been repeatedly challenged, no reliable evidence has been produced to refute it. Elmslie, writing in 1920, accepted this view and went on to

say that the deformity was essentially one of the mid-tarsal joint. It was "a displacement of the navicular and cuboid inwards at the mid-tarsal joint with rotation of the os calcis which brings its anterior extremity downwards and inwards." He then added: "this position of the os calcis is simply an exaggeration of that which the bone assumes when the foot is plantar-flexed and inverted; the cuboid is subluxated inwards on the os calcis, the facet for articulation with it lies to the inner side of the anterior extremity of the os calcis . . . thus the anterior extremity of the os calcis becomes conical in shape." Ten years later Brockman (1930) came to the conclusion that the core of the deformity was the medial dislocation of the navicular on the talus—"a congenital subluxation of the head of the talus out of its socket, owing to a congenital atresia of the socket"—and that all other changes in the foot were adaptive.

These views are not universally accepted, but though there is some reason to doubt whether they describe and adequately explain all cases of congenital club foot, they do appear to describe satisfactorily most cases and to provide something on which a rational treatment can be based. They imply that the essential lesion in a club foot is a congenital dislocation of the navicular bone on the talus, that this bone carries with it the cuboid bone and the calcaneum, that changes of shape in the skeletal and soft tissues are secondary and adaptive, and that the essential element in manipulative reduction must be the replacement of the navicular bone on the end of the talus, so restoring the medial column of the foot. The operation for relapsed club foot which is described in this paper is based on these inferences and the effect of the operation appears to be evidence of their validity.

If we assume, therefore, for the purpose of this argument that the primary deformity is a subluxation of the talo-navicular joint and that the aim of treatment must be the reduction of this displacement, it becomes necessary to consider the part played by the secondary adaptive skeletal changes in maintaining this deformity and resisting its correction. The resistance encountered when a club foot is manipulated is essentially the resistance offered by any joint which has been dislocated for a long time—the resistance of contracted soft tissues and possibly of joint surfaces which are no longer congruous. But there is also in the lateral column of the foot a second line of resistance resulting partly from overgrowth in length of this lateral column and partly from the shape of the calcaneo-cuboid joint. The lateral column of the foot is not only longer than the medial column, being the arc of a bigger circle, but the shape of the calcaneo-cuboid joint offers its own resistance. Elmslie described the anterior end of the calcaneum as being "conical"; I cannot confirm this, but the anterior articular surface of the bone seems to face forwards and medially and not just forwards as in the normal. This adaptive change in the lateral column may not be very marked at birth, but it becomes a more important factor as the child grows older with the talo-navicular dislocation remaining unreduced, and it explains why the operation of medial release of soft tissues does not always result in a stable reduction of the deformity.

PRINCIPLES OF TREATMENT

The obstructive part played by the calcaneum and cuboid bone has long been suspected, and several attempts have been made to overcome it by shortening the lateral column. Ogston in 1902 enunciated "a new principle of curing club foot in severe cases in children a few years old." He advocated enucleation of the cuboid bone, of the anterior part of the calcaneum and of the head of the talus, but his method could not succeed because he ignored a first principle in the treatment of club foot—that the medial column of the foot must be restored and not weakened. More recently Johanning (1958) has revived the idea of enucleating the cuboid bone alone; it is clear, however, from his insistence on the importance of after-treatment and his admission that other operative procedures sometimes became necessary later, that although this may have helped to correct the deformity the correction remained unstable. Other methods have included wedge-resection of the cuboid bone, of the calcaneum,

of the mid-tarsal joint and of the tarsus as a whole, but all have failed to produce a correction of deformity which remained stable throughout the period of growth.

Clearly it is not enough merely to shorten the lateral column of the foot. It is also necessary to overcome the resistance offered by the obliquity of the calcaneo-cuboid joint and at the same time to facilitate reduction of the talo-navicular dislocation. This can be achieved only by wedge excision of the calcaneo-cuboid joint combined with release of the contracted tissues on the medial side of the foot to allow lateral shift and lateral rotation of the navicular bone. It has been found in practice that the operation does not always result in proper reduction of the talo-navicular dislocation, but it produces sufficient lateral rotation of the navicular bone to bring the first metatarsal bone into line with the talus, and the fused and shortened calcaneo-cuboid bone serves to hold it in this position (Figs. 1 and 2).

FIG. 1

FIG. 2

These sketches illustrate some of the effects of the operation on the skeleton. In some cases, especially in younger children, an accurate reduction of the talo-navicular dislocation is possible; in others, as in this sketch, the medial displacement of the navicular bone persists but sufficient lateral rotation of the bone is obtained to bring about a realignment of the tarsus.

The real test of the operation, however, and of the validity of the assumptions on which it is based, is whether it corrects the varus deformity of the heel. It does in fact do so, and as will be seen, it can even produce a gross valgus inclination of the heel. There is an evident relationship between the angle of inclination of the heel and the relative lengths of the medial and lateral borders of the foot, and the wider significance of this finding is discussed later.

THE OPERATION

The aim of treatment is to secure sufficient lateral rotation of the navicular bone to bring the first metatarsal bone into line with the talus, and to correct equinus.

The first step is to soften the foot and correct deformity as much as possible by means of the serial wedge plasters advocated by Kite (1935, 1939). Relapsed club feet are often tough and rigid, and better results are obtained from operations performed on pliable feet than on rigid feet.

The operation is performed through two incisions—a medial incision which allows division of contracted soft tissues, and a lateral incision which exposes the calcaneo-cuboid joint.

The medial incision starts just in front of the tubercle of the navicular bone and runs backwards along the line of the tendon of tibialis posterior, beneath the medial malleolus, and then

up the leg along the anterior border of the tendo calcaneus for a distance of two or three inches. The tight plantar structures are divided with a tenotome and any cavus which may be present can then be corrected with a wrench. The tendon of tibialis posterior is exposed throughout its length from medial malleolus to its insertion into the navicular bone. In some feet it will be found to be a well differentiated tendon; in others it may be poorly differentiated in its distal half inch and it may even merge with a small mass of tough fibrocartilaginous tissue which may occupy the space between the medial surface of the head of the talus and the medially subluxated navicular bone. The tendon must be dissected free of this slab of tissue and the tissue mass excised to expose the talo-navicular joint. The tendon is then lengthened by Z-plasty, taking care to allow for a substantial increase in length, and the capsule of the talo-navicular joint is divided on its superior, medial and inferior surfaces to allow free lateral movement of the navicular on the talus. The proximal half of the incision is then deepened to expose the tendo calcaneus, which is isolated and lengthened by Z-plasty. This will only occasionally allow correction of equinus; in most cases it is also necessary to divide freely the posterior capsule of the ankle and any tight strands of fibrous tissue that may be running parallel with the tendon; in some cases the tendon will be poorly differentiated, and very free dissection and division of tissue will be needed to free the back of the ankle and allow dorsiflexion of the joint. In a small minority of older feet even this free dissection will not permit correction to the right angle and the extra leverage of a wrench may be needed, but this wrench should not be used strongly and it should not be used at all until every strand of contracted soft tissue has been divided. It is, nevertheless, essential to correct equinus at least to the right angle before proceeding to the second part of the operation, and failure to do this at this stage will mar the final result. The elongated tendons should not be sutured until the second part of the operation has been completed.

The lateral incision crosses the calcaneo-cuboid joint and runs parallel with the tendon of peroneus brevis; the skin flaps are retracted and the joint is fully exposed. The next step, excision of the calcaneo-cuboid joint, is the critical stage of the operation. So far, nothing has been done except to make correction of deformity possible by releasing contracted tissues. Now by excision of a wedge of the right shape and size it is possible to correct any deformity that may be present. If there is cavus deformity the wedge should be thicker on its dorsal than its plantar surface and if the foot is rocker-shaped the wedge should be thicker on its plantar surface. If the forefoot is supinated the cuboid can be rotated on the calcaneum in such a way as to bring the head of the first metatarsal bone to the ground. If the correct wedge is removed the cut surfaces of the bones can be brought into apposition in such a way that all deformities can be seen to be corrected—and, incidentally, the navicular can be seen to have moved laterally on the head of the talus, thus exposing more of the medial surface of the head of this bone. It is important to realise that unless deformity is gross and the child old, the wedge will be thin—hardly thicker than the joint itself. It is easy to remove too much bone and to find that when the cut surfaces come together the deformity has been over-corrected. Those who have been accustomed to performing triple arthrodesis for talipes equino-varus need to be particularly careful because they may have been in the habit of over-correcting to allow for some relapse, especially in younger children. There will be no relapse after this operation because growth of the medial column of the foot will keep pace with growth of the lateral column and the shape of the foot will remain unchanged. It is therefore of the greatest importance to secure as exact a correction of deformity as is possible, and for this reason it is best to use two staples to hold the calcaneum and cuboid securely together; one staple is not enough because it will not prevent rotation of one bone on the other, and sutures are insecure and difficult to insert accurately.

The elongated tendons are then sutured and the wounds closed. The foot is immobilised in plaster until the joint is soundly arthrodesed. Radiological evidence of fusion is not seen in the young, and it is probably wise to continue immobilisation for about five months.

Walking in plaster is permitted after six weeks and ordinary shoes are worn after the plaster has been removed.

In twenty-six out of the thirty feet now under review the tendon of the tibialis anterior was transplanted to the outer side of the foot. This may have contributed something to the stability of the correction, but my impression is that it did not do so, and because it always produced a passive dropping of the forefoot, I have in recent years omitted it from the operation.

RESULTS

The operation was done on thirty feet between 1953 and 1956. The shortest follow-up period is therefore nearly four years and the longest nearly seven years. The ages of the children at the time of operation ranged from three years to fourteen years but most were between four and eight years.

It would be idle to attempt a statistical analysis of the results because the initial factors are too variable and the series is too small; one can only report impressions, and the first and most obvious impression is that the correction of deformity obtained at operation is, at any rate within the limits of the review period, permanent (Figs. 3 to 6). In no case has there been any change of shape in spite of the absence of any kind of after-care. If the shape is satisfactory when the plaster is removed, it will remain satisfactory. It is the constancy of this fact which, more than anything else, distinguishes this operation from any other performed by me for the relapsed club foot.

Another feature is that the operation can correct all elements of the deformity, including the varus deformity of the heel (Figs. 7 to 14). It is known, of course, that a soft-tissue release operation, alone and without calcaneo-cuboid fusion, can sometimes give the same correction in young infants and can even produce a rigid valgus foot if it is accompanied by an over-vigorous manipulation. However, the feet now under review are those of older children and it has become evident that even in this age group the subtalar joint retains a potential of mobility which is released when the mid-tarsal deformity is corrected. Sometimes, and usually in fibrotic feet, this potential is only enough to allow the heel to move into valgus; in others it is sufficient to yield a fairly mobile tarsus, and some of these feet have gained a surprising range of controlled side-to-side movement—more than enough to allow accommodation to sloping surfaces. The degree of mobility seems to depend on a number of factors: the age of the child at the time of operation (the best age is probably about six years), the severity of the deformity, the number of operations and manipulations already performed on the foot, and the elastic quality of its soft tissues.

A third impression is that the operation yields a serviceable foot of good shape, comfortable, strong and plantigrade. It allows the child to live a normal life free from such encumbrances as irons, altered shoes and night splints.

A less satisfactory feature is the limited active dorsiflexion and the tendency to dropping of the forefoot which results from transplantation of tibialis anterior to the outer side of the foot. This transplantation was omitted in four of the feet without ill effect, and these feet do not show the slight weakness of dorsiflexion which characterises the other twenty-six. I suspect that the transplantation is unnecessary and have omitted it from recent operations not included in this series, but it must be recorded as having been performed on twenty-six out of the thirty feet under review. It is a visibly functioning tendon in all of them, and it may therefore have been a factor in preventing relapse.

Technical errors account for six unsatisfactory results. In one the deformity was under-corrected, in two it was over-corrected and in three the result was marred by persistent equinus. Under-correction and over-correction result from lack of care when excising the calcaneo-cuboid joint. The wedge of bone which is excised must be of the right thickness; removal of insufficient bone will not fully correct the deformity and removal of too much bone

FIG. 3

FIG. 4

FIGS. 3 TO 6

Case 1—This was the first of the series. Both feet were clubbed at birth. The right foot was adequately corrected but the left relapsed into deformity. The operation was performed in June 1953 at the age of six. The radiographs (Figs. 3 and 4), which show the fused calcaneocuboid joint, and photographs (Figs. 5 and 6) were taken in November 1960.

FIG. 5

FIG. 6

FIG. 7

FIG. 8

Case 2—Feet before operation in a child aged five.

FIG. 9

FIG. 10

Case 2—Appearance of feet three years after operation.

will over-correct it (Figs. 15 to 17). The possible wider significance of this and the remedy for over-correction will be discussed later.

Persistence of equinus was at first thought to be due to adaptive broadening of the unengaged part of the upper articular surface of the talus, and corrective measures such as wedge osteotomy of the lower end of the tibia, section of the tibio-fibular ligaments and trimming of the talus were considered. Wedge osteotomy of the tibia was tried in two cases but with only a fair result in one and with a poor result in the other. Reconsideration of the problem in relation to the third foot suggested that persistent equinus might be due to nothing more than inadequate release of contracted soft tissues at the back of the ankle. The original operation was therefore repeated on this foot with greater thoroughness and an adequate correction was obtained. I am now persuaded by this, and by more recent experience, that broadening of the talus is not an important factor in preventing correction of deformity. It may sometimes prevent dorsiflexion above the right angle—which matters little—but it very rarely obstructs dorsiflexion to the right angle.

One more impression needs to be recorded. It is never wise to omit any part of this operation or to perform the operation in stages. Though performed through two incisions it is one procedure, and accurate correction of the deformity by excision of the calcaneo-cuboid joint is possible only while the tarsal joints are free to move into new positions—that is, while they are free from the restraining effect of soft tissues. This freedom from restraint is so important that it is never safe to omit any part of the release procedure, however unnecessary some part of it may appear to be.

DISCUSSION

The operation described in this paper serves two purposes—it provides a satisfactory method of dealing with the relapsed club foot and it yields experimental evidence of the validity of the theory that, whatever the etiology of the club foot may be, the essential deformity is a medial displacement or rotation of the navicular bone on the talus. Relapse results from recurrence of this displacement or, more probably, from failure to correct it fully at the primary manipulations.

This prompts some reflections on the primary treatment of club foot as well as on the management of relapsed and neglected cases. The conventional teaching on the treatment of club foot is that one should by manipulation “correct the adduction, inversion and equinus elements of the deformity,” thus implying that there are three deformities that have to be corrected in turn; but it seems clear that such corrections, though at first apparently adequate, can be false and that their spurious character will only become apparent later when the foot is freed from its splintage and “relapse” occurs. It is unfortunate that late ossification of the tarsus deprives us of the help of radiography in these cases. Were the tarsal bones all ossified at birth, there seems little doubt that we would have learned to concentrate our efforts on repositioning the navicular bone on the talus, and that we would now be as alert to the danger of trying to correct adduction and inversion by applying pressure to the forepart of the medial border of the foot—thus causing the cuneiform joints to yield—as we are to the danger of correcting equinus by applying pressure to the forepart of the sole of the foot and so causing the mid-foot to yield and produce a “rocker” foot. The first step in the correction of a club foot should be replacement of the navicular bone on the talus; when this has been done the cuboid bone will have been pushed laterally and it will have taken with it the anterior end of the calcaneum which will have swung clear of the anterior end of the talus; the heel will have moved into valgus and the way will be clear for correction of equinus. Equinus is best corrected by pulling downwards on the back of the heel. Early tenotomy of the tendo calcaneus is sometimes practised and it has recently been suggested as a primary procedure, but one doubts the wisdom of this, for a tight calcaneal tendon can, by stabilising the heel, aid the reduction

FIG. 11

FIG. 12

Case 3—Feet before operation in a child of six.

FIG. 13

FIG. 14

Case 3—Appearance of feet three years after operation.

of the talo-navicular deformity and facilitate the lateral swing of the anterior end of the calcaneum, which in turn facilitates correction of the equinus.

It is not claimed that correct application of these principles will secure an adequate and permanent correction of every club foot. There are deformities which are so severe that, in my hands at any rate, they defy full correction. It is in such very resistant cases that early tenotomy of the tibialis posterior and calcaneal tendons might be thought to be helpful, but I have not found it so and I think it possible that in this small minority of exceedingly resistant cases relative overgrowth (or incompressibility) of the lateral column of the foot is already an obstructive factor, even at birth, and that one can do no more than maintain such feet in as good a shape as possible until surgical correction becomes feasible.

FIG. 15

FIG. 16

FIG. 17

Case 4—Here is shown the effect of over-correcting the deformity, and the changes that result from shortening and lengthening the lateral column of the foot. Figure 15—June 1955, before operation. Note the medial displacement of the navicular on the talus. Figure 16—April 1956, after wedge-resection of the calcaneo-cuboid joint. Too much bone has been removed and the talo-navicular dislocation is over-reduced. The clinical effect is a rigid valgus deformity of the foot. Figure 17—November 1960, after lengthening the calcaneum. The talo-navicular relationship is now normal and the clinical shape of the foot is satisfactory.

The improvement gained by manipulation has to be maintained at first by splintage and later by effective action of the peroneal muscles, but here again it must be kept in mind that even strong peroneal muscles cannot be expected to evert a dislocated foot and that it is of little use trying to develop peroneal activity when the navicular bone is still tucked around the medial side of the head of the talus.

If it becomes evident that the foot is relapsing into deformity treatment must start afresh but at this stage the resistance offered by the foot has become greater and full correction is often impossible. Mechanical aids are therefore employed and the traditional tool is a wrench or a wedge used under anaesthesia, but these can bruise the foot and lead to fibrosis of soft

tissue. Kite's method of correcting deformity by serial plasters is more gradual and probably more effective and less damaging to the tissues. It has justly found favour because it often yields satisfactory results; but it does not always succeed, and Kite (1957) has admitted that "if operative treatment of club foot, done at an early age, would give results as excellent as those obtained by operative treatment of other deformities, I would certainly support this approach."

This remark of Kite's echoes a widespread dissatisfaction with the effectiveness of the many operative procedures that have been suggested during the last sixty years for dealing with relapsed club foot and there can be little doubt that all have proved to be disappointing. Some have failed because they are unsound and others because they are inadequate. They can be divided into three broad groups—tendon transplantations, operations for release of contracted soft tissues, and bone resections or enucleations. The tendon transplantation operations are based on the assumption that the cause of relapse is muscle imbalance and, when this is so, they may succeed; but they must fail when the cause of the relapse is a dislocated joint and they therefore fail in most cases. Medial release of soft tissues fails when performed alone because, though soundly conceived, it is incomplete and does not take into account the obstruction offered by the deformed calcaneo-cuboid joint and the overgrown lateral column of the foot. It can correct the deformity in younger children but it does not stabilise the foot: relapse occurs unless the after-treatment is prolonged or the deformity is so over-corrected that a permanent valgus deformity is produced. The bone resections and enucleations have failed because they attacked either the medial column of the foot, such as the head of the talus or the talo-navicular joint, or the wrong part of the lateral column. It is obviously wrong to shorten or weaken the medial bony column of the foot; on the contrary, the aim should be to restore it and ensure that its growth in length keeps pace with that of the lateral column. The attacks on the lateral column are sounder in principle because they have been based on the obvious fact that this column, being relatively longer than the medial column, needs to be shortened, but they have failed in practice because it is not enough merely to shorten the lateral column by resecting a portion of the calcaneum or cuboid bone; it must be broken at a point that will permit sufficient lateral rotation of the navicular to bring the first metatarsal bone into line with the talus and it must be mended in such a way that it stabilises the foot by holding the navicular in its derotated position. This can be achieved only by excising and arthrodesing the calcaneo-cuboid joint.

Perhaps the most interesting single point that has emerged from this series of cases is the conversion of varus into valgus. In two of the cases the valgus produced was rigid and severe—a foot with a valgus heel and a convex medial border. The significance of this change was not at first appreciated and since it was obviously necessary to replace the heel beneath the ankle, a Dwyer-type osteotomy of the calcaneum was attempted but without success; the bone was freely divided but the hind fragment could not be moved and the deformity remained uncorrected. It then became obvious that excessive shortening of the lateral border of the foot had produced an excessive lateral rotation of the navicular on the head of the talus and that the remedy was to undo the calcaneo-cuboid fusion and to lengthen the lateral border of the foot by inserting a wedge graft (Figs. 16 and 17). This was tried and it produced, in varying degree, three effects; the heel moved towards neutral, the convexity on the medial border was reduced, and the foot as a whole moved slightly into equinus.

From this it appears that the relative lengths of the medial and lateral columns of the foot can be responsible, in some measure, for valgus and varus inclinations of the heel and that if these relative lengths are altered the inclination of the heel will change. Given a mobile or potentially mobile tarsus, the head of the talus will act as a pivot around which a short lateral column will pull the foot into valgus and a long lateral column will push it into varus. I am satisfied that this is so because it is a principle that has been seen to work not only in the correction of club foot and in the re-correction of the over-corrected club foot; it also works

in the correction of calcaneo-valgus. Calcaneo-valgus can be corrected by using a bone graft to lengthen the anterior part of the calcaneum; whether this correction is durable and worthwhile remains to be seen, but one point of relevance to this paper has emerged from experience of the operation; lengthening of the calcaneum produces two effects which are immediately visible at operation—it pushes the heel into varus and the ankle into equinus. It can, in fact, produce an equino-varus deformity of the foot and it thus provides some additional support for the view that the essential deformity in club foot is in the mid-tarsal region, and that the ankle and subtalar deformities are little more than inevitable consequences of this primary deformity. It does not however throw any light on the cause of this primary deformity, which remains a subject for speculation.

SUMMARY

1. An operation which can correct congenital club foot deformity in older children is described.
2. The operation is based on the assumption that the essential element in a complex tarsal deformity is a displacement of the navicular bone on the talus and that all other elements of the deformity are secondary and adaptive.
3. The results of the operation are noted and the implications of some of its effects are discussed.

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REFERENCES

- ADAMS, W. (1866): *Club-Foot*. London: John Churchill and Sons.
- BROCKMAN, E. P. (1930): *Congenital Club-Foot*. Bristol: John Wright and Sons Ltd.
- BROWNE, D. (1934): Talipes Equino-Varus. *Lancet*, ii, 969.
- BROWNE, D. (1937): Modern Methods of Treatment of Club-Foot. *British Medical Journal*, ii, 570.
- ELMSLIE, R. C. (1920): The Principles of Treatment of Congenital Talipes Equino-Varus. *Journal of Orthopaedic Surgery*, 2, 669.
- FRIED, A. (1959): Recurrent Congenital Club-Foot. *Journal of Bone and Joint Surgery*, 41-A, 243.
- FRIPP, A. T. (1951): The Relapsed Club Foot. *Proceedings of the Royal Society of Medicine* (Section of Orthopaedics), 44, 873.
- JOHANNING, K. (1958): Excochleatio Ossis Cuboidei in the Treatment of Pes Equino-varus. *Acta Orthopaedica Scandinavica*, 27, 310.
- KITE, J. H. (1932): The Treatment of Congenital Clubfeet. *Journal of the American Medical Association*, 99, 1,156.
- KITE, J. H. (1935): The Treatment of Congenital Club-Feet. *Surgery, Gynecology and Obstetrics*, 61, 190.
- KITE, J. H. (1939): Principles Involved in the Treatment of Congenital Club-Foot. *Journal of Bone and Joint Surgery*, 21, 595.
- KITE, J. H. (1957): Discussion American Academy of Orthopaedic Surgeons. *Journal of Bone and Joint Surgery*, 39-A, 283.
- OGSTON, A. (1902): A New Principle of Curing Club-Foot in Severe Cases in Children a Few Years Old. *British Medical Journal*, i, 1,524.
- SINGER, M., and FRIPP, A. T. (1958): Tibialis Anterior Transfer in Congenital Club Foot. *Journal of Bone and Joint Surgery*, 40-B, 252.
- WILEY, A. M. (1959): Club Foot. *Journal of Bone and Joint Surgery*, 41-B, 821.
- WISHART, J. H. (1818): *A Memoir on the Congenital Club Feet of Children*. Translation from the Italian of Scarpa. Edinburgh: Constable and Company. London: Longman, Hurst, Rees, Orme and Brown.