NAVICULO-CUNEIFORM FUSION IN THE TREATMENT OF FLAT FOOT*

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Flat foot, or the unstable everted foot, is a highly controversial subject on several issues. As a prelude to this paper it is therefore necessary to assert two main premises on which the work reported here has been based. 1) Flat foot of severe degree is a disabling condition which causes restriction of activity in young adults and induces morbidity in later life. Correction of the deformity by operation in young patients is worth while if it is possible.

FIG. 1

In the normal weight-bearing foot the axes of talus, navicular, medial cuneiform and first metatarsal form a straight line.

2) The medial longitudinal arch of the foot and therefore the posture of the foot depend upon the intrinsic structure of the bones and joints and the integrity of the plantar ligaments. Muscles are concerned solely with balance and the protection of ligaments from abnormal stress. Though they are able temporarily to lift a sagging arch, they cannot constantly maintain an arch in which there is a ligamentous or bony defect. This latter view is perhaps the most controversial. It gains support from the material in this paper.

ANATOMICAL TYPES OF FLAT FOOT

Whatever theory of posture is held, it cannot be denied that in flat foot the long arch sags. In the normal weight-bearing foot the axes of talus, navicular, medial cuneiform and first metatarsal form a straight line (Fig. 1). Theoretically sag may occur at one or all of three points—the three joints which link the segments of the arch.

It is possible to demonstrate radiologically the anatomical situation of the break in the arch. Lateral radiographs of the foot must be taken with the patient standing erect with his muscles relaxed as far as possible. Collaboration by the radiographer is essential

FIG. 2

Simple stand and cassette holder for lateral radiography.

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FIG. 3

FIG. 4

FIG. 5

The three anatomical types of flat foot. Figure 3—Talo-navicular break ("perpendicular" talus). The axes of navicular, medial cuneiform and first metatarsal remain in line. Figure 4—Naviculo-cuneiform break. The axis of the navicular corresponds to that of talus but lies well below the medial cuneiform and first metatarsal. Figure 5—Combined break. Both talo-navicular and naviculo-cuneiform joints are faulty. The axis of the navicular lies below the talus and first metatarsal segment.

in ensuring the relaxed position when exposure is made. It is helpful to have a simple stand and cassette holder so that a standard position and technique can be adopted (Fig. 2). Investigation in this way shows that the unstable foot can be classified into three distinct anatomical types. The metatarso-cuneiform joint never gives way. It is a flat stable joint with a small range of movement. The break may occur at the talo-navicular joint alone (the so-called perpendicular talus deformity), it may occur at the naviculo-cuneiform joint alone, or there may be relaxation at both these joints in a combined sag. Determination of the site of the break in the arch is most reliably achieved by drawing a line through the axis of the navicular. It can then be seen whether angulation occurs proximal or distal to the navicular, or at both situations (Figs. 3 to 5).

Assessment of the relative frequency of these anatomical types is not easy. Of a very large number of patients with flat foot of varying degree a comparatively small proportion has been investigated. The impression has been gained that the naviculo-cuneiform defect is more common than the other types.

Clinical examination—Clinically it is difficult to detect at which joint the fault lies. A simple test referred to as the "toe-raising test" gives an indication but is not entirely reliable (Fig. 6). While the patient stands with weight on both feet, the great toe is fully dorsiflexed. This manoeuvre restores the arch and gives stable posture in all cases of naviculo-cuneiform break (Figs. 7 and 8), and in most combined breaks, but it does not do so when the talus is perpendicular. There is then insufficient leverage to force the navicular under the head of the talus. The efficiency of the toe-raising test is vitiated by a tight tendo calcaneus—an element in the deformity to be mentioned later.

FIG. 6

Toe raising test. Elevation of the great toe balances up the foot in naviculo-cuneiform break and in most combined breaks.

An interesting anatomical point emerges in connection with this toe-raising test. If the long arch is incompetent for any reason, the foot rolls medially and the calcaneum becomes everted at the subtalar joint. Eversion is not a pure movement in one plane, but is associated with rotation about the head of the talus, and produces a valgus position of the foot in relation to the vertical axis of the talus. Therefore even when the arch sags at the naviculo-cuneiform joint alone, the valgus element of the flat-foot deformity is produced at the talo-navicular joint. But it is a normal movement, in a normal joint. Toe raising, by restoring the vertical arch, automatically corrects the valgus (Figs. 9 and 10).

OPERATIVE CORRECTION

In 1931 Hoke described the operation of naviculo-cuneiform fusion as treatment for relaxed flat foot. He believed that muscles were pre-eminent in maintaining the long arch and claimed that the operation lengthened the lever through which they worked and thereby rendered them more effective. He recommended lengthening the tendo calcaneus at the same time. In 1937 Butte reported seventy-six feet operated upon, and claimed satisfactory results in half. He suggested that the operation was most successful when lateral radiographs showed a sag at the naviculo-cuneiform joint. If it is accepted that the posture of the foot depends upon the structure of the joints and the integrity of the ligaments, and if radiographs show a localised defect in the long arch at the naviculo-cuneiform joint, the logical assumption

FIG. 7

FIG. 8

Naviculo-cuneiform break (Fig. 7) corrected by toe raising (Fig. 8).

FIG. 9

FIG. 10

Same foot in antero-posterior view. Automatic correction of valgus angulation at talo-navicular joint.

follows that fusion of this joint in the corrected position should restore the arch, balance the foot, and cure the deformity, without seriously impairing the mobility of the foot.

During the four-year period 1946-1949, forty-six feet in twenty-five patients, all between the ages of eleven and fourteen, have been operated upon, and the cases have been followed up for periods varying from five years to fifteen months after operation. The operation is easy but must be performed with precision. Exposure of the first cuneiform is improved by division of the broad tendon of tibialis anterior across half its width. Adjacent joint surfaces of navicular and medial cuneiform are excised. While an assistant holds the foot firmly in the corrected position a slot is cut in the navicular and cuneiform bones across the joint to receive an accurately cut cortical and cancellous graft from the upper third of tibia, which is countersunk firmly (Fig. 11). The excised joint space is packed with bone chips. Plaster is applied to hold the foot in full correction and must be carefully moulded round the first metatarsal. If the tendo calcaneus is tight the foot is put up in slight equinus. In this series the tendo calcaneus has not been lengthened. No weight bearing is permitted for three months. Walking in plaster is allowed during the fourth month.

FIG. 11

Excision of joint surfaces and insertion of tibial key graft while the foot is held strongly in the corrected position.

Indications for operation—All the patients subjected to operation had previously received conservative treatment for variable periods (some for many years). Operation was recommended when growth had proceeded to a sufficient stage to permit fusion, because there was marked instability of the feet which was either causing restriction of activity or was considered likely to do so in the future. In twenty-six of the forty-six feet there was pain after long walks; twenty-four caused restricted activity at games; while in fourteen the main complaint came from the parents, who were greatly harrassed by the rapid break-down of shoes after a few weeks' wear, in spite of Thomas heels and wedges.

RESULTS

In assessing results the balance of the foot, function and mobility, relief of symptoms, and cosmetic appearance have been taken into account. Cases have been graded as excellent or good—classified together as satisfactory—and as unsatisfactory. To qualify for satisfactory assessment the relaxed foot must have good balance, function must be unrestricted, and symptoms must be completely relieved. Twenty-five of the forty-six feet have been graded as excellent, and thirteen as good. Thus thirty-eight of the forty-six (or 82 per cent) can be regarded as satisfactory. Twenty-four of these previously complained of pain in the feet, and all were completely relieved. A typical case is shown in Figures 12 to 15.

FIG. 12

FIG. 13

Case 1—Severe flat-foot deformity with pain after long walks. Conservative treatment unsuccessful. Operation at age fifteen. Figure 12—Before operation. Figure 13—Four years after operation.

FIG. 14

FIG. 15

Case 1. Figure 14—Radiograph before operation. Figure 15—Four years after operation.

Thirteen feet, although they fulfilled the necessary criteria for a satisfactory result, failed to achieve the highest grade for the following reasons. Eight were not quite completely balanced and might have been a little better had the naviculo-cuneiform angle been slightly more corrected. One deformity was slightly over-corrected and presented a trace of inversion at the heel (Figs. 16 and 17). Three had rather prominent navicular tubercles which spoiled the cosmetic appearance of a well balanced foot. In one case there was slight crepitus at the midtarsal joint but the foot was otherwise excellent. One patient developed a pseudarthrosis in one foot but after a second operation two years later gained an excellent result.

Eight feet (18 per cent) were classed as unsatisfactory. Five of these were among the first eight feet operated upon. In two cases failure was due to pseudarthrosis. Walking

FIG. 16

FIG. 17

Case 2—Severe flat-foot deformity with pain after long walks. Operation at age twelve. Figure 16—Before operation. Figure 17—Two years after operation. There is slight inversion of the right heel.

had been allowed in plasters three weeks after operation. Fusion failed and correction was lost. In five the operation failed to restore the arch. This failure was attributed to bad selection; further scrutiny of the pre-operative radiographs showed that the break was not confined to the naviculo-cuneiform joint, but that the talo-navicular joint was also involved. One patient reported five years after operation with a stiff midtarsal joint and radiological evidence of osteoarthritis. Probably the graft was inserted too deeply and had encroached on the talo-navicular joint. The failures can all be attributed to errors in technique or to faulty selection and are avoidable. Failure of fusion occurred three times in early cases before it was realised that early weight bearing must not be allowed. In one foot re-operation achieved complete success.

The tendo calcaneus—In twenty-three of the cases which proved satisfactory it was noted before operation that the tendo calcaneus was tight. The tendon was not lengthened, but at follow-up all these patients had a normal range of dorsiflexion. When the heel is habitually everted the calf muscles no longer need to extend fully and they undergo adaptive shortening. Once the arch is stabilised re-adaptation quickly occurs. Tendon lengthening is unnecessary.

Comment—The operation is not by any means a universal cure for flat foot. Selection of cases must be made with great care and depends on a reliable radiographic technique. Provided the defect is shown to be exclusively or preponderantly at the naviculo-cuneiform joint, the operation affords an excellent means of restoring a normal arch and preserving an almost fully mobile foot.

SUMMARY

1. Radiological investigation of cases of flat foot shows that they form three distinct anatomical types according to the precise level of the break in the arch.
2. When the break occurs at the naviculo-cuneiform joint alone, fusion of this joint in normal alignment should correct the deformity.
3. The results of operation on forty-six feet are analysed. Eighty-two per cent proved satisfactory. Failures are discussed and are considered avoidable by careful selection and operative technique.

REFERENCES

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