Neonatal foot deformities and their relationship to developmental dysplasia of the hip

AN 11-YEAR PROSPECTIVE, LONGITUDINAL OBSERVATIONAL STUDY

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In a prospective study over 11 years we assessed the relationship between neonatal deformities of the foot and the presence of ultrasonographic developmental dysplasia of the hip (DDH). Between 1 January 1996 and 31 December 2006, 614 infants with deformities of the foot were referred for clinical and ultrasonographic evaluation. There were 436 cases of postural talipes equinovarus deformity (TEV), 60 of fixed congenital talipes equinovarus (CTEV), 93 of congenital talipes calcaneovalgus (CTCV) and 25 of metatarsus adductus.

The overall risk of ultrasonographic dysplasia or instability was 1:27 in postural TEV, 1:8.6 in CTEV, 1:5.2 in CTCV and 1:25 in metatarsus adductus.

The risk of type-IV instability of the hip or irreducible dislocation was 1:436 (0.2%) in postural TEV, 1:15.4 (6.5%) in CTCV and 1:25 (4%) in metatarsus adductus. There were no cases of hip instability (type IV) or of irreducible dislocation in the CTEV group.

Routine screening for DDH in cases of postural TEV and CTEV is no longer advocated. The former is poorly defined, leading to the over-diagnosis of a possibly spurious condition. Ultrasonographic imaging and surveillance of hips in infants with CTCV and possibly those with metatarsus adductus should continue.

Neonatal deformities of the foot and developmental dysplasia of the hip (DDH) are both common paediatric orthopaedic conditions. An association between the two has been claimed.^{1,2} Textbooks cite a probable relationship and state that deformity of the lower limb is a risk factor for DDH or dislocation of the hip.³ This association has been disputed.^{4,5}

The Standing Medical Advisory Committee and Standing Nursing and Midwifery Advisory Committee implemented screening guidelines for the detection of congenital dislocation of the hip in the United Kingdom in 1969⁶ and they were last updated in 1986.⁷ Deformities (postural or structural) of the foot, the family history, breech delivery, torticollis and oligohydramnios are all listed as risk factors for DDH.^{6,7} The guidelines stated that 60% of cases of DDH originated as a result of these risk factors, although this figure has been disputed.^{8,9} Risk factors are currently thought to be associated with 30% to 31% of ultrasonographically-important DDH.^{8,9} The National Screening Committee (UK) currently considers abnormalities of the foot to be a risk factor in DDH.¹⁰

In our longitudinal, observational prospective study over 11 years we have assessed neonatal deformities of the foot and their relationship to DDH.

Patients and Methods

Between 1 January 1996 and 31 December 2006, 41 474 infants were born in the Blackburn district. Paediatricians diagnosed deformities of the foot in 614 of these infants and referred them to the paediatric orthopaedic clinic as part of a screening programme for DDH. The senior author (RWP) examined all the hips clinically using the Barlow and Ortolani tests¹¹ and ultrasonographically using Harcke's dynamic¹²⁻¹⁴ and modified Graf's static morphological methods.¹⁵⁻¹⁷ A simplified Graf classification was used in which a Graf angle of over 60° was classified as normal (type I), of 43° to 60° as type II, and below 43° and stable as type III. A dislocatable or dislocated hip was classified as type IV.¹⁷

Most of the neonates were assessed in the specialist clinic before the age of ten weeks. All infants with neurological or syndromic conditions were excluded from the study.

Deformities of the foot. Fixed congenital talipes equinovarus (CTEV) is usually an obvious diagnosis. The deformities of the foot and ankle include equinus and varus of the heel, with apparent supination and adductus of the mid- and forefoot. In addition, there may be wasting of the calf muscles, and posterior and medial skin creases.^{18,19} In our department the

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Table I. Numbers and types of dysplasia in each group

Group	Normal hips	Type of dysplasia			Total
	I	II	III	IV	
Postural TEV*	420	14	1	1	436
CTEV†	53	7	0	0	60
CTCV‡	75	12	0	6	93
Metatarsus adductus	24	0	0	1	25

* TEV, talipes equinovarus deformity

† CTEV, congenital talipes equinovarus

‡ CTCV, congenital talipes calcaneovalgus

Table II. Referral rates for deformities from 1996 to 2006

Year	Postural TEV*	CTEV†	CTCV‡	Metatarsus adductus	Total
1996	28	6	5	4	43
1997	23	7	11	0	41
1998	41	5	5	2	53
1999	23	6	9	0	38
2000	47	3	9	4	63
2001	61	8	9	5	83
2002	48	1	10	1	60
2003	9	6	10	2	27
2004	28	8	9	2	47
2005	38	5	7	4	54
2006	90	5	9	1	105
Mean (range)	39.6 (9 to 90)	5.5 (1 to 8)	8.5 (5 to 11)	2.3 (0 to 5)	Total: 55.8 (27 to 105)

* TEV, talipes equinovarus deformity

† CTEV, congenital talipes equinovarus

‡ CTCV, congenital talipes calcaneovalgus

scoring system of Harrold and Walker²⁰ was routinely used to confirm objectively that the foot deformity was fixed.

Congenital talipes calcaneovalgus (CTCV) is postural and mobile, and the diagnosis is also usually straightforward. The foot is dorsiflexed and may be in contact with the shin. The heel is in a valgus position.¹⁸ Cases of congenital vertical talus were excluded.

Postural talipes equinovarus (TEV) is defined as a persistent fetal position in which the foot is supple, can be pushed into a normal position and has no fixed deformity.²¹ Wynne-Davies²² stated that these feet are in equinovarus at birth, but correct easily within weeks and show no tendency to relapse. This diagnosis is rather 'soft' and could be termed as a variation of the normal. This makes it vague⁴ and possibly inaccurate, leading to the possibility of over-diagnosis of a non-pathological condition.

Forefoot adductus is characterised by a medial deviation of the forefoot.²³ This can be a subtle diagnosis since minor degrees of metatarsus adductus may be considered to be normal in the perinatal paediatric assessment. Therefore this condition may be under-diagnosed.

Other foot abnormalities were not considered since the literature does not suggest an association with DDH. These included curly toes, varus fifth toe, tarsal coalition and fibular hemimelia.

Statistical analysis. This compared the relative risk (RR), the odds ratio (OR), the 95% confidence interval (CI) for relative risk and the p-value using the chi-squared test. A p-value of ≤ 0.05 was considered statistically significant.

Results

Of the 614 infants with deformities of the foot 436 had postural TEV, 60 CTEV, 93 CTCV and 25 metatarsus adductus deformities (Table I).

Within the postural TEV group there were 14 type-II hips, one type-III and one type IV-hip. The CTEV group included seven with type-II dysplasia and no type-III or -IV hips. The CTCV group contained 12 with type-II dysplasia, none with type-III, but six with type-IV. In the metatarsus adductus group there was one 'late' irreducible dislocated hip (type-IV) (Table I).

The number of referrals for postural TEV was very variable over the 11-year period with a mean of 39.6 per year (9.0 to 90.0; 95% CI 26.5 to 52.7; Table II). The 95% CI was wide, suggesting that the data and the diagnosis may not have been accurate. This confirmed our view that this condition may be a 'soft' diagnosis and that it may not be a true or pathological condition. All 'at-risk' infants were assessed in the specialist clinic after four to six weeks of age. All cases resolved spontaneously without the need for

passive manipulation, physiotherapy, strapping or serial casting.

The number of referrals for CTEV was reasonably steady over the 11 years with a mean of 5.5 per year (1.0 to 8.0; 95% CI 4.3 to 6.6; Table II). There were only 60 cases, but the 95% CI range was narrow and the incidence was 1.46 per 1000 births which is consistent with the incidence of 1 to 2 per 1000 births overall in the United Kingdom.²² This suggested that the diagnosis and data were accurate.

Referrals for CTCV were also reasonably steady over the 11 years with a mean of 8.5 per year (5.0 to 11.0; 95% CI 7.3 to 9.6; Table II). There was a total of only 93 cases but the 95% CI range was narrow. However, at 2.2 per 1000 births the incidence was slightly higher than the published rate of 1.0 per 1000,²² but it was felt that the diagnosis and data were accurate.

There were only 25 cases of metatarsus adductus over the 11 years (mean 2.3 per year (0 to 5); 95% CI 1.3 to 3.3; Table II). This incidence of 0.60 per 1000 was lower than that stated by Wynne-Davies²² at 1 per 1000. There is evidence that the incidence may be decreasing with the abandonment of the prone sleeping position.²⁴ The numbers were too small to be analysed statistically.

The overall risk of all types of dysplasia or instability was as follows: 1:27 in postural TEV, 1:8.6 in CTEV, 1:5.2 in CTCV and 1:25 in metatarsus adductus. The relative risk of dysplasia or instability in CTCV *vs* postural TEV was 5.27 (95% CI of RR 2.57 to 10.80; OR 6.30; $p < 0.0001$). That in CTCV *vs* combined CTEV and postural TEV was 4.17 (95% CI of RR 2.15 to 8.10; OR 4.93; $p < 0.0001$) and that in CTEV *vs* postural TEV was 3.18 (95% CI of RR 1.25 to 8.08; OR 3.46, $p = 0.0057$).

Of the 614 cases, there was only one of type-III dysplasia. This was in the postural TEV group and was not possible to analyse statistically.

There were eight type-IV hips. The risk of type-IV hip instability or irreducible dislocation was 0.2% (1:436) in postural TEV, 6.5% (1:15.4) in CTCV and 4% (1:25) in metatarsus adductus. No type-IV instability or dislocation was seen in the CTEV group.

The relative risk of type-IV instability or irreducible dislocation in CTCV *vs* postural TEV was 14.06 (95% CI of RR 2.80 to 70.80; OR 14.96, $p < 0.0001$). That in CTCV *vs* metatarsus adductus was 1.61 (95% CI of RR 0.18 to 14.0; OR 1.65, $p = 0.64$) and that in metatarsus adductus *vs* postural TEV was 17.44 (95% CI of RR 1.06 to 287.4, OR 18.12, $p = 0.005$).

CTCV has a statistically significant higher risk of dysplasia or instability than CTEV and postural TEV. Metatarsus adductus has a statistically significant higher risk of type-IV instability than postural TEV although it is acknowledged that our metatarsus adductus numbers were small.

Discussion

The current guidelines in the United Kingdom for the detection of congenital dislocation of the hip or DDH list foot

deformities (postural or structural) as risk factors for DDH and advise clinical screening.^{6,7} The National Screening Committee's recommendations advise selective ultrasonographic imaging of the hip for abnormalities of the lower legs.^{6,7}

Clinical examination for hip instability using the Barlow and Ortolani tests has a high specificity, but a low sensitivity.²⁵ Ultrasonographic imaging of the hip for the diagnosis of DDH has a high sensitivity, but a low specificity.²⁶ The natural history of neonatal instability of the hip and stable acetabular dysplasia is natural resolution in most cases (90%).^{11,27,28} Type-II dysplasia is generally thought to represent an immature rather than a pathological condition. In the 614 cases there were only eight of type-IV and one of type-III. Screening for risk factors in DDH does not meet the ideal criteria of a successful screening programme.²⁹

Postural TEV. This is poorly defined, vague and subjective. There appears to be no accurate definition.^{21,22} We feel that this mobile 'deformity' is a normal variation and is not a true condition. It does not require investigation or treatment. Because of the 'soft' diagnosis of postural TEV there were wide variations in the referral rates from nine to 90 in any one year. Since there was a low rate of associated hip abnormalities (Graf type-III and type-IV 1:218) we do not feel that it is a true risk factor.

CTEV. Wynne-Davies²² reported an incidence of DDH of 0.6% with CTEV and Westberry, Davids and Pugh³⁰ of 0.28% with CTEV. Our screening results for CTEV showed seven cases of type-II dysplasia, none of which progressed with all hips developing normally without treatment. There were no cases of type-III or type-IV dysplasia or instability.

CTCV. In 1955 Browne³¹ stated that there was an association between congenital dysplasia of the hip and CTCV based on his clinical experience, although he did not present any clinical data. In a retrospective study in 1964, Wynne-Davies²² demonstrated an incidence of 4% to 5% of congenital dysplasia of the hip in CTCV. Our results showed that CTCV had a statistically significant risk for DDH, with a 6.5% risk of Graf type-IV instability. There were no cases of Graf type-III dysplasia.

Metatarsus adductus. Kumar and MacEwen²³ reported an incidence of hip dysplasia in metatarsus adductus of 1.53% based on radiological analysis. No data or statistics were given. Jacobs³² reported an incidence of 10% based on radiological evaluation. In our study there was an incidence of 4% of irreducible dislocation. However, we acknowledge that there were only 25 cases, with the one abnormal hip presenting as an irreducible dislocation.

We feel that infants with CTCV and possibly metatarsus adductus should continue to be screened for DDH. There is no strong relationship to postural or fixed CTEV deformities in DDH. TEV and idiopathic CTEV should not be considered as risk factors for DDH and should not be routinely screened.

Neurological or syndromic conditions such as Larson's syndrome¹⁸ which have a relationship to joint dislocations should continue to be screened for hip dislocation or sub-

luxation, but the hip dislocation in these cases should not be regarded as true DDH since the dislocation is secondary.

At present, foot deformity as a risk factor for the development of DDH is too vague a term and needs to be re-defined in the guidelines of the United Kingdom.

Supplementary material

A further opinion by Dr M. Letts is available with the electronic version of this article on our website at www.jbjs.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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