Occlusal asymmetries in children with congenital hip dislocation

Virpi Harila*, Marita Valkama**, Koshi Sato***, Shane Tolleson****, Shad Hanis****, Chung H. Kau***** and Pertti Pirttiniemi*
*Department of Oral Development and Orthodontics, Institute of Dentistry, University of Oulu, Finland, **Department of Pediatrics and Adolescence, University Hospital, Oulu, Finland, ***Isahai Dental Clinic, Takasaki, Japan, ****Department of Orthodontics, University of Texas, Houston and *****Department of Orthodontics, University of Alabama at Birmingham, USA

Correspondence to: Virpi Harila, Department of Oral Development and Orthodontics, Institute of Dentistry, University of Oulu, PL 5281, 90014 Oulu, Finland. E-mail: Virpi.Harila@oulu.fi

SUMMARY Developmental dysplasia of the hip (DDH) has been associated with other congenital postural deformities and associated with asymmetric features in the body. The aim of this study was to examine the associations between developmental DDH and malocclusions in preschool and school children.

The subjects were 60 children (40 girls and 20 boys) born during 1997–2001 in Northern Ostrobothnia Hospital District and having developmental DDH and treated by Von Rosen method. The control group consisted of 71 Finnish children (46 girls and 25 boys) matched by age and gender. Children participated the cross-sectional study at the age of 5–10 years; the mean age of the DDH children was 8.0 (SD 1.4) and controls 7.9 (SD 1.4) years. Dental examinations, intra-oral photographs, and clinical examination including growth measurements were carried out.

The DDH children had significantly more lateral crossbites than controls (30/9.9 per cent; $P < 0.003$). Overall, 77.8 per cent of cases were unilateral crossbites and found more on the right side (50 per cent) compared to the left side (22.2 per cent). Girls had more crossbite compared to boys (77.8/22.2 per cent; odds ratio 2.53).

Children with congenital hip dislocation are more predisposed to the asymmetric growth of occlusion and the development of crossbite. The genetic and environmental factors including intrauterine conditions in addition to the splint therapy may be possible influencing factors. This study will give additional information of the development of occlusal asymmetries and the multifactorial nature of the aetiology of lateral malocclusions.

Introduction

Congenital dislocation of the hip has been recognized for many centuries. The condition was described and named by Hippocrates, who suggested uterine pressure and birth trauma as possible causes (Record and Edwards, 1958). The prevalence of developmental dysplasia of the hip (DDH) is about 1 per cent of all newborns. DDH is a congenital condition with dislocated, dislocatable, or subluxatable hip. The American Academy of Pediatrics Subcommittee on Developmental Dysplasia of the Hip has defined DDH as occurring in two types, teratologic DDH and typical DDH. Teratologic DDH is extremely rare, the incidence is about 1/25 000 births (Cady, 2006). The aetiology of the DDH is multifactorial and partly unresolved. It has been associated with other 'congenital postural deformities' like torticollis (Tien *et al.*, 2001; von Heideken *et al.*, 2006), scoliosis, and talipes (Dunn, 1976). Factors commonly associated with DDH are positive family history, breech presentation, female sex, oligohydramniosis, primiparity, and associated congenital anomalies (Chan *et al.*, 1997; Herring, 2002; von Heideken *et al.*, 2006; Abu Hassan and Shannak, 2007). High birthweight (>4000 g), post-maturity and older maternal age are also included to risk factors (Chan *et al.*,

1997). Family studies have provided evidence that there is genetic predisposition to DDH based on polygenic-multifactorial inheritance (Record and Edwards, 1958; Chan *et al.*, 1997).

Deformational plagiocephaly is the most common subgroup of plagiocephaly and the incidence of asymmetries has been supposed to be increased due to 'back to sleep' campaign to promote supine infant positioning to reduce sudden infant death syndrome according to the American Academy of Pediatrics (1992) recommendation. Increase in posterior deformational plagiocephaly is related to supine sleeping in the literature (Peitsch *et al.*, 2002; Darvann *et al.*, 2006). There have also been found many associations between head posture and craniofacial morphology (Solow and Tallgren, 1976; Huggare, 1987; Zepa *et al.*, 2000).

In the previous studies, surgically treated children with torticollis have been found to have increased asymmetry of facial skeleton, craniofacial structures and dental arches, malocclusions and larger need for orthodontic treatment than the general population (Pirttiniemi 1989). Higher frequencies of posterior crossbite and more asymmetric features of malocclusions with scoliosis have been found (Huggare *et al.*, 1991; Ben-Bassat *et al.*, 2006).

DDH has earlier been associated with other congenital postural deformities like torticollis, scoliosis, and talipes (Dunn, 1976; Tien *et al.*, 2001; von Heideken *et al.*, 2006). Asymmetric features in the body in the cases of DDH have also been found (Watson 1971).

There is very little information regarding the occlusion of children with congenital hip dislocation. This gives a reason to study the association of DDH and occlusal asymmetries.

We hypothesize that children with congenital hip dislocation would have a tendency toward craniofacial and occlusal asymmetry. The aim of this study is to examine the association between developmental DDH and malocclusions in preschool and school children.

Subjects and methods

The study was approved by the Ethics committee of the Northern Ostrobothnia Hospital District. The subjects consisted of 60 Finnish children (40 girls and 20 boys) born during 1997–2001 in Northern Ostrobothnia Hospital District and having developmental DDH and treated by Von Rosen splint therapy. This treatment method has been generally used from the 1970s. The treatment began after birth before leaving for home. During the treatment, child is forced for many weeks, approximately 7–12 weeks, on his back-sleeping position and the hip is stabilized by the splint.

The control group consisted of 71 Finnish children (46 girls and 25 boys) randomly selected from the governmental birth register matched by birthday, month, year, and gender according to the subject patients. Children participated the cross-sectional study at the age of 5–10 years; the mean age of the DDH children was 8.0 (SD 1.4, range 5.8–10.6) and controls 7.9 (SD 1.4, range 5.9–10.5) years.

Oral dental examinations and intra-oral photographs were performed by one author (VH). Occlusal variables including the molar sagittal relationships were recorded. The sagittal occlusion of the permanent molars was determined using Angle's classification and the method of Björk *et al.* (1964) as guides in recording the results. A classification of the occlusion on both sides of the dental arch to an accuracy of half a cusp was thus obtained. The occlusion of the molars was classified as neutral, mesial, or distal. A neutral molar relationship was either definite (the mesiobuccal cusp of the permanent upper first molar occluded into the buccal fossa of the lower first molar) or less than half cusp mesial or distal (the mesiobuccal cusp of the upper first molar occluded less than half a cusp mesially or distally relative to the buccal fossa of the lower first molar), whereas a distal or mesial molar relationship was either from half to full cusp mesial/distal or more than full cusp mesial/distal. Crossbite was defined according the method by Björk *et al.*(1964). Crossbite was diagnosed, when the buccal cusps of posterior teeth occluded lingually to those of mandibular teeth, and at least one tooth pair was in crossbite.

The full medical background data were also available. Children with plagiocephaly, craniosynostosis, torticollis, and syndromes were excluded.

There was a questionnaire for parents concerning oral habits like the duration of finger and dummy sucking. Sleeping position and feeding habits (breast/bottle) were not recorded because parents did not remember clearly the sleeping position and the feeding method and duration.

Results

Unilateral DDH was diagnosed on the left side in 50 per cent of children and on the right side in 21.7 per cent and the prevalence of DDH on both sides was 28.3 per cent. The DDH children had significantly more crossbites than the controls (30/9.9 per cent; $P < 0.003$). Girls had more crossbites compared to boys [77.8/22.2 per cent; odds ratio (OR) 2.53; Table 1]. Overall, 77.8 per cent of the cases were unilateral crossbites and more on the right side compared to left (50/22.2 per cent; Table 2). The association between the side of DDH and crossbite was examined, but there were no significant association found. Children having DDH on the left side had more crossbites on the right side (6/10). When the DDH was on the right side (6), crossbite exist on the left (2) or right side (2) equally (Table 2).

The results concerning the sagittal molar relationships suggest a greater prevalence of asymmetric molar relationships in the DDH group (13.3 per cent) than in the controls (8.5 per cent). The prevalence of Class AI/Class AII (corresponds right side/left side) molar relationships was 13.3 per cent in the DDH group and 5.6 per cent in the controls, whereas the proportion of Class AII/AI molar relationships was 0 per cent in the DDH group and 2.8 per cent in the controls. There was bilateral Class AI molar relationships in 65 per cent of cases in the DDH group and 69 per cent in the controls. The prevalence of bilateral Class AII molar relationships was 21.7 per cent in the DDH group and 22.5 per cent in the controls. The mean overjet was 2.8 mm (SD 1.1) in the DDH children and 3.2 mm (SD 1.6) in the controls and the mean overbite was 3.2 mm (SD 1.6) in the study group and 3.0 mm (SD 1.9) in the controls (Table 3).

The mean duration of sucking habit, including finger and dummy sucking, was 13.9 (SD 1.5) months for the DDH children and 15.5 (SD 1.7) months for the controls. There was not significant association between sucking habit and crossbite in our study, and according to logistic regression analysis, the OR was 0.97 and $P < 0.157$.

Discussion

There are only few studies concerning facial asymmetry and malocclusions in DDH children. The prevalence of crossbite in the deciduous and mixed dentitions varies from 8 to 23 per cent, being more frequent in unilateral forms (Cozza *et al.*, 2005; Ovsenik, 2009). In the present study,

DDH children had significantly more crossbites compared to controls. The prevalence of crossbite being quite high, 30 per cent in DDH children and 9.9 per cent in the controls. Mandibular asymmetry has also been reported to be linked to the development of facial asymmetry (Pirttiniemi, 1994) and it is in association with occlusal asymmetry (Staudt and Kiliaridis, 2010). Unilateral masticatory function may result in changes in the shapes and dimensions of the mandible and maxilla, and normal occlusion with bilateral symmetric masticatory function during early phases of growth are important for normal development (Pirttiniemi, 1994; Poikela, 2000). Morphological malocclusion like crossbite and anterior open bite may be a potential factor for temporomandibular joint dysfunction (Egermark-Eriksson et al., 1990).

Aetiological factors for crossbite are multifactorial. In addition to heredity, the major causes and aetiological factors of crossbite are forces resulting from sucking

habits (tongue, finger, and pacifier, lip), airway obstruction, inadequate nasal breathing, and mouth breathing, allergies, septum problems, enlarged tonsils, and adenoids and skeletal growth abnormalities (Nanda et al., 1972; Ogaard et al., 1994; Ngan and Fields, 1997). Oral habits, finger- and thumb-sucking habits if long lasting and intensive, may lead to unilateral crossbite. Sucking habits are quite normal until the age of 3 years, but the presence of these habits after that age significantly increases the development of undesirable effects on dental arch form and occlusion (Warren and Bishara, 2002). In the present study, the average duration of sucking habit was 15 months in controls and 13.5 months in the DDH children. There was not statistically significant association between the duration of sucking habit and the prevalence of crossbite.

The influence of muscular environment on general dental development has been emphasized in the study by Ghafari et al. (1988). The results showed the prevalence of open bite and posterior crossbite being higher in children with myopathies. The role of early feeding on occlusion appears quite unclear based on published literature (Karjalainen et al., 1999; Warren and Bishara, 2002). Breastfeeding and bottle feeding involve different orofacial muscles and may lead to differences in growth of the maxilla and dental arches. Breastfeeding has been found to have positive effects on the development of an infant's oral cavity, including improved shaping of the hard palate resulting in fewer malocclusions and proper tooth alignment (Palmer, 1998).

The aetiology of the DDH is multifactorial and partly unresolved. It has been associated with other congenital postural deformities like torticollis, scoliosis, and talipes (Dunn, 1976; Tien et al., 2001; von Heideken et al., 2006). Positive family history, breech presentation, female sex, oligohydramniosis, primiparity, and associated congenital anomalies are often associated with DDH (Chan et al., 1997; Herring, 2002; von Heideken et al., 2006; Abu Hassan and Shannak, 2007). Post-maturity, high birthweight, and older maternal age are also included to risk factors (Chan et al., 1997). DDH is in relation to difficult intrauterine position, when the hip is pushed against the mother's lumbosacral spine. In the study by Watson (1971),

Table 1 The prevalence of crossbite in the dysplasia of the hip (DDH) and in the control children.

Study group	n	Crossbite % (n)	Girls	Boys
DDH	60	30% (18)	35% (14)	20% (4)
Controls	71	9.9% (7)	8.5% (6)	1.4% (1)
Chi-square analysis		P < 0.003***		

Table 2 The association of side of crossbite and side of dysplasia of the hip (DDH).

DDH	n	Crossbite right	Crossbite left	Crossbite right and left
Right	5	2	2	1
Left	10	6	2	2
Right and left	3	1	1	1
Total	18	9	5	4

DDH right: luxation right, subluxation right, and luxation right and subluxation left; DDH left: luxation left, subluxation left, and luxation left and subluxation right; DDH right and left: luxation right and left and subluxation right and left.

Table 3 Comparison of the molar relationships, overjet, and overbite in dysplasia of the hip (DDH) and control children.

Study group	Symmetric molar relationship % (n)	Asymmetric molar relationship % (n)	AI/AI % (n)	AII/AII % (n)	AI/AII % (n)	AII/AI % (n)	Overjet mean (mm)	Overbite mean (mm)
DDH	86.7 (52)	13.3 (8)	65 (39)	21.7 (13)	13.3 (8)	0	2.79 (SD 1.07)	3.15 (SD 1.61)
Controls	91.5(65)	8.5 (6)	69 (49)	22.5 (16)	5.6 (16)	2.8 (4)	3.23 (SD 1.61)	3.00 (SD 1.90)

AI/AI: Class I molar relationship on the right side/Class I on the left side; AII/AII: Class II molar relationship on the right side/Class II on the left side; AI/AII: Class I molar relationship on the right side/Class II on the left side; AII/AI: Class II molar relationship on the right side/Class I on the left side.

the relation between the side of plagiocephaly, dislocation of hip, scoliosis, bat ears, and sternocleidomastoid tumour was investigated and they reported a relation between various asymmetric features.

Posterior deformational plagiocephaly has been related to supine sleeping position (Peitsch *et al.*, 2002; Darvann *et al.*, 2006) and children with plagiocephaly have increased risk for cranial and mandibular asymmetry (St. John *et al.*, 2002; van Vlimmeren *et al.*, 2004). The mandibular asymmetry in deformational posterior plagiocephaly has been suggested to be secondary to rotation of the cranial base and anterior displacement of the temporomandibular joint (TMJ) and the degree of auricular displacement was found to correlate with the severity of cranial asymmetry (St. John *et al.*, 2002). In the present patient sample, DDH children were treated by the method of Von Rosen splint therapy and the method has been generally used from the 1970s. During the treatment, child is forced for approximately 7–12 weeks on his back-sleeping position and the hip is stabilized by the splint. The position and movement of head is restricted and this may increase the risk for cranial asymmetry. The prevalence of head shape asymmetries and plagiocephaly in DDH children has not been reported. There are reports on association of DDH and muscular torticollis, the prevalence of DDH being 15–20 per cent in children with muscular torticollis (Iwahara and Ikeda, 1962; Hummer and MacEwen, 1972; Tien *et al.*, 2001).

DDH has been reported to occur four times more frequent in girls than boys and in the unilateral DDH cases, it has been diagnosed four times more often on the left hip compared to the right hip and bilaterally in 25 per cent of the cases (Aronsson *et al.*, 1994; Cady 2006). The results of this study confirm the previous findings, DDH being more common on the left side.

This finding reflects the deformational aetiology of DDH because babies use to have their left hip adducted *in utero* and the hip is in unstable position, secondary to pressure from their mother's sacrum (Cady, 2006). Our finding supports these reports, the prevalence of DDH in girls being larger and DDH being more common on the left side. The possible association between the side of DDH and crossbite was examined in our study, but there were no significant association found. Children having DDH on the left side tend, however, to have more crossbites on the right side, but when the DDH is located on the right side, crossbite exist either on the left or right side.

Genetic factors are also important in the aetiology of DDH and there is a tendency for typical DDH, to occur in certain families. Family studies have provided evidence that there is genetic predisposition to DDH based on polygenic-multifactorial inheritance (Record and Edwards, 1958; Chan *et al.*, 1997). It has been shown that acetabular dysplasia and increased ligamentous laxity may be in part inherited as a multiple gene system (Wynne-Davies, 1970). The increased joint laxity in the congenital DDH patients has been suggested to be due to an anomaly of oestrogen

metabolism (Andren and Borglin, 1961) in addition to familial joint laxity (Carter and Wilkinson, 1964). The increased laxity of capsule around joint may also include temporomandibular joint and children with DDH and associated asymmetric growth and crossbite may be later in life predisposed to TMJ problems.

In the present study, children with DDH were found to have increased prevalence of occlusal asymmetry. The genetic and environmental factors including intrauterine conditions in addition to the splint therapy may be possible influencing factors. It has been already known that infants may born with asymmetries due to their intrauterine position and asymmetries from early infancy can lead to permanent deformation of the head, neck, and face (Stellwagen *et al*, 2008). The orthodontic treatment of malocclusions with asymmetries are often difficult and long lasting to treat especially in adulthood. Therefore, early detection and identification of the aetiological risk factors for asymmetric growth will give the opportunity to prevent asymmetric growth and possible TMJ problems and improves the effectiveness and success of treatment. In the future also the methods for the treatment of DDH may improve the possibility to avoid the risk for asymmetric growth.

Conclusions

Children with congenital hip dislocation are more predisposed to asymmetric growth of occlusion and development of lateral crossbite. This study will give additional information of the development of occlusal asymmetries and the multifactorial nature of the aetiology of lateral malocclusions.

Acknowledgements

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