

# Comparison of lip incompetence by remote video surveillance and clinical observation in children with and without cerebral palsy

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**SUMMARY** This study aimed to compare two methods of assessing lip position so that an appropriate method could be used to assess whether a relationship existed between lip position and drooling in children with cerebral palsy. This investigation compared the use of a new, remote video surveillance (RVS) technique with direct clinical assessment of lip position by determination of intra- and inter-examiner agreement. Lip position was assessed in both techniques using the Jackson lip classification. Two groups of school children took part: one group suffered from cerebral palsy (CP), but the second group consisted of unaffected individuals. Based on Kappa statistics, intra- and inter-examiner agreements were generally found to be moderate for the individual methods ( $\kappa = 0.48\text{--}0.54$ ), whilst agreement between the two methods was found to be good ( $\kappa = 0.68$ ). The results showed moderately good examiner-agreement in the assessment of lip position, using either method and the Jackson lip classification. Consequently, lip position can be assessed by either RVS or direct clinical assessment, the choice depending on the physical circumstances surrounding the assessor and operator preference. However, RVS may offer a more unobtrusive approach.

## Introduction

Children with cerebral palsy (CP) may suffer difficulties including mental and physical, as well as oral and dental problems. A major oral problem is acknowledged to be drooling and it has been suggested that this occurs due to lack of oral and peri-oral sensory perception (Blasco *et al.*, 1990) or due to an inability to maintain jaw closure interfering with the ability to form a lip seal (Ray *et al.*, 1983). However, it has also been reported that drooling may spontaneously resolve (Franklin, 1993; Franklin *et al.*, 1996), whilst in unaffected children, lip competence may change with age (Vig and Cohen, 1979). Nevertheless, though orthodontic treatment for CP children has been attempted and has mostly been aimed at achieving an anterior oral seal, claims for a reduction in drooling have

been anecdotal (Fischer-Brandies *et al.*, 1987; Limbrock *et al.*, 1990; Becker and Shapira, 1996). In addition, the relationship between lip position and drooling is unknown and changes in lip length and thickness (Mamandras, 1988) and lip competence with age (Vig and Cohen, 1979) have only been assessed cephalometrically in normal populations, despite the problems associated with cephalometric assessment being well known (Houston *et al.*, 1992; Tng *et al.*, 1994). This study therefore formed the first stage of an investigation to assess relationships between age, lip position, drooling, and CP. In order to do this, a method had to be established by which lip position could be assessed and it is this aspect which is described in the present paper. Ultimately, if successful, it would allow the relationship between lip position and age to be assessed in

unaffected children, and allow comparison with children with CP so that associations with drooling could be investigated.

The assessment of the orofacial soft tissues for orthodontic purposes is known to be difficult (Houston *et al.*, 1992), but its importance has recently been emphasized by Ackerman and Proffit (1997). Furthermore, Ackerman *et al.* (1999) have stated that 'a paradigm shift' is required in orthodontics so that greater account is taken of soft tissue assessment. They pointed out that for this to happen, new information and new methods of assessing the soft tissues are needed. This study was therefore intended to develop a means of assessing lip position (and, indirectly, lip competence) in children with CP and unaffected children. By assessing these two groups, it was felt that the method developed would be relatively robust as the groups chosen represented extreme variations. However, previous experience (Franklin, 1993; Franklin *et al.*, 1996) had shown that children with CP were unlikely to take part in a study that might be seen as invasive or involve techniques requiring complex co-operation (including travel when this would not be of direct benefit to their condition). Furthermore, few children with CP attended the Leeds Dental Institute. Therefore, in order to: maximize participation, but minimize the demands placed upon both the children and their carers, and gain access to a wide age range and achieve a useful sample size, the study was to be school-based. Consequently, the technique needed to be unobtrusive, allow record keeping and, as far as was possible, minimize disruption to the schools. Various methods have been used to assess lip position, but they have mostly related to aesthetics or to the smile line, and since lips are mobile structures, influenced by emotion, methods to assess their position are difficult (Nicol, 1955). Those methods that have been used are based on direct clinical examination, photographic, or cephalometric methods; videos have been utilized, but only comparatively recently.

### *Radiographic*

Such methods, as well as being invasive, clearly did not lend themselves to use within schools.

However, the relationship of the lip line to the incisor teeth has been undertaken using profile radiographs (Nicol, 1955), and growth of the soft tissue facial structures was analysed cephalometrically by Subtelny (1959), as well as more recently by Vig and Cohen (1979) and Mamandras (1988). These studies used serial radiographic records of untreated subjects to investigate the growth of the lips relative to the skeletal structures (Subtelny, 1959) or the relative and absolute growth changes in lip morphology and lip length in growing children (Vig and Cohen, 1979; Mamandras, 1988). Nevertheless, as well as the invasive nature of cephalometry, it may also suffer from problems with respect to posturing and positioning. Whilst measurement error can be assessed, this would not encompass errors of posture.

### *Photographic*

Comparatively few such studies exist. Hulseley (1970), in an investigation to evaluate the lip-tooth relationship present in the smile, used a standardized orientated frontal photograph of each subject's face, taken when the subject was asked to smile. Each photograph was rated by 20 lay assessors into five categories (poor, fair, good, very good, and excellent). Although the intra-examiner agreement of the assessors was good, inter-examiner ratings were said to be 'widespread'. Consequently, although less invasive than radiographs, the method was relatively subjective and may still have included a postured rather than a 'natural' smile.

More recently, Ackerman *et al.* (1998) scanned photographs into a computer using a multimedia program in order to assess the aesthetics of posed smiles with the aid of a smile mesh. Although this method used non-standardized photographs, the correlation coefficients for inter-examiner reliability and smile reproducibility were high. However, it has been suggested that this is not the ideal way of assessing inter-examiner reliability, since correlations would be expected to be high when examiners measure the same aspects of the same items (Houston, 1983). In addition, whilst the method demonstrated a means of specifically assessing the smile, it did not assess lip position

**Table 1** The Jackson Lip Classification (1962) for the upper and lower lips.

Upper lip relative to the upper incisors	Lower lip relative to the upper incisors
Grade 0—when viewed horizontally, the middle third of the lower border of the upper lip is positioned above the crowns of the central incisor teeth.	Grade 0—when viewed horizontally, the middle third of the upper border of the lower lip is positioned below the crowns of the central incisor teeth.
Grade 1—when viewed horizontally, the middle third of the lower border of the upper lip covers any part of the cervical third of the crown.	Grade 1—when viewed horizontally, the middle third of the upper border of the lower lip covers any part of the incisal third of the upper incisor crown.
Grade 2—the middle third of the lower border of the upper lip covers any part of the middle third of the crown.	Grade 2—the middle third of the upper border of the lower lip covers any part of the middle third of the upper incisor crown.
Grade 3—the middle third of the lower border of the upper lip covers any part of the incisal third.	Grade 3—the middle third of the upper border of the lower lip covers any part of the cervical third of the upper incisor crown.
	A negative grade indicates that the lower lip is trapped behind the upper incisors.

or competence, and therefore could not be used for the present study.

### Clinical

Lips are frequently classified as competent or incompetent, but whilst simple to use and non-invasive, this assessment is too crude for assessing changes in lip position. It has been stated that only two positions of the upper and lower lips are reproducible and suitable for study: the lip position at rest and the lip position at maximum smile (Peck *et al.*, 1992). The lip position at rest has been classified into four grades (Table 1) for both the upper and lower lip (in relation to the upper incisors), instead of only using the terms competent/incompetent (Jackson, 1962). Unfortunately, although the method has been used in clinical studies (Haynes, 1975, 1977), no reproducibility tests have ever been carried out.

Recently, Peck *et al.* (1992) measured upper lip–tooth–jaw relationships in the vertical dimension both at rest and on smiling. Measurements were made directly on the face in the two positions. Lip competence was assessed from measurements of the inter-labial gap. Once again, although the difficulty of measuring lip lengths and position was acknowledged as great, no error study was performed. In addition, marking the face in order to obtain direct measurements was not a suitable option for the current study,

since many children with CP have facial tremors and other uncontrollable movements.

In the circumstances, in order try and assess lip position in detail, it was decided to use the Jackson classification. However, to overcome the problem of postured lip positions being assessed, the option of remote video surveillance (RVS) was considered. Video cameras have been used in medicine in behavioural and postural studies, although most have not described the method in detail. For example, Kaplan (1995) used a video camera to compare pedalling smoothness of children with CP and those without. Myhr *et al.* (1995) carried out a 5-year follow-up of functional sitting position of children with CP using a video camera and photographic records. A similar postural study was undertaken by Green *et al.* (1995) to investigate the ability of unaffected infants and those with CP to lie and sit. An exception to these more general, postural studies, is the work of Ekman and Friesen (1982) who used video recordings to develop the facial action coding system to measure, in detail, facial movement. However, whilst this method focused on the anatomy, action and resulting facial appearance of each muscle activity (as demonstrated by frame-by frame analysis of video recordings), it does not relate the muscle action to the teeth in a quantifiable manner. Furthermore, the authors acknowledged that their method did not include all of the distinguishable

actions of the lower part of the face due to the 'nearly infinite number of actions of the hinged lower jaw and rubbery lips'. Subsequently, Nafziger (1994) used the method to assess facial expression in patients pre- and post-orthognathic surgery. Details of the set up are lacking and, once more, were not apparently standardized. Nevertheless, the method appeared to meet the needs of that study satisfactorily.

Whilst video recordings have also been used to assess food consistency and swallowing activity in children with CP (Croft, 1992), covert use of video recordings is probably best known in the detection of Munchausen syndrome by proxy, a form of child abuse in which the carer exacerbates illness in the child to obtain medical attention (Freeman *et al.*, 1993). Such techniques have been shown to give a sensitivity of over 90 per cent in suitably screened cases (Samuels and Southall, 1992).

In dentistry, video recordings have been used to assess behavioural aspects in children, such as whether behaviour alters according to the presence or absence of parents during dental treatment (Fenlon *et al.*, 1993). Tsinidou *et al.* (1992) used the method to compare the sedative effectiveness of two drugs in children by assessment of crying, movement, sleep, and overall behaviour. The video recordings were then evaluated by three assessors who gave their ratings individually. Since inter-examiner agreement showed that out of 708 evaluations, 93 per cent fully agreed (the remainder only differing from each other by not more than a scale point) the method was shown to be reproducible.

Lip and tongue function have also been assessed in children with Downs' syndrome and compared with the function of that of unaffected children (Glatz-Noll and Berg, 1991). The study group consisted of children ranging from 2 months to 12 years of age, but the control group only involved children of less than 4 years of age. This was because objective recordings of older children were found to be more difficult due to their increased awareness of being filmed (RVS not being used). All recordings took 5 minutes; measurements were made twice and the error of the method was found to be

relatively small. For example, for tongue protrusion, the error was 2.9 seconds during double registrations of 5 minutes. Video recordings have also been used to assess surgical, cosmetic, and functional success following cleft lip and palate surgery (Morrant and Shaw, 1996). In that study, the variables assessed were not the same as those in the present investigation, but inter-examiner agreement was found to range from moderate to good when the symmetry of upper lip movement was studied.

Such studies show that, despite lack of standardized techniques, video recordings can be used to assess some variables, especially if they involve behaviour or posture. However, information regarding examiner reliability and reproducibility using video recordings is limited and, apart from their use in Munchausen syndrome by proxy, none have used a RVS technique. As this research was intended to maximize participation by taking the study to schools and by using as atraumatic a technique as possible, it was decided to combine the use of a simple, clinical assessment of lip position (the Jackson classification) with the use of a remote video recording. This paper describes how this method compared with direct, clinical assessment of lip position by assessing both intra- and inter-examiner agreement. The results of the investigation of the relationships between age, lip position, drooling, and CP will be described separately.

## Subjects and materials

Appropriate applications for ethical approval in order to gain consent before approaching the special, and ordinary primary and secondary schools (in the Leeds area) were submitted to and approved by the Leeds Western Health Authority Research Ethics Committee. Consent from the schools, as well as from parents or guardians was required. A letter, information sheet, and consent form were sent to all the schools involved, and then to the parents or guardians once a school had agreed to participate. Ethical approval also allowed access to children attending the Paedodontic and Orthodontic Departments of the Leeds Dental Institute.

### Assessment of lip position

The Jackson lip classification (Jackson, 1962) was used to assess lip position at rest, both from the video recording and by direct clinical assessment. The assessment is shown in Table 1.

### Selection criteria

As the children formed part of a larger study, the selection criteria were as follows:

1. Children were not to have any digit-sucking habits or, if they had, these should have ceased at least 1 year previously as the habit may have affected their true occlusion (and, indirectly, lip position). However, it was felt that if the habit had ceased over a year earlier, then it was likely that relapse to the true position would have occurred.
2. Children were not to have had or be undergoing any orthodontic treatment.

Once consent had been obtained, data collection for each individual for the study involved several procedures:

*Visit 1:* photographing the childrens' faces for identification purposes.

*Visit 2:* videoing of the particular participant without their knowledge. The aim was to record the position of the upper and lower lips in relation to the upper incisors when the mandible was considered to be in the rest position. However, as the intention was to assess intra-examiner agreement of lip position, a number of individuals were videoed on two separate occasions, but not more than 4 weeks apart. As the participants were growing children it was decided not to leave more than 4 weeks between recordings in case growth itself influenced the findings. The children involved in this part of the investigation are shown in study A and Table 2. All the various aspects of the research are described in studies A–E. The sample sizes were based, where possible, on using a minimum of

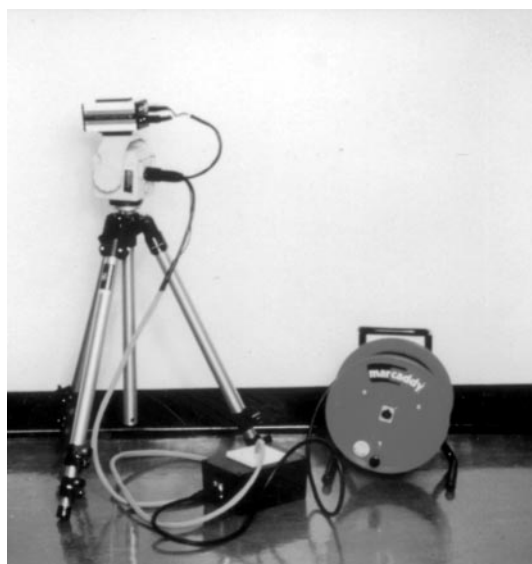
**Table 2** Participants in studies A and D to assess the reproducibility of lip position over time.

Total number of participants	Age (years)			Sex	
	14	15	16	Male	Female
(CP) ( <i>n</i> = 11)	4	3	4	9	2

approximately 10 per cent of the total sample size for the major sample (which was intended to be approximately 60 children per group).

### The video technique and the direct, clinical assessment of lip position

The rest position of the lips was assessed using a RVS (Figures 1 and 2) in order to avoid recording a postured position. This method was used to try and ensure that participating children were not aware (conscious) of being observed. The video camera was approximately the size of an egg box with a small, retractable lens within a



**Figure 1** The remote video surveillance camera with its tripod and cabling.



**Figure 2** The video monitor and the remote pan/tilt/zoom control unit.

fixed length tube. Consequently, when the lens zoomed in or out to focus, no evidence of this was outwardly visible. The system also had a pan and tilt mechanism, which allowed the lens to be turned to face in the appropriate direction. However, as this resulted in the whole camera box being manoeuvred, it was not evident to any one individual exactly who the camera was facing. The video system consisted of a 460-line resolution  $\times 12$  auto focus remote zoom camera (Broadcast Equipment Ltd., Camberley, UK); a 12-volt pan/tilt unit (Videmech, Newport, South Wales, UK); QVS PT 12 Pan/tilt controller with zoom control (Quadrant, Nottingham, UK); QVS extendable portable camera support (Quadrant, Nottingham, UK); TC 14 S 1 RH 14-inch colour monitor (Panasonic, Bracknell, UK); and a video player (Panasonic), and control cables, video cables, power supply, and fittings with portable cable drum.

The auto focus remote zoom control was positioned in a corner of each classroom or clinic. Consequently, the distance of the camera from each participant varied, but it was important that its position did not interrupt their activities. The lighting used was that in the

classroom or clinic. The participant was observed through the colour monitor and the maximum close-up view gave a magnification of  $\times 12$  on the monitor. A close-up of the mouth area was obtained using the QVS PT pan/tilt controller. The pan/tilt controller could be moved approximately 90 degrees to each side (right and left), and about 45 degrees up and down. Therefore, any movement of the participant within these angles could be videoed. The monitor, observer (NZ), and the pan and tilt unit were positioned either in the same room or in a separate room depending on the layout of the school and individual school requirements. Each child was videoed until the observer was satisfied that the rest position of the lips had been recorded. This therefore allowed repeated observation of the video. According to Jackson (1962), the rest position occurs when the participant is sitting upright and when the mandible is in the physiological rest position with the orofacial muscles completely relaxed. Direct clinical assessment of lip position was also carried out using the Jackson classification as previously described at the same time as visit 1, but without telling the individual that it was being undertaken.



**Table 3** Participants in studies B and D.

Total number of participants ( <i>n</i> = 16)	Age (years)			Sex	
	5–8	9–13	14–19	Male	Female
CP	4	4	0	2	6
Unaffected	2	3	3	2	6
Total	6	7	3	4	12

*Study A: to assess the reproducibility of lip position over time (by intra-examiner agreement) —assessment of two videos of children with CP, taken at separate times (Table 2)*

As only one school with CP children had allowed more than two visits to carry out the data collection, this school was used for this aspect of the study. Eleven children with CP, all of them of secondary school age, were videoed twice on two separate days. The videos were viewed once for each recording by the main observer. This group was also involved in study D.

*Study B: to assess intra- and inter-examiner agreement of the Jackson lip classification using the video technique (Table 3)*

Sixteen participants were involved. Eight CP children (four of primary and four of secondary school age) and eight unaffected children (three of primary and five of secondary school age) were included. The video recordings were viewed twice by the main observer and by a second observer (FL). Each viewing was separated by one week. Each observer made their own independent assessment.

The lip position of the unaffected children in this study was also assessed clinically twice, at least 2 weeks, but not more than 4 weeks apart for each participant. The results were compared with the CP children as described in study D.

*Study C: to assess inter-examiner agreement of the Jackson lip classification clinically (Table 4)*

Ten unaffected children who attended the Orthodontic Department of the Leeds Dental

**Table 4** Participants in study C (unaffected children).

Total number of participants	Age (years)		Sex	
	10–13	14–17	Male	Female
(unaffected; <i>n</i> = 10)	7	3	1	9

Institute were involved in this part of the study, but not in the main investigation. Both the examiners clinically assessed the lip position independently on the same day and then the readings were compared.

*Study D: to assess intra-examiner agreement of lip position in the same individual (over time) clinically using the Jackson lip classification (Tables 2 and 3)*

The same 11 children as in study A (Table 2) were involved, together with the eight unaffected children from study B (Table 3). The lip position was measured twice clinically at least 2 weeks, but not more than 4 weeks apart for each participant and the results were compared.

*Study E: to compare, by intra-examiner agreement, the video assessment of lip position with the clinical assessment of lip position (Table 5)*

Lip position was assessed in 35 participants (unaffected children) to compare the video and clinical assessment using the Jackson lip classification (1962). It was undertaken to

**Table 5** Participants in the study to assess intra-examiner agreement of the video assessment with the direct, clinical assessment of lip position.

Total number of participants	Age (Years)			Sex	
	5–9	10–14	15–19	Male	Female
(Unaffected, <i>n</i> = 35)	14	15	6	14	21

**Table 6** Value for kappa and the strength of agreement.

Value of $\kappa$	Strength of agreement
<0.20	Poor
0.21–0.40	Fair
0.41–0.60	Moderate
0.61–0.80	Good
0.81–1.00	Very good

$\kappa$  = kappa value

establish whether clinical and video assessment showed good agreement in an attempt to measure validity.

## Results

All the results were analysed using Kappa ( $\kappa$ ) statistics (Altman, 1991) as shown in Table 6. The number of children in the studies to assess examiner agreement varied due to restrictions placed by the schools on access and the number of visits allowed. Increasing the number of visits to the schools would have led to some schools refusing access. Consequently, as the error studies needed to be completed before the main study could proceed, the numbers were necessarily minimized. Study E, where the number of subjects was larger, was undertaken later as the outcome of the earlier studies was satisfactory.

*Study A: to assess the reproducibility of lip position over time (assessment of two videos of children with CP, taken at separate times, Table 2)*

Intra-examiner agreement:  $\kappa = 0.48$  = moderate agreement.

*Study B: to assess intra- and inter-examiner agreement of the Jackson lip classification using the video technique (mixed sample involving CP and unaffected children, Table 3)*

Intra-examiner agreement:  $\kappa = 0.49$  = moderate agreement.

Inter-examiner agreement:  $\kappa = 0.51$  = moderate agreement.

*Study C: to assess inter-examiner agreement of the Jackson lip classification clinically (unaffected children, Table 4)*

Inter-examiner agreement:  $\kappa = 0.51$  = moderate agreement.

*Study D: to assess intra-examiner agreement of assessing lip position in the same individual (over time) clinically using Jackson lip classification (Tables 2 and 3)*

Intra-examiner agreement:  $\kappa = 0.54$  = moderate agreement (CP children).

Intra-examiner agreement:  $\kappa = 0.36$  = fair agreement (unaffected children).

*Study E: to assess intra-examiner agreement of the video assessment of lip position with the clinical assessment of lip position (unaffected children, Table 5)*

Intra-examiner agreement:  $\kappa = 0.68$  = good agreement. Bearing in mind the results of study D, the good agreement found in study E may even have been improved had it involved children with CP.

## Discussion

This study showed that it is possible to achieve fair-to-moderate agreement for the assessment of lip position, using either direct, clinical assessment, or indirectly, from a video recording using the Jackson lip classification. The fact that good agreement was found between the two methods also lent support to the validity of the assessment. However, it was noted that the results for intra-examiner agreement (over time) using the video showed moderate agreement whilst direct, clinical assessment (over time) produced only 'fair' agreement, i.e. was less satisfactory than the video recording, at least for the unaffected children.

Children with CP were included in the study for the reasons mentioned, but also because it



was felt that they would have more difficult lip positions to assess and thus maximize the likely errors encountered. It is perhaps not surprising that agreement was not better due to the ease with which individuals may posture, especially if they become aware that their lips are being observed. However, the fact that intra-examiner agreement with respect to the children with CP was better than that for the unaffected children was surprising. This may have been due to the unaffected children having developed awareness of what was being observed during direct, clinical assessment, even though they had not been specifically informed. Also, they may have paid more attention to the activities of the examiner on the second occasion. This result suggests that covert video recording offers a more unobtrusive method than direct clinical assessment. In addition, the children with CP were severely physically handicapped and five were also probably mentally handicapped (although data on this latter aspect were not collected), which may have affected their ability to interact with their surroundings. Had it been possible to standardize positioning of the video system, even greater examiner agreement may have been feasible, but due to the 'field' conditions encountered, this was not possible.

## Conclusions

The Jackson lip classification provides moderate inter- and intra-examiner agreement of lip position and can be used satisfactorily either directly, clinically, or via a remote, video surveillance recording. However, the video system offered a more unobtrusive method and allowed a longer period of assessment, which may provide better opportunity to determine when the rest position has been achieved. Overall, the system was considered sufficiently robust for use in the study to analyse relationships between age, lip position, drooling, and CP. Finally, whilst it is acknowledged that a weakness of the present study was the lack of a standardized setting, nevertheless, the results suggest that for future use, if the provision of standardized settings is feasible, then this might further improve the value of the method in making soft tissue assessments.

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## References

- Ackerman J L, Proffit W R 1997 Soft tissue limitations in orthodontics: treatment planning guidelines. *Angle Orthodontist* 67: 327–336
- Ackerman J L, Ackerman M B, Brensinger C M, Landis J R 1998 A morphometric analysis of the posed smile. *Clinical Orthodontics and Research* 1: 2–11
- Ackerman J L, Proffit W R, Sarver D M 1999 The emerging soft tissue paradigm in orthodontic diagnosis and treatment planning. *Clinical Orthodontics and Research* 1: 49–52
- Altman D G 1991 *Practical statistics for medical research*. Chapman, London.
- Becker A, Shapira J 1996 Orthodontics for the handicapped child. *European Journal of Orthodontics* 18: 55–67
- Blasco P A *et al.* 1990 Consensus statement of the consortium on drooling, July 10–11, University of Virginia Health Sciences Center, Charlottesville, Virginia (©United Cerebral Palsy Associations Inc.) USA
- Croft R D 1992 What consistency of food is best for children with cerebral palsy who cannot chew? *Archives of Disease in Childhood* 67: 269–271
- Ekman P, Friesen WV 1982 Measuring facial movement with the facial action coding system. In: Ekman, P (ed.) *Emotion in the human face*, 2nd edn. Cambridge University Press, Cambridge, pp. 178–211
- Fenlon W L, Dabbs A R, Curzon M E 1993 Parental presence during treatment of the child patient: a study with British parents. *British Dental Journal* 174: 23–28
- Fischer-Brandies H, Avallé C, Limbrock G J 1987 Therapy of orofacial dysfunctions in cerebral palsy according to Castillo-Morales: first results of a new treatment concept. *European Journal of Orthodontics* 9: 139–143
- Franklin D L 1993 The prevalence of malocclusion in children with cerebral palsy. Thesis, University of Leeds
- Franklin D L, Luther F, Curzon, M E J 1996 The prevalence of malocclusion in children with cerebral palsy. *European Journal of Orthodontics* 18: 637–643

- Freeman L N, Mokros H, Poznanski E O 1993 Violent events reported by normal school aged children: characteristics and depression correlates. *Journal of the American Academy of Child and Adolescent Psychiatry* 32: 419–423
- Glatz-Noll E, Berg R 1991 Oral dysfunction in children with Down's syndrome: an evaluation of treatment effects by means of video registration. *European Journal of Orthodontics* 13: 446–451
- Green E M, Mulcahy C M, Pountney T E 1995 An investigation into the development of early postural control. *Developmental Medicine and Child Neurology* 37: 437–448
- Haynes S 1975 The lower lip position and incisor overjet. *British Journal of Orthodontics* 2: 201–205
- Haynes S 1977 Prevalence of upper lip posture and incisor overjet. *Community Dentistry and Oral Epidemiology* 5: 87–90
- Houston WJB 1983 The analysis of errors in orthodontic measurements. *American Journal of Orthodontics* 83: 382–390
- Houston W J B, Stephens C D, Tulley W J (eds) 1992 Cephalometric analysis. In: *A textbook of orthodontics*, 2nd edn. Butterworth-Heinemann Ltd, Oxford, pp. 80–118
- Hulsey C M 1970 An esthetic evaluation of lip-teeth relationships present in the smile. *American Journal of Orthodontics* 57: 132–144
- Jackson D 1962 Lip positions and incisor relationships. *British Dental Journal* 112: 147–155
- Kaplan S L 1995 Cycling patterns in children with and without cerebral palsy. *Developmental Medicine and Child Neurology* 37: 620–630
- Limbrock G J, Hoyer H, Scheying H 1990 Drooling, chewing and swallowing dysfunction in children with cerebral palsy: treatment according to Castillo-Morales. *Journal of Dentistry for Children* 57: 445–451
- Mamandras A H 1988 Linear changes of the maxillary and mandibular lips. *American Journal of Orthodontics and Dentofacial Orthopedics* 94: 405–410
- Morant D G, Shaw W C 1996 Use of standardized video recordings to assess cleft surgery outcome. *Cleft Palate-Craniofacial Journal* 33: 134–142
- Myhr U, Von Wendt L, Norrlin S, Radell U 1995 Five-year follow-up of functional sitting position in children with cerebral palsy. *Developmental Medicine and Child Neurology* 37: 587–596
- Nafziger Y J 1994 A study of patient facial expressivity in relation to orthodontic/surgical treatment. *American Journal of Orthodontics and Dentofacial Orthopedics* 106: 227–237
- Nicol W A 1955 The relationship of the lip line to the incisor teeth. *Dental Practitioner* 6: 12–17
- Peck S, Peck L, Kataja M, 1992 Some vertical lineaments of lip position. *American Journal of Orthodontics and Dentofacial Orthopedics* 101: 519–524
- Ray S A, Bundy A C, Nelson D L 1983 Decreasing drooling through techniques to facilitate mouth closure. *American Journal of Occlusal Therapy* 37: 749–753
- Samuels M P, Southall D P 1992 Munchausen syndrome by proxy. *British Journal of Hospital Medicine* 47: 759–762
- Subtelny J D 1959 A longitudinal study of soft tissue facial structures and their profile characteristics, defined in relation to underlying skeletal structures. *American Journal of Orthodontics* 45: 481–507
- Tng T H, Chan T C, Hägg U, Cooke M S 1994 Validity of cephalometric landmarks. An experimental study on human skulls. *European Journal of Orthodontics* 16: 110–120
- Tsinidou K G, Curzon M E, Sapsford D J 1992 A study to compare the effectiveness of temazepam and a chloral hydrate/hydroxyzine combination in sedating paediatric dental patients. *International Journal of Paediatric Dentistry* 2: 163–169
- Vig P S, Cohen A M 1979 Vertical growth of the lips: A serial cephalometric study. *American Journal of Orthodontics* 75: 405–415