



Jones, T., Leary, S., Atack, N., Chawla, O., Ness, A., Ireland, A., & Sandy, J. (2016). Are photographs a suitable alternative to dental study casts when assessing primary surgical outcome in children born with unilateral cleft lip and palate? *European Journal of Orthodontics*, 38(4), 341-344. DOI: 10.1093/ejo/cjv058

Link to published version (if available):
[10.1093/ejo/cjv058](https://doi.org/10.1093/ejo/cjv058)

[Link to publication record in Explore Bristol Research](#)
PDF-document

This is the accepted author manuscript (AAM). The final published version (version of record) is available online via Oxford University Press (OUP) at DOI: <http://dx.doi.org/10.1093/ejo/cjv058>. Please refer to any applicable terms of use of the publisher.

University of Bristol - Explore Bristol Research

General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:
<http://www.bristol.ac.uk/pure/about/ebr-terms.html>

Are photographs a suitable alternative to dental study casts when assessing primary surgical outcome in children born with unilateral cleft lip and palate?

Abstract

Objective: To compare the use of the 5 Year Olds' Index on both dental study casts and intraoral photographs when measuring primary surgical outcome for children born with unilateral cleft lip and palate (UCLP).

Design: A cross-sectional study.

Setting: Models and photographs collected from cleft units across the United Kingdom as part of the CCUK (Cleft Care UK) study were scored by two clinicians at the School of Oral and Dental Sciences, Bristol, United Kingdom.

Participants: Five year old children born with UCLP as part of the CCUK study. 198 had dental study casts available and 49 had intraoral photographs available.

Methods: The records of both groups, i.e. study casts (n=198) and photographs (n=49) were scored using the 5 Year Olds' Index on two occasions by two examiners.

Results: Reliability of scoring is reduced for intraoral photographs compared to dental study casts. Using weighted Kappa the inter-rater reliability for dental study casts was 0.72 to 0.77 and the inter-rater reliability for intraoral photographs was 0.52 to 0.59.

Limitations: The photographs and study casts were not matched for each individual and were collected by a number of different clinicians in each unit, both of which will have had an effect on the quality and consistency of the final records.

Conclusions: Dental study casts provide more reliable results and thus still represent the gold standard when assessing primary surgical outcome in cleft care using the 5 Year Olds' Index.

Introduction

Primary surgical outcomes for children born with a cleft can be measured with a number of different indices such as the GOSLON Yardstick (used in 10 year olds) (1) or the 5 Year Olds' Index (used in 5 year olds) (2). In both cases outcome is assessed by scoring the patient study models against a reference set of models developed for each index. This method has been found to be reliable (3, 4), but dental impressions have to be taken of the patient in order to produce the dental study casts. This can be difficult in a five year old child and alternative approaches have been developed to assess primary surgical cleft outcomes.

Nollet *et al.* previously applied the GOSLON Yardstick to photographs of dental study casts (5) and found them to be as reliable as the casts. Although photos can be more easily stored and the casts subsequently destroyed to reduce demands on storage space, dental impressions still need to be taken for this method in order to produce the dental study casts. Liao *et al.* in 2009 compared the reliability of scoring using the GOSLON Yardstick on dental study casts and direct intraoral dental photographs (6) and found no significant difference in scoring reliability between the two media. A similar comparison has also been carried out using the 5 Year Olds' Index again with little difference in reliability being found between intraoral photographs and dental study casts (7).

This would suggest that we should routinely use intraoral photographs as opposed to dental study casts in order to make it is easier for both the patient and clinician when assessing surgical outcome at 5 and 10 years of age.

To confirm whether photographs can be used instead of study models we used the 5 Year Olds' Index to score a series of dental study casts and intraoral photographs derived from a large national study.

Method

We conducted a cross sectional study (known as Cleft Care UK, CCUK) of five-year-old children born with unilateral cleft lip and palate (UCLP). This study is described in detail elsewhere (8). Briefly, we collected records of five-year-old children from cleft centres in the UK born over a two year period. The cleft centres were asked to identify eligible participants with defined inclusion and exclusion criteria. The inclusion criteria comprised:

- *Five year old children born with complete unilateral clefts of the lip and palate, including any with soft tissue Simonart's bands of less than 5mm.*
- *Children born between 01/04/2005 and 31/03/2007.*
- *The child was aged between 5.3 and 5.9 years. If a child failed to attend the initial scheduled research audit clinic, they were invited to attend the subsequent clinic up until the age of 6.5 years, although some children were included outside these age ranges and adjusted for in the final analysis.*

Exclusion criteria included associated syndromes or developmental delay, which interfered with record collection, or because parents and/or the child declined to participate in the study.

A sample of 198 dental study casts were available from a total sample of 268 children included in the national study. Seventy of these refused to have dental impressions. However, 49 of these 70 children did consent to intraoral photographs being taken. These intraoral

photographs were then used instead of dental study casts to measure the primary surgical cleft outcome for these 49 children.

Standardised instructions were given to each unit detailing the technique for taking intraoral photographs. For each child where intraoral photographs were to be scored rather than dental study casts, a minimum of three photos were included. These were frontal, right and left lateral views in occlusion. The occlusal plane should remain level with the child in an upright position. The lateral views should be centred on the premolars so as to give an accurate view of the buccal segment relationship. If available, a profile view in occlusion was also included to show the overjet measurement. The protocol for the included photographs was based on a previous publication validating the 5 Year Olds' Index for use on intraoral photographs rather than dental study casts (7).

These photographs were cropped (7.26x10.35cm) and rotated to centre the image on the occlusion. They were then orientated on one side of A4 paper per patient with the patient's identifying number at the top centre of the page and printed on high quality glossy photographic paper. They were orientated in either landscape or portrait format depending on the number of included photos for each patient. All photographs were cropped to a standard size although the quality of the photographs was dependent on the original image and varied between patients (Figure 1).

Scoring of the dental study casts and photographs was carried out by two examiners using the 5 Year Olds' Index. The first examiner being a consultant orthodontist who originally described the index and hence had extensive experience in its use. The second examiner a post-CCST senior specialty registrar in orthodontics also had previous experience with the index.

The dental study casts were arranged in a random order (generated using www.ablebits.com) and customised scoring sheets were provided for each examiner.

The intraoral photographs were arranged in a random order into two separate display books to allow the examiners to easily flick through them when scoring.

5 Year Olds' Index reference casts and instruction sheets on the indices use were provided for the examiners. Both the dental study casts and the photographs were scored once by each examiner in one day in separate scoring sessions.

One week later, after the casts and photographs had been rearranged into a different random order, they were scored for a second time by both examiners. All of the data were then entered into an Excel spreadsheet, with 10% of the data entry repeated to ensure it had been entered correctly.

Statistical analysis

Levels of agreement (reliability) were calculated using weighted Kappa statistics (9). Kappa / weighted Kappa values ranged from 0 to 1 and these are commonly interpreted using guidelines proposed by Landis and Koch (10), which are shown in Table 1. There are various possible weights that could be chosen to derive weighted Kappas, but as equal steps between the different categories for each of the indices are assumed, linear weights were used.

In this study, weighted Kappa values were calculated to compare two examiners (inter-examiner) and to compare two time periods for the same examiner (intra-examiner).

Results

Twenty six percent (n=70) of five year old UCLP patients included in the CCUK sample did not have dental study casts available for examination. A lack of cooperation from the child was the most common reason given for not having dental study casts. Forty nine of this cohort of 70 patients did consent to having intraoral photographs.

Tables 2 and 3 show the intra-rater and inter-rater levels of agreement for the dental study casts scoring and photo scoring respectively.

The comparison between the inter-rater reliabilities when scoring dental study casts and photos is illustrated in Figure 2.

Almost perfect intra-rater agreement and substantial inter-rater agreement was achieved for dental study casts. Intra-rater agreement for the photos varied from moderate to almost perfect and inter-rater agreement was moderate. Larger confidence intervals for the photograph data is because of the smaller sample in the photograph group compared to the dental study cast group.

Discussion

In the CCUK study, 70% of the children who refused dental impressions did consent to having intraoral photographs taken and it is likely this was because photographs were deemed less intrusive by the patient than having impressions taken (11). However, it is important to note that high quality photographs of the dentition that give a true representation of the occlusion are also challenging to obtain, due to the need for the child to sit still and tolerate mirrors and retractors. From our own perspective it became clear that the photographs were much easier to transport and store, with the 49 photographs taking up 1/25 the amount of storage space of the 198 dental study casts. They could also easily be stored on a computer. Despite these apparent advantages, the weighted Kappa reliability scores were much lower for the photographs compared to the dental study casts. There are several potential

explanations for this. The previous study which compared intraoral photographs to dental study casts when scoring with the 5 Year Olds' Index only included records which were deemed 'adequate' (7). This amounted to 38% of the total records which might have been included, implying that many of the photographs were not deemed of sufficient quality to be included. Unfortunately, not all of the photographs in the CCUK sample were of a high quality. They included many cases where the left and right lateral views of the occlusion were not taken from the correct angle to give a good view of the buccal occlusion. In two extreme cases photos were included where the teeth were slightly out of occlusion. A lateral view, which showed the overjet measurement using a stainless steel ruler has also been suggested to improve validity and reliability (7). Overjet views were available for some, but not all of the CCUK sample. Fourteen of the included sets of photos had no overjet view included. Of those which did include a lateral overjet view, only three took the photograph with a stainless steel ruler in place to accurately grade the overjet. Each unit included in CCUK were given a set of standardised instructions on how to take intraoral photographs and which views to include. Despite this, the above problems were encountered frequently. Thus a high degree of patient cooperation and skill are still required to take good quality intraoral photographs. The 49 patients who had their photographs included in this study had previously refused to have impressions taken and cooperation with photography is also likely to have been compromised.

Despite these shortcomings, examiner 1 achieved a very acceptable intra-rater weighted Kappa score of 0.82. Examiner 1 had extensive experience of scoring photographs using the 5 Year Olds' Index whereas examiner 2 did not. It may be that experience and calibration is more important when scoring photographs, a finding supported by previous work (7).

Although the photograph reliability scores are clearly lower than the study model reliability scores, they are not that different to those reported by McAuliffe *et al.* (7). The photograph

inter-examiner reliability scores achieved in CCUK were slightly higher than the 0.46 and 0.48 reported in the earlier study. They accounted for these scores by two of their examiners being less consistent, and, if they were excluded this increased the scores to 0.65 to 0.67. However, even with this allowance the scores still fell below those achieved for study models in the CCUK study.

Studies comparing scoring with dental study casts and photographs of dental study casts generally recorded higher Kappa scores for photographs than those in this study (5). This is likely because high quality photographs are much simpler and easier to obtain from static dental study casts compared to obtaining intraoral photographs of five year old children. This discrepancy in the quality of photographs would account for the difference in Kappa scores between the studies.

Although intraoral photographs do not seem to provide the consistently high reliability of plaster dental study casts, there are other possible media that could be used to replace dental study casts. As intraoral scanner technology improves and becomes more common place, this may provide a reliable alternative. This would avoid the need for dental impressions and allow storage on a computer but also still provide a 3D image of the dentition. There is some evidence of the potential advantages of this media (12, 13). Reliability of scoring using 3D images of the dentition was shown to be comparable to plaster study casts when using the 5 Year Olds' Index (12). Currently, the main barrier for use of 3D digital models is the availability of digital scanners, although this should improve as the technology is refined and becomes more affordable.

Limitations of the study

Although this study presents a ‘real world’ assessment of the difference between intraoral photographs and dental study casts, there were some limitations in the design. Matching the photographs and study casts for the same individuals would have allowed a more direct assessment of the two media, and ideally all of the records should have been collected by one experienced clinician. Instead, again reflecting the real life nature of the study, the records were collected by different clinicians at the individual units.

Conclusion

The existing evidence that UCLP five-year-old outcomes can be obtained from either intraoral photographs or study models is not robust. This study showed that reliability when scoring using intraoral photographs is lower than when dental study casts were used. This may have been a reflection of the degree of co-operation in the photographic group. If high quality intraoral photographs and experienced examiners are available then reliability scores comparable to dental study casts might be achieved. Based on the current available evidence, dental study casts still provide the gold standard when assessing primary surgical outcome in cleft care.

Acknowledgements

We would like to thank the families that took part in this study. We would also like to thank the clinicians and staff in the cleft centres that supported this project.

This publication presents independent research commissioned by the National Institute for Health Research (NIHR) under its Programme Grants for Applied Research scheme (RP-PG-

0707-10034). The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

References

1. Mars, M., Plint, D.A., Houston, W.J., Bergland, O., Semb, G. (1987) The Goslon Yardstick: a new system of assessing dental arch relationships in children with unilateral clefts of the lip and palate. *Cleft Palate J*, 24, 314-22.
2. Atack, N., Hathorn, I., Mars, M., Sandy, J. (1997) Study models of 5 year old children as predictors of surgical outcome in unilateral cleft lip and palate. *Eur J Orthod*, 19, 165-70.
3. Flinn, W., Long, R.E., Garattini, G., Semb, G. (2006) A multicenter outcomes assessment of five-year-old patients with unilateral cleft lip and palate. *Cleft Palate Craniofac J*, 43, 253-8.
4. Hathaway, R., Daskalogiannakis, J., Mercado, A., Russell, K., Long, R.E., Cohen, M., et al. (2011) The Americleft study: an inter-center study of treatment outcomes for patients with unilateral cleft lip and palate part 2. Dental arch relationships. *Cleft Palate Craniofac J*, 48, 244-51.
5. Nollet, P.J., Katsaros, C., van 't Hof, M.A., Bongaarts, C.A., Semb, G., Shaw, W.C., et al. (2004) Photographs of study casts: an alternative medium for rating dental arch relationships in unilateral cleft lip and palate. *Cleft Palate Craniofac J*, 41, 646-50.
6. Liao, Y.F., Huang, C.S., Lin, I.F. (2009) Intraoral photographs for rating dental arch relationships in unilateral cleft lip and palate. *Cleft Palate Craniofac J*, 46, 415-9.
7. McAuliffe, N.J., Jones, A.P., Cumberbirch, V.C., Russell, J.I. (2011) The use of the 5-year-olds' index: comparison between study models and intraoral photographs. *Cleft Palate Craniofac J*, 48, 526-31.

8. Persson, M., Sandy, J., Waylen, A., Wills, A., Al-Ghatam, R., Hall, A., et al. (2015) A cross-sectional survey of five year old children with non-syndromic unilateral cleft lip and palate: Cleft Care UK. *Orthodontics and Craniofacial Research*, Submitted.
9. Cohen, J. (1968) Weighted Kappa: Nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin*, 70, 213-20.
10. Landis, J.R., Koch, G.G. (1977) The measurement of observer agreement for categorical data. *Biometrics*, 33, 159-74.
11. Al-Ghatam, R., Jones, T., Ireland, A., Attack, N., Chawla, O., Deacon, S., et al. (2015) Structural Outcomes in the Cleft Care UK study – Dento-facial Outcomes. *Orthodontics and Craniofacial Research*, Submitted.
12. Chawla, O., Deacon, S.A., Attack, N.E., Ireland, A.J., Sandy, J.R. (2011) The 5-year-olds' Index: determining the optimal format for rating dental arch relationships in unilateral cleft lip and palate. *Eur J Orthod*, 34, 768-72.
13. Leenarts, C.M., Bartzela, T.N., Bronkhorst, E.M., Semb, G., Shaw, W.C., Katsaros, C., et al. (2012) Photographs of dental casts or digital models: rating dental arch relationships in bilateral cleft lip and palate. *Int J Oral Maxillofac Surg*, 41, 180-5.

Figure legend

Figure 1. Example of cropped intraoral photographs ready to be scored using the 5 Year Olds' Index.

Figure 2. Weighted Kappa and 95% Confidence Intervals for inter-rater reliability for scoring sessions 1 and 2 when scoring dental study casts and photos in CCUK study.