European Journal of Orthodontics 34 (2012) 322–326
doi:10.1093/ejo/cjr020
Advance Access Publication 11 May 2011

Visual perception of skeletal class and biotype in Spain

Martín Romero-Maroto*, Iván Nieto-Sánchez*, Manuel Míguez-Contreras* and Ana López-de-Andrés**

Departments of *Stomatology, Anatomy and Human Embryology and **Preventive Medicine and Public Health, Rey Juan Carlos University, Madrid, Spain

Correspondence to: Ana López de Andrés, Department of Preventive Medicine and Public Health, Rey Juan Carlos University, Avenida de Atenas s/n, Alcorcón, 28922 Madrid, Spain. E-mail: ana.lopez@urjc.es

SUMMARY The aim of this study was to determine and compare the visual accuracy of students and experienced orthodontists in distinguishing the different skeletal classes and facial biotypes using only lateral photographs. A group of 19 orthodontic students (4 males and 15 females, aged between 23 and 30 years) and 9 experienced orthodontists (three males and six females, aged between 30 and 56 years) were shown a slide presentation of 100 (50 males and 50 females) patients aged between 8 and 42 years and were asked to indicate the skeletal class and the facial biotype of each subject. Data were analysed using a one-way repeated measures analysis of variance, with Bonferroni *post hoc* adjustment for multiple testing. *P*-values less than 0.05 were considered statistically significant.

Only 32.75 per cent of the participants identified the facial biotype of the patients with respect to Rickett's vertical (Vert) pattern and 47.96 per cent the skeletal class. The students performed better than the experienced orthodontists ($P < 0.05$) but only for skeletal class. The results indicate that lateral photographs are not sufficient for determining the skeletal class or facial biotype of patients.

Introduction

Intra- and extraoral photographs taken before orthodontic treatment form an essential part of patient's records. Clinical records are completed with study models, lateral cephalograms, dental pantomographs, and different cephalometrics (Steiner, 1953; Ricketts, 1961; McNamara, 1984). These sources of data offer useful information about the malocclusion and aid in treatment planning (Graber and Vanarsdall, 2000; Proffit and Fields, 2000).

Many studies have been published regarding the quality of clinical photographs (Meredith, 1997; Sandler and Murray, 2002; Decker, 2004; Kula *et al.*, 2004; Palomo *et al.*, 2004; McKeown *et al.*, 2005; Bister *et al.*, 2006; Sandler *et al.*, 2009) and a few have investigated the photographic analysis of certain angular widths and lengths (Ferrario *et al.*, 1993; Fernández-Riveiro *et al.*, 2002, 2003; Fariaby *et al.*, 2006). Measurements made on photographs have been compared with stereophotogrammetry and anthropometry (Ghoddousi *et al.*, 2007). Zhang *et al.* (2007), who compared photographs with cephalometrics, concluded that correlations between measurements made on lateral photographs and lateral radiographs were only moderate. Bishara *et al.* (1995a,b), who used photography to assess the reliability of facial change after orthodontic treatment, concluded that frontal photographic measurements were more reliable than those obtained from lateral photographs and that linear measurements were more reliable than angular measurements. Takada *et al.* (2000), who created an inference modelling of human visual judgement of sagittal jaw-base relationship based on cephalometry, stated that excessive labial or palatal inclinations of the upper central incisors, dental bimaxillary protrusion, increased mandibular effective length, and lower anterior face height influence human visual judgement of the antero-posterior skeletal relationship.

Photographs of patients have also been used to evaluate aesthetics (Maple *et al.*, 2005; Kiekens *et al.*, 2008; Lane and Harrel, 2008; Shafiee *et al.*, 2008; Schabel *et al.*, 2009a,b; Oh *et al.*, 2009). Recently, three-dimensional systems have provided a new useful tool (Lane and Harrel, 2008; Plooij *et al.*, 2009) but norms are yet to be established for this technology.

Since Broadbent (1931), standardized cephalometric analysis has been used extensively for diagnosis and treatment planning. On the other hand, Atchison *et al.* (1991), Han *et al.* (1991), and Hansen and Bondemark (2001) have shown that lateral cephalograms do not significantly affect treatment planning.

Nevertheless, most studies do not address the issue of perception of the malocclusion when viewing a lateral photograph. The aim of this research was to evaluate the accuracy of both students and experienced orthodontists in distinguishing the different skeletal classes and facial biotypes, using only lateral photographs.

There are three basic facial biotypes: brachyfacial, mesofacial, and dolichofacial. Brachyfacial describes a horizontal growth pattern, dolichofacial a vertical growth pattern (Ricketts, 1960), and mesofacial a well-balanced face with harmonious musculature and a pleasant soft tissue profile (Clark, 2002).

Subjects and methods

The present research was approved by the Research Ethics Committee of the Faculty of Health Sciences, University Rey Juan Carlos, Madrid, Spain. It was a cross-sectional study carried out by 9 (three males and six females, aged between 30 and 56 years) experienced orthodontists (with more than 3 years orthodontic experience) and 19 (4 males and 15 females, aged between 23 and 30 years) master of orthodontic students (four first-, seven second-, and eight third-year students, all female, except for two first-year, one second-year, and one third-year student) who volunteered to participate in this study. Participants were shown a computer presentation of 100 lateral photographs of patients (50 males and 50 females aged between 8 and 42 years) who attended the Dental Clinic of Rey Juan Carlos University, Madrid. These patient's facial biotype and skeletal class had been previously diagnosed using Ricketts (1961) lateral cephalometric analysis (standard pattern) by an experienced orthodontist (MMC) who manually identified the landmarks. The computer software Nemoceph® NX 2005 (Nemotec, Madrid, Spain) was then used to complete the Ricketts lateral cephalometric analysis in order to identify the skeletal class and facial biotype of the patients. The landmark identification and cephalometric analysis were repeated after a period of 1 month. Whenever the biotype according to the Vert or skeletal class varied, the lateral photograph was not included in the slide presentation. This occurred for three subjects resulting in three new patients being added to the slide presentation. To determine the facial biotype with the Vert (Ricketts *et al.*, 1982), information on the following variables is required: facial depth [(Ricketts norm: 87 degrees, standard deviation (SD) 3 degrees), facial axis (norm: 90 degrees, SD 3 degrees), mandibular arch (norm: 26 degrees, SD 4 degrees), mandibular plane (norm: 26 degrees, SD 4 degrees), and lower face height (norm: 47 degrees, SD 4 degrees)]. Subsequently, the difference between the patient value and Ricketts norm is divided between the SD for each measurement, with a minus sign if the deviation goes to dolichofacial or a plus sign if the measurement tends do brachyfacial. The results for each value were summed and divided by five. The resulting number is the Vert. Facial biotype was classified as mesofacial (proportioned) when the value was between −0.5 and +0.5, over +0.5 as a brachyfacial (horizontal growth) pattern, and below −0.5 as dolichofacial (vertical growth).

There were 53 brachyfacial, 22 mesofacial, and 25 dolichofacial patients. For skeletal class, there were 42 Class I, 41 Class II, and 17 Class III patients in the slide presentation. Each photograph was numbered to avoid confusion and there was no time limit to complete the questionnaire. The participants were asked to classify the skeletal class and facial biotype according to Ricketts Vert just by observing the photographs. The questionnaires were collected and identification rate was measured twice by two different operators (MMC and INS) to avoid errors.

Lateral photographs of each subject were taken with a digital camera (Reflex Olympus E-330®; Shinjuku-ku, Tokyo, Japan). Each subject was photographed 5 ft from the camera with the head in natural posture and the lips at rest with the right side of the face towards the experienced orthodontist (MMC) who took all the profile photographs. The Frankfort plane was approximately parallel to the floor. The radiographs were digitized and processed using the cephalometric software Nemoceph® NX 2005. Data expressing the percentage of concordance with respect to the standard pattern were analysed using one-way repeated measures analysis of variance, with Bonferroni *post hoc* adjustment for multiple testing using Prism Software Version 3.0 for Windows (San Diego, California, USA). Estimates were made using the 'svy' (survey commands) function of the Prism 3.0 program, which enabled incorporation of sampling design and weights into all statistical calculations. Statistical significance was set at $P < 0.05$ (two-tailed).

Results

Table 1 shows that only 32.75 per cent of participants correctly identified the facial biotype of the patients with respect to the Ricketts (vert) pattern. Students performed slightly better than experienced orthodontist at identifying the facial biotype, although the differences were not statistically significant ($P > 0.05$).

A brachyfacial biotype was the most difficult to identify (19.95 per cent; $P < 0.05$) versus dolichofacial (49.15 per cent), as well as mesofacial (43.18 per cent). This was true for the three groups (all, students, and experienced orthodontists; $P < 0.05$). No statistically significant differences were found between mesofacial and dolichofacial types for any of the three groups ($P > 0.05$).

Table 1 also shows that third-year students had better results than first-year students ($P < 0.05$) but these differences were only significant for mesofacial and dolichofacial patterns ($P < 0.05$). The differences between the second-year students were not significant ($P > 0.05$). No differences between each course year students were found for brachyfacial patterns ($P > 0.05$).

The gender differences for facial biotype were not statistically significant ($P > 0.05$), but for dolichofacial patterns, females performed better than males ($P < 0.05$; Table 1).

Only 47.96 per cent correctly identified the skeletal class of the patient (Table 2). Class II was the easiest to identify. This was true for the three groups (all, students, and experienced orthodontists; $P < 0.05$).

Table 1 Visual discrimination of facial biotype (expressed as a percentage of the identification rate) using photographs.

Group	Total	Dolichofacial	Mesofacial	Brachyfacial
All (%), *n* = 28	32.75	49.14	43.18	19.95
Male (%), *n* = 7	32.14	38.86	42.86	24.53
Female (%), *n* = 21	32.95	52.57	43.29	18.42
Students (%), *n* = 19	33.00	53.68	42.11	19.46
Subgroup				
First-year students (%), *n* = 4	25.25	39.00	32.95	15.57
Second-year students, (%) *n* = 7	34.43	56.57	39.61	21.83
Third-year students, (%) *n* = 8	35.63	58.50	48.86	19.34
Experienced Orthodontists (%), *n* = 9	32.22	39.56	45.45	20.96

Table 2 Eye discrimination of skeletal class (expressed as a percentage of the identification rate) using photographs.

Group	Total	Class I	Class II	Class III
All (%), *n* = 28	47.96	39.46	60.71	36.76
Male (%), *n* = 7	43.43	34.01	59.23	28.57
Female (%), *n* = 21	49.48	41.27	61.21	39.50
Students (%), *n* = 19	50.63	39.97	63.80	43.03
Subgroup				
First-year students (%), *n* = 4	34.75	32.14	38.42	7.35
Second-year students (%), *n* = 7	54.71	38.78	68.29	61.34
Third-year students (%), *n* = 8	55.00	44.94	72.56	44.85
Experienced orthodontists, (%) *n* = 9	42.33	38.36	54.20	25.53

The results for first-year students were poorer than for the second- and third-year students ($P < 0.05$). Students performed better than experienced orthodontists ($P < 0.05$). No gender differences were found for skeletal class ($P > 0.05$). Both males and females were better at identifying Class II ($P < 0.05$; Table 2).

Considering the identification of skeletal classes individually, for Class I, no statistically significant differences were found between the three groups of students (first, second, and third year; $P > 0.05$). Regarding Class II patients, no differences were found between the second- and third-year students ($P > 0.05$) but both second- and third-year students were better than first year students ($P < 0.05$). For Class III patients, first-year students performed better than second- and third-year students ($P < 0.05$), but, interestingly, second-year students performed significantly better than third-year students ($P < 0.05$). First-year students' identification of Class III was significantly poorer than for Class II or Class I ($P < 0.05$). The second-year group showed no differences between identification of Class I or Class III ($P > 0.05$; Table 2).

A Class II skeletal pattern was the easiest to determine ($P < 0.05$) but no differences were found between Class I and Class III subjects. Determination of Class II was 60.71 per cent versus Class I (39.46 per cent) and Class III (36.76 per cent). Skeletal class was easier to determine than facial biotype ($P < 0.05$).

Discussion

The purpose of this study was to determine if orthodontists and orthodontic students could accurately determine the skeletal classes and facial biotypes of patients using only lateral photographs. It is difficult to compare this study with others as no similar articles were found in the literature.

Takada *et al.* (2000) studied the variables that influenced the subjective classification of sagittal jaw relationship. The differences compared with the present study are that they gave the participants the full records (including lateral radiographs) and that the sample was divided between patients whose classification of the antero-posterior jaw relationship could be made with certainty (58.53 per cent) and those cases (46 per cent) where one or two examiners felt unable to give such a judgement with any confidence.

In the present study (with the limitation that only lateral photographs were shown and not lateral radiographs), 47.96 per cent correctly identified the skeletal class, which is slightly lower than in the study of Takada *et al.* (2000). Those authors also pointed out that the degree of prominence of the chin and the overall inclination of the anterior contour of the symphysis between pogonion and menton influence the judgement of the orthodontist. The present results also show that brachyfacial patterns with more prominent chins are more difficult to identify, which is in accordance with the findings of Takada *et al.* (2000).

Zhang *et al.* (2007) found a moderate correlation between cephalometric and facial photographic measurements of craniofacial form. They reported that vertical landmarks in photographs are not as influenced by the soft tissues; they correlate more than antero-posterior points. SNA did not correlate between photography and cephalometry. Nevertheless, it was found out that skeletal class, which is an antero-posterior parameter, was more easily identified than biotype (47.96 versus 32.75 per cent), which is more related to the vertical plane. This could mean that there is a difference between perception of the vertical plane and real measurements even if they are carried out on photographs.

The main limitation of this study is that the photographs were not divided into Class II, Class III, or dolicho and brachyfacial pattern according to the SDs. It would be interesting to determine for future studies if a Class II with a SD of 3 is easier to identify than a Class II with a SD of 1. The ages of the patients were also not specified to participants, which could lead to confusion. Another limitation was the small number of participants. In spite of these limitations, the findings demonstrate limits in perception of malocclusion evident when using only a lateral photograph.

Conclusions

Although lateral photographs can be helpful, they seem unreliable for determining the skeletal class or facial biotype of a patient. Dolichofacial and mesofacial patterns were easier to discriminate, while a brachyfacial type was significantly the most difficult to identify. A Class II was the most recognizable skeletal class from a lateral photograph and a Class III the least recognizable.

References

Atchison K A, Luke L S, White S C 1991 Contribution of pre-treatment radiographs to orthodontists' decision making. Oral Surgery, Oral Medicine, and Oral Pathology 71: 238–245

Bishara S E, Cummins D M, Jorgensen G J, Jakobsen J R 1995a A computer assisted photogrammetric analysis of soft tissue changes after orthodontic treatment. Part I: methodology and reliability. American Journal of Orthodontics and Dentofacial Orthopedics 107: 633–639

Bishara S E, Jorgensen G J, Jakobsen J R 1995b Changes in facial dimensions assessed from lateral and frontal photographs. Part I: methodology. American Journal of Orthodontics and Dentofacial Orthopedics 108: 389–393

Bister D, Mordarai F, Aveling R M 2006 Comparison of 10 digital SLR cameras for orthodontic photography. Journal of Orthodontics 33: 223–230

Broadbent B H 1931 A new X-ray technique and its application to orthodontia. Angle Orthodontist 1: 45–66

Clark W J 2002 Twin Block functional therapy. Applications in dentofacial orthopaedics. Mosby-Wolfe, London

Decker J 2004 Image editing. American Journal of Orthodontics and Dentofacial Orthopedics 125: 215–219

Fariaby J, Hossini A, Saffari E 2006 Photographic analysis of faces of 20-year-old students in Iran. British Journal of Oral and Maxillofacial Surgery 44: 393–396

Fernández-Riveiro P, Smyth-Chamosa E, Suárez-Quintanilla D, Suárez-Cunqueiro M 2003 Angular photogrammetric analysis of the soft tissue facial profile. European Journal of Orthodontics 25: 393–399

Fernández-Riveiro P, Suárez-Quintanilla D, Smyth-Chamosa E, Suárez-Cunqueiro M 2002 Linear photogrammetric analysis of the soft tissue facial profile. American Journal of Orthodontics and Dentofacial Orthopedics 122: 59–66

Ferrario V F, Sforza C, Miani A, Tartaglia G 1993 Craniofacial morphometry by photographic evaluations. American Journal of Orthodontics and Dentofacial Orthopedics 103: 327–337

Ghoddousi H, Edler R, Haers T, Wertheim D, Greenhill D 2007 Comparison of three methods of facial measurement. International Journal of Oral Maxillofacial Surgery 36: 250–258

Graber T, Vanarsdall R 2000 Orthodontics: current principles and techniques. Mosby, Inc., St Louis

Han U K, Vig K W, Weintraub J A, Vig P S, Kowalski C J 1991 Consistency of orthodontic treatment decisions relative to diagnostic records. American Journal of Orthodontics and Dentofacial Orthopedics 100: 212–219

Hansen K, Bondemark L 2001 The influence of lateral head radiographs in orthodontic diagnosis and treatment planning. European Journal of Orthodontics 23: 452–453

Kiekens R M A, Kuijpers-Jagtman A M, van 't Hof M A, van 't Hof B E, Maltha J C 2008 Putative golden proportions as predictors of facial esthetics in adolescents. American Journal of Orthodontics and Dentofacial Orthopedics 134: 480–483

Kula K, Kula T J, Glaros A, Barlow J 2004 Evaluation of printed and monitor-displayed images taken with digital cameras and imported into the Dolphin imaging system. Seminars in Orthodontics 10: 220–225

Lane C, Harrel W Jr 2008 Completing the 3-dimensional picture. American Journal of Orthodontics and Dentofacial Orthopedics 133: 612–620

Maple J R, Vig K W, Beck F M, Larsen P E, Shanker S 2005 A comparison of providers' and consumers' perceptions of facial-profile attractiveness. American Journal of Orthodontics and Dentofacial Orthopedics 128: 690–696

McKeown H F, Murray A M, Sandler P J 2005 How to avoid common errors in clinical photography. Journal of Orthodontics 32: 43–54

McNamara J A Jr 1984 A method of cephalometric evaluation. American Journal of Orthodontics 86: 449–469

Meredith G 1997 Facial photography for the orthodontic office. American Journal of Orthodontics and Dentofacial Orthopedics 111: 463–470

Oh H S *et al.* 2009 Correlations between cephalometric and photographic measurements of facial attractiveness in Chinese and US patients after orthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopedics 136: 762–763

Palomo J M, Wolf G R, Hans M G 2004 Use of digital photography in the Case orthodontic clinic. American Journal of Orthodontics and Dentofacial Orthopedics 126: 381–385

Plooij J M *et al.* 2009 Evaluation of reproducibility and reliability of 3D soft tissue analysis using 3D sterophotogrammetry. International Journal of Oral and Maxillofacial Surgery 38: 267–273

Proffit W, Fields H 2000 Contemporary orthodontics. Mosby, Inc., St Louis

Ricketts R M 1960 A foundation for cephalometric communication. American Journal of Orthodontics 46: 330–357

Ricketts R M 1961 Cephalometric analysis and synthesis. Angle Orthodontist 31: 141–156

Ricketts R M, Roth R H, Chaconnas S J, Schulhof R J, Engle G A 1982 Orthodontic diagnosis and planning. Rocky Mountain Data Systems, Denver

Sandler J, Murray A 2002 Clinical photographs—the gold standard. Journal of Orthodontics 29: 158–167

Sandler J *et al.* 2009 Quality of clinical photographs taken by orthodontists, professional photographers and orthodontic auxiliaries. American Journal of Orthodontics and Dentofacial Orthopedics 135: 657–662

Schabel B J, Franchi L, Baccetti T, McNamara J A Jr 2009a Subjective vs. objective evaluations of smile esthetics. American Journal of Orthodontics and Dentofacial Orthopedics 135: S72–S79

Schabel B J, McNamara J A Jr, Franchi L, Baccetti T 2009b Q-sort assessment vs. visual analog scale in the evaluation of smile esthetics. American Journal of Orthodontics and Dentofacial Orthopedics 135: S61–S71

Shafiee R, Korn E L, Pearson H, Boyd R L, Baumrind S 2008 Evaluation of facial attractiveness from end-of-treatment facial photographs. American Journal of Orthodontics and Dentofacial Orthopedics 133: 500–508

Steiner C C 1953 Cephalometrics for you and me. American Journal of Orthodontics 39: 729–755

Takada K, Sorihashi Y, Stephens C D, Itoh S 2000 An inference modeling of human visual judgment of sagittal jaw-base relationships based on cephalometry: Part I. American Journal of Orthodontics and Dentofacial Orthopedics 117: 140–147

Zhang X, Hans M G, Graham G, Kirchner H L, Redline S 2007 Correlations between cephalometric and facial photographic measurements of craniofacial form. American Journal of Orthodontics and Dentofacial Orthopedics 131: 67–71