Original Article

Effect of cephalograms on decisions for early orthodontic treatment

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ABSTRACT

Objective: To assess the extent to which cephalograms modify therapeutic decisions related to early orthodontic treatment.

Materials and Methods: Diagnostic records of six patients requiring early treatment were digitized for this purpose. A total of 234 orthodontists were then asked to select therapeutic measures on a treatment-planning sheet at two different times (T1 and T2). Three groups of orthodontists were formed and were provided with case-specific records either including or not including cephalograms and the appended tracing values. Forty-seven orthodontists completed all phases of the questions.

Results: Statistical analysis revealed only two statistically significant differences between the first (T1) and second (T2) treatment plans, both concerning options of transverse treatment. None of the other results showed any significant changes from T1 to T2 treatment planning.

Conclusion: It follows that cephalograms did not influence therapeutic decisions for early orthodontic treatment and should not be routinely used in very young patients. (*Angle Orthod.* 2013;83:1059–1065.)

KEY WORDS: Early treatment; Cephalogram; Treatment decision

INTRODUCTION

According to the guidelines of the German statutory health insurers, early orthodontic treatment refers to treatments initiated before the late phase of mixed dentition.[1] Diagnostic steps performed for early treatment include impression taking, extraoral and intraoral photography, and panoramic radiography, and most orthodontic offices are known to also use lateral cephalometry on a routine basis.[2–4] Although radiation exposure carries a risk of promoting malignant diseases, especially in young patients,[5,6] adequate diagnostic techniques are required in any type of treatment planning.

In 2010, the German Orthodontic Society stated that treatment planning in patients who still have their deciduous dentition when therapy is initiated can remain confined to history taking, extraoral and intraoral clinical examinations, identification of functional problems and a study cast.[7] The diagnostic standard does not include obtaining and evaluating cephalograms and orthopantomograms in this age group, although both technologies may be required in selected cases that involve complex needs for differential diagnosis, such as children with respiratory disorders. In such situations lateral cephalograms could identify a risk for sleep disturbances[8] or, in cases with mandibular hypoplasia, help to judge the effective airway space.[9]

Han and coworkers[5] and Bruks and coworkers[10] demonstrated that adequate information for orthodontic treatment planning can be obtained solely on the basis of tooth impressions and clinical examinations. Although additional radiographs will yield even more information about the severity of any existing malocclusion, they scarcely influence the degree of certainty regarding orthodontic treatment planning.[11–13] Stephens and coworkers[14] showed that different clinicians may decide on different treatment plans on the basis of identical diagnostic records.

Cephalograms are low-distortion and almost isometric images that offer two-dimensional information about the relation of the dentition to the skull. As such, they can be used in conjunction with other examination

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Table 1. Overview of Patients[a]

Patient	Sex	Age	KIG[b]	Malocclusion	Overjet, Overbite
1	M	7 years, 5 months	M4	Dental class III with skeletal class III	−1.0 mm, 1.0 mm
2	M	5 years, 2 months	M4	Dental class III with skeletal class III	−5.0 mm, 0.0 mm
3	F	7 years	P4	Dental class I with skeletal class I	1.5 mm, −1.0 mm
4	M	7 years, 10 months	D5	Dental class II with skeletal class II	9.5 mm, 4.5 mm
5	M	8 years, 4 months	D5	Dental class II with skeletal class II	11.0 mm, 4.5 mm
6	F	7 years, 3 months	O4	Dental class II with skeletal class II	9.0 mm, −8.5 mm

[a] M indicates male; F, female; KIG, orthodontic indication group.

[b] KIG: indication for early orthodontic treatment according to the guidelines of the German Statutory Health Insurers: M4 = inverse overjet (0–3 mm), P4 = lack of space >4 mm, D5 = overjet >9 mm, O4 = open bite (>4 mm).

techniques to assist in making a diagnosis,[15] monitoring the course of treatment, evaluating treatment outcome, and defining the duration of the retention phase. They do not, however, offer functional information or information about craniofacial relations in the transverse plane.

The objective of the present study was to assess the extent to which cephalograms influence therapeutic decisions for early orthodontic treatment.

MATERIALS AND METHODS

The research question was addressed by selecting diagnostic records of six patients (two girls and four boys) on file at the Department of Orthodontics of the University of Tübingen. Institutional approval for the study was obtained from the Ethics Committee of the Tübingen University Medical School (project ID 189/2011A). All data for this study were collected in Germany.

The criterion for selecting these patients was early treatment classification by assigning the treatment requirements of each case to orthodontic indication groups (KIG) in accordance with a pertinent decision by the German Federal Committee of Dentists and Health Insurers.[1] Patients with craniofacial anomalies were excluded. The six selected cases were representative of the most typical situations requiring early treatment. None of the six patients had bad habits that were responsible for disrupting the normal development of the dentition.

The patient examinations were conducted and the diagnostic records were created before mixed dentition began or during the early phase of mixed dentition. The youngest patient was 5 years and 2 months old when treatment started and was the only one with a completely deciduous dentition. All other patients were in the early phase of mixed dentition. The oldest patient was 8 years and 4 months old. The mean age of all patients was 7 years and 2 months (Table 1).

The casts, intraoral/extraoral photographs, orthopantomograms, and cephalograms obtained for the six patients were retrospectively analyzed, digitized, aliased, and mailed out in hard copy to the orthodontists participating in the study. The orthodontists to be interviewed for the survey were randomly selected from the members list of the German Orthodontic Society. Based on the method reported by Devereux and coworkers,[16] the orthodontists were assigned to three groups: A, B, or C. The clinicians in group A were provided with all records of the various patients for both times (T1 and T2), except for the cephalograms. T1 and T2 were at least 6 weeks apart. Group B was provided with all records other than the cephalograms at T1 and with the complete records, including the cephalograms (and their cephalometric evaluations), at T2. Group C received all records, including the cephalograms (and their cephalometric evaluations), on both occasions (T1 and T2). The first mailing to the clinicians who had agreed to participate in the study included the group-specific sets of T1 records. The second mailing with the group-specific T2 records was dispatched later to those orthodontists who had completed and returned the treatment-planning sheet.

A total of 234 orthodontists were asked to take part in the study, and 106 (45%) agreed. Of these, 82 (77%) returned the completed survey sheet of treatment decisions they had reached based on the T1 records. Of the 82 clinicians who successfully completed the first part of the survey, 47 (57%) also returned the survey sheet for the T2 records (Figure 1). The survey sheet mailed to the clinicians along with the T1 and T2 records was specifically developed to capture their treatment decisions (Figure 2).

Statistical Analysis

Data were evaluated with appropriate statistics software (SPSS Statistics 20; SPSS Inc, Chicago, IL). McNemar's χ^2 test (for a fourfold table) and Bowker's test of symmetry (for a contingency table) were used to test dependent samples for significant differences. In this specific case, any changes in treatment decisions between T1 and T2 were analyzed. The level of significance for the χ^2 test was set at 5%. Analysis of the treatment plans also included use of the kappa coefficient to indicate degrees of agreement.

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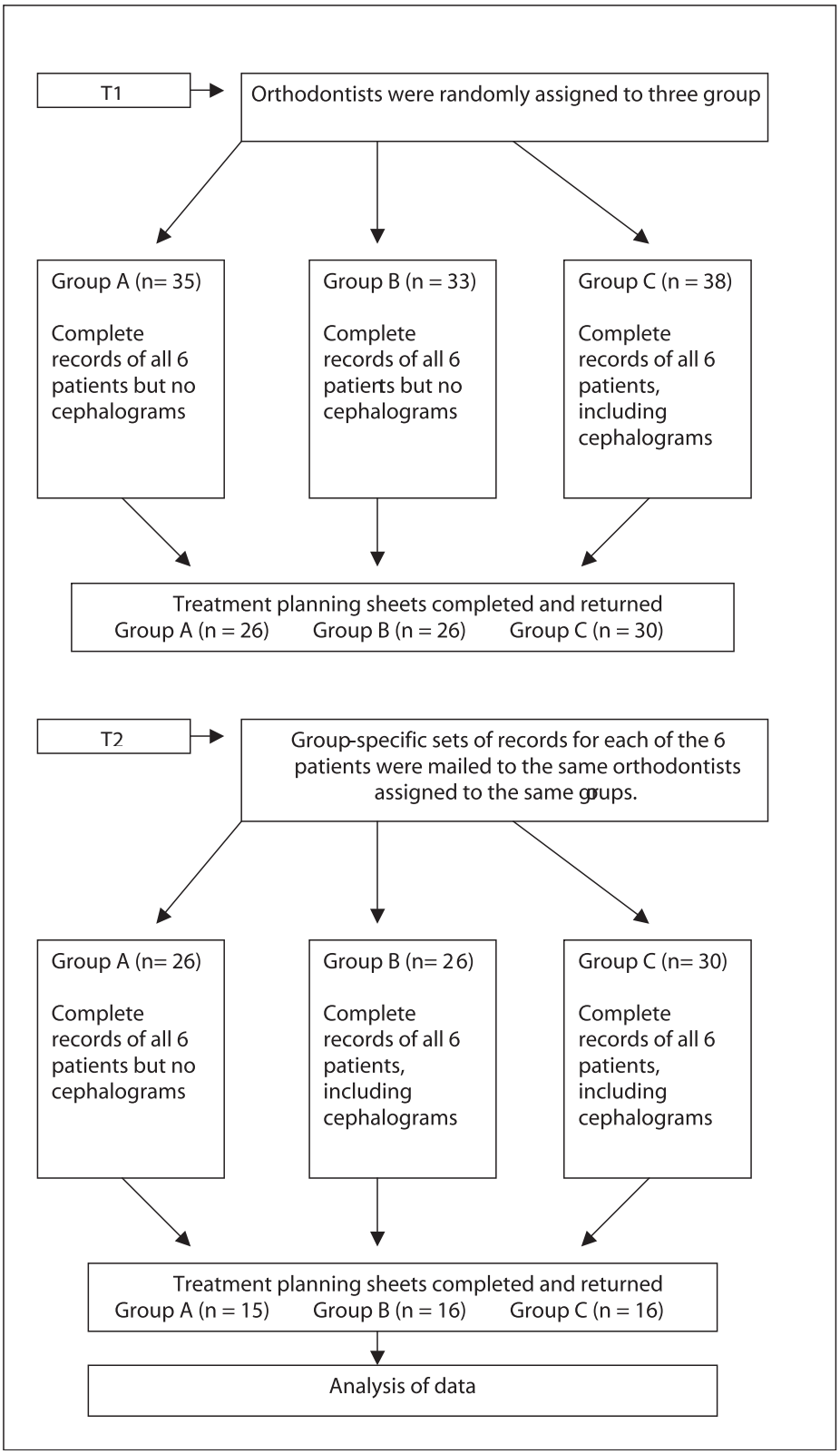

Figure 1. Treatment planning sheet used to collect the surveyed data.

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Treatment planning sheet

Please check boxes as needed:

		Sagittal active development	Transversal active development	Growth inhibition	Extraction	Mandibular midline correction	Crossbite correction	Removable appliance	Fixed appliance	Combined fixed/ removable	Do you feel that any additional information should have been supplied for treatment planning? Please specify.
Patient 1	Maxilla	o	o	o	o		o	o	O	o	
	Mandible	o	o	o	o	o					
Patient 2	Maxilla	o	o	o	o		o	o	o	o	
	Mandible	o	o	o	o	o					
Patient 3	Maxilla	o	o	o	o		o	o	o	o	
	Mandible	o	o	o	o	o					
Patient 4	Maxilla	o	o	o	o		o	o	o	o	
	Mandible	o	o	o	o	o					
Patient 5	Maxilla	o	o	o	o		o	o	o	o	
	Mandible	o	o	o	o	o					
Patient 6	Maxilla	o	o	o	o		o	o	o	o	
	Mandible	o	o	o	o	o					

Code

Figure 2. Flow chart of the survey.

RESULTS

Figure 3 summarizes the results of statistical analysis. It gives an overview of deviations (*P*-value) and agreements (κ-value) between the treatment plans returned by groups A, B, and C at T1 and T2.

The entire study revealed merely two statistically significant differences between therapeutic decisions made at T1 versus T2. These two differences were found in group A ($\kappa = 0.071$) and group C ($P = 0.016$); both concerned the treatment option of mandibular transverse development in patient 4 (overjet more than 9 mm). No other significant differences between the decisions reached at the T1 versus T2 planning stages were observed for any of the treatment options in any of the remaining five patients.

In group B, no significant deviations were noticed between the treatment decisions reached at T1 versus T2 (Figure 3). This group of clinicians was the only one receiving different sets of patient records at T1 (cephalograms not included) and T2 (cephalograms included).

Figure 3 also illustrates that decisions for sagittal treatment showed better agreement between both planning times than decisions for transverse treatment.

DISCUSSION

Six clinical cases were selected for this study that offered a large, but still manageable, amount of diagnostic material. It was reasonable to assume that a larger number of clinical cases would be so time-consuming to process that few orthodontists would have been willing to participate.[16] The six selected cases were representative of the most typical situations requiring early treatment.[3,17,18]

The second treatment plans (T2) were developed by the clinicians not earlier than 6 weeks and not later than 10 weeks after the first ones (T1). A minimum delay of 6 weeks between T1 and T2 can be assumed to ensure a washout period after which clinicians will no longer remember the treatment decisions they made the first time around (T1) when they reevaluate the case at T2.[19]

In general it is impossible to judge the work of the participants by evaluating a questionnaire. In this study no sign of unreliable work was found.

In contrast to North America, for example, in Germany functional appliances are already used for early treatment. Before orthodontic treatment using functional appliances an appropriate diagnostic procedure should be carried out.[1] Because cephalograms

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T1 vs. T2: Deviation (* / + / -) AND Agreement (0 / W / D / S / T)

		Sagittal active development	Transversal active development	Growth inhibition	Extraction	Mandibular midline correction	Crossbite correction	Removable appliance	Fixed appliance	Combined fixed/ removable
Patient 1	Maxilla	A- B- C-	A+ B- C+ AD CS	A- B- C-	A+ B- C- AT		A- B- C-	A+ B+ C+ AS BD CT	A- B+ C- BT	A+ B+ C+ AS BD CT
	Mandible	A- B- C+ CT	A- B+ C+ AT BD CD	A+ B+ C+ AS BD CD	A- B- C-	A- B- C-				
Patient 2	Maxilla	A- B- C-	A+ B+ C- AT BT	A- B- C-	A- B- C-		A- B- C-	A+ B+ C+ AS BT CS	A- B+ C+ BT CT	A+ B+ C+ AS BT CS
	Mandible	A- B- C+ CT	A- B- C-	A+ B+ C+ AD BW CS	A- B- C-	A- B- C-				
Patient 3	Maxilla	A- B+ C+ BT CD	A+ B+ C+ AS BT CW	A- B- C+ CT	A- B+ C+ BT CT		A- B- C+ CT	A+ B+ C- AS BT	A+ B- C- AS	A+ B+ C- AT BT
	Mandible	A- B+ C+ BT CS	A+ B- C+ AS CT	A- B- C+ CT	A+ B- C+ AT CT	A- B- C-				
Patient 4	Maxilla	A- B- C+ CD	A+ B+ C- AS BD	A+ B- C+ AD CT	A- B+ C+ BT CT		A- B- C-	A- B+ C+ BT CT	A- B- C-	A- B+ C+ BT CT
	Mandible	A+ B- C- AT	A+ B+ C* A0 BS CW	A- B- C-	A+ B+ C- AT BT	A- B- C-				
Patient 5	Maxilla	A+ B- C- AS	A+ B+ C+ AT BS CD	A+ B+ C- AW BS	A- B- C+ CT		A- B- C-	A+ B+ C+ AT BT CW	A+ B+ C+ AT BT CT	A+ B+ C+ AS BS CD
	Mandible	A- B- C+ CS	A+ B+ C+ AD BT CD	A- B- C-	A- B- C+ CT	A- B- C+ CT				
Patient 6	Maxilla	A- B- C+ CT	A- B- C-	A+ B- C+ AT CT	A+ B- C- AT		A- B- C-	A+ B+ C+ AS BD CW	A- B- C+ CT	A+ B+ C+ AT BD CT
	Mandible	A+ B+ C+ AD BD CS	A+ B+ C+ AW BT CD	A- B- C+ CT	A- B+ C+ BS CS	A- B- C-				

Figure 3. Deviation (P) und agreement (κ) between two treatment plans developed for six patients by three groups of orthodontists (A, B, and C) at two different points in time (T1 versus T2). $P \leq .05$ (significant deviation) = highlighted with a grey background and marked with **(*)**; $0.05 < P < 1$ (nonsignificant deviation) = marked with **(+)**; $P = 1$ (no deviation) = marked with **(-)**. $\kappa \leq 0.1$ (no agreement) = 0; $0.1 \leq \kappa \leq 0.4$ (weak agreement) = W; $0.4 \leq \kappa \leq 0.6$ (distinct agreement) = D; $0.6 \leq \kappa \leq 0.8$ (strong agreement) = S; $0,8 \leq \kappa \leq 1.0$ (total agreement) = T.

will yield even more information about the severity of any existing malocclusion,[20] in daily clinical practice lateral cephalometry is routinely used, though this decision often does not reflect whether this is really necessary.

As these data are collected in Germany, it is clear that is the findings are relevant for this country. Future studies will have to investigate whether they may be also relevant for other countries.

A limitation to the study design was the fact that the orthodontists had to conduct treatment planning without an opportunity to actually examine the patients in vivo. Implementing diagnosis and treatment planning of clinical cases solely on the basis of patient records is an option in exceptional situations.[21] Buchanan and coworkers[22] observed good agreement between levels of orthodontic treatment requirements defined either exclusively on the basis of clinical examination or exclusively on the basis of study casts and photographs.

Our study design also differed from daily practice in that it provided the orthodontists only with photographs not with the study casts as such, which might have rendered the evaluation of casts more difficult than usual. According to Mok and coworkers,[23] two-dimensional digital photographs can be used alternatively to study casts in evaluating malocclusion and deciding whether orthodontic treatment is required.

The entire study revealed only two instances of orthodontists changing their minds from the first (T1) to the second (T2) treatment plan, one occurring in group A ($\kappa = 0.071$) and the other one in group C ($P = .016$). As both groups were provided with identical patient records at T2 and T1, these significantly modified decisions could not have been due to added information about the patient as in the form of a cephalogram. Also, both of these significant differences between T1 and T2 concerned the treatment option of mandibular transverse development in patient 4 (overjet more than 9 mm). Therefore, whether or not a cephalogram (and its cephalometric evaluation) was included in the records of patient 4 could not have made a difference to orthodontic planning, considering Rakosi and Jonas's[24] finding that cephalograms do not offer any information about transverse relations. Groups A and C were also found to have planning differences

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between T1 and T2 for patient 5 (overjet more than 9 mm), but these differences were not statistically significant. To summarize, some uncertainty was noted in two of the six patients about the treatment option of mandibular transverse development. The use of photographs instead of study casts may have led to false estimation of the transverse situation of the mandible.

A distinct but not statistically significant difference ($\kappa = 0.250$) between the treatment plans returned at T1 versus T2 was noted for the treatment option of maxillary transverse development in patient 3 (lack of space more than 4 mm). The patient records in group C were not expanded to include the cephalogram from T1 to T2; furthermore,, the cephalogram would not offer any information about transverse relations. Hence, there was no way that the multitude of modifications to treatment planning in group C would have been related to the cephalogram. Conversely, the treatment decisions in group B regarding the option of maxillary sagittal development were found to be in total agreement between T1 and T2 ($\kappa = 1.0$), even though the cephalograms were added to the patient records for the T2 stage.

CONCLUSIONS

- Plans for early orthodontic treatment conceived by the same clinicians at two different points in time (T1 and T2) did not reveal any significant differences between sagittal treatment decisions. They did reveal significant differences between transverse decisions, but lateral cephalograms do not offer information about transverse problems.
- The conclusion must be drawn that therapeutic decisions for early (ie, before the late phase of mixed dentition) orthodontic treatment are not significantly influenced by the presence or absence of cephalograms and cephalometric evaluations, which therefore should not be routinely obtained for this purpose.

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