Original Article

Consistency of Treatment Planning Decisions in Class II Malocclusions Using Digital and Plaster Models

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ABSTRACT

Aim: The aim of this study is to evaluate the treatment-planning value of digital models compared with plaster models and determine the consistency of treatment decisions.

Materials and Method: Twenty-eight models of Class II malocclusion subjects were used for treatment planning by 3 orthodontists. The orthodontists decided on a treatment plan using digital models at the first session and a plaster model in the second session. Treatment decisions were classified and recorded as extraction, distalization, functional appliance, or auxiliary treatments. McNemar test and kappa statistics were used for statistical analysis. Statistical significance was set at $p < 0.05$.

Results: No statistically significant difference was found between the treatment-plan decisions using digital or plaster models. Kappa statistics was fair for auxiliary ($_K$=0.222), moderate for distalization ($_K$=0.222), and substantial for extraction ($_K$=0.634) and functional appliance ($_K$=0.771) procedures.

Conclusion: The results of this study revealed that digital models can be used for treatment planning as an alternative to plaster models. (*Turkish J Orthod* 2013;26:19–22)

KEY WORDS: Class II Malocclusion, Digital Model

INTRODUCTION

Plaster casts manufactured from alginate impressions have remained the most commonly used dental models in orthodontic clinics. Dental models are an integral part of an orthodontist's armamentarium. Orthodontists classify malocclusion, identify aberrations, and formulate treatment objectives with the information gathered from dental casts. The morphology of the teeth, the teeth's position relative to the arch, and the degree of malposition can be visualized, and dental classification can be determined. Such study models are assumed to be the major record used for treatment planning.[1]

Many orthodontists, however, use computer-based records, such as digital photographs and radiographs. Digital models are also becoming popular, as digital storage has the advantages of easy access, no need for storage space, and the ability to be shared via the Internet.[2] With digital models, intra-arch, interarch, and transverse relationships can be evaluated. They also allow orthodontists to visualize proposed treatment outcomes and make diagnostic setups.[1] Peluso *et al*.[1] reported that this technology leads to higher quality of treatment and patient satisfaction. They also stressed that bite registration is the most important factor in the assessment of interarch relationships, such as overbite, overjet, and occlusal contacts.[1]

Models are important diagnostic tools in orthodontic diagnosis and treatment planning. In a study of Han *et al*.,[3] records of 57 patients were evaluated by 5 orthodontists, who were asked to plan the treatments. They reported that 55% of the treatment-plan decisions did not change considerably with the addition of diagnostic tools other than study models. Rheude *et al*.[4] conducted a study to evaluate the

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treatment-planning value of digital and plaster casts. Seven orthodontists evaluated 7 study models for treatment planning on 2 different occasions; digital models were used on the first occasion and plaster models on the second. They reported that 13% of diagnostic characteristics, 12% of treatment procedures and 6% treatment plans were changed after plastic models were give to evaluators. In a study by Whetten *et al*.,[5] 2 groups of orthodontists were given digital and plaster models and asked to make treatment plans. In the first group, treatment plans were made using digital models at the first stage and plaster models at the second stage. In the second group, treatment plans were made with plaster models at both stages. They reported overall proportions of agreement between 0.777 and 0.870 for the digital/plaster group and between 0.818 and 0.873 for the plaster/plaster group.

The purpose of the present study was to determine the diagnostic and treatment-planning value of digital models compared with plaster models without the benefit of photographs and radiographs.

MATERIALS AND METHODS

Pretreatment records of all patients who underwent active orthodontic treatment at the University of İzmir Katip Çelebi Orthodontic Clinic were evaluated. Selection criteria were as follows;

- At least half cusp Class II molar relationship on 1 side
- All teeth present except third molars
- No impacted teeth
- No previous orthodontic treatment
- No obvious asymmetry
- Age 12–18 years

Records of patients who required orthognathic surgery as part of their orthodontic treatment were excluded. In total, 28 models were included to the study.

Digital models were obtained from plaster casts (including the wax bite wafer) using a model scanner (3Shape R700 Scanner, Copenhagen, Denmark).

Three orthodontists who were familiar with using digital models in treatment planning evaluated the records. Three categories established: (1) extraction vs nonextraction, (2) distalization vs no distalization, (3) functional appliance vs no functional appliance, (4) auxiliary appliance vs no auxiliary appliance. If extraction of 1 or more teeth was planned, then extraction was marked. Functional appliance treatment was marked regardless of the extraction necessity before or after treatment. Distalization was not divided into extraoral or intraoral distalization. Other treatment plans, excluding these treatment plans, were marked as auxiliary (e.g., multibracket fixed appliance therapy, Class II elastic use, or rapid maxillary expansion without functional appliance treatment).

The patient information documents and models were assigned a code number for blinding. Patient information, including patient's age, gender, cephalometric data, radiographic data (panoramic and hand-wrist information), and functional, extraoral, and intraoral examination, was prepared. Evaluators were given a plaster or digital-model version of records (with patient information) in the first session and the other version in the second session. They were asked to write their treatments as extraction, distalization, functional appliance treatment, or auxiliary.

Statistical Analysis

All statistical evaluations were performed using Statistical Package for Social Sciences version 20 (SPSS, Chicago, IL, USA). All treatment plan decisions were tested with McNemar test. A nonsignificant result indicated an agreement between 2 decisions, whereas a significant test result showed lack of agreement. In total, 168 evaluations were performed and 84 comparisons were evaluated. Kappa statistics were also performed for each treatment decision. Statistical significance was set at $p < 0.05$.

RESULTS

Cross tabs for each treatment procedure are shown in Table 1. A matching extraction decisions was made 69 of 84 times. When a mismatch arose, 11 times the digital-model session gave a positive response for extraction whereas this occurred 4 times for the plaster models.

For distalization decisions, 73 out of 84 decisions matched. When a discrepancy arose, a positive response for distalization was made 3 times for the digital model and 8 times for the plaster model.

Matching results for functional appliance treatment were 75 of 84. A positive response was given in 5 decisions with the digital model and 4 decisions with the plaster model.

Total agreement was seen 78 of 84 times for auxiliary appliance treatments. A positive response

Table 1. Cross tabs for each treatment procedure

	Digital		
Plaster	**No**	**Yes**	**Total**
Extraction			
No	42	11	53
Yes	4	27	31
Total	46	38	84
Distalization			
No	64	3	67
Yes	8	9	17
Total	72	12	84
Functional appliance			
No	48	5	53
Yes	4	27	31
Total	52	32	84
Auxiliary			
No	77	1	78
Yes	5	1	6
Total	82	2	84

was given 1 time with the digital model and 5 times with the plaster model when a discrepancy arose.

McNemar test results and kappa statistics for each procedure are shown in Table 2. No statistically significant difference was found between the treatment-plan decision using either plaster or digital models.

Guidelines for interpreting kappa statistics according to Richmond *et al*.[6] are shown in Table 3. Kappa statistics ranged between 0.222 and 0.771. The highest agreement between treatment decisions was recorded for the functional appliance group. The auxiliary treatment group gave the lowest agreement with kappa statistics. Substantial agreement was recorded for functional appliance and extraction treatment decisions. This was fair for auxiliary appliance treatment decisions and moderate for distalization treatment decisions.

DISCUSSION

According to the results of the McNemar test, digital-model use did not significantly affect Class II

Table 2. McNemar test results and kappa scores for each treatment procedure

	Plaster vs Digital	
	McNemar Test	**Kappa Statistic**
Extraction	0.118	0.634
Distalization	0.227	0.544
Functional appliance	1,000	0.771
Auxillary appliance	0.219	0.222

Table 3. Guidelines for kappa statistic interpretation

Kappa Statistics	**Strength of Agreement**
<0	Poor
0–0.2	Slight
0.21–0.4	Fair
0.41–0.6	Moderate
0.61–0.8	Substantial
0.81–1.00	Almost perfect

treatment decisions. Our results are in consistent with those of Whetten *et al*.,[5] who reported good agreement between surgery, extraction, and auxiliary appliance decisions when either plaster or digital models were used.

When the mismatches were evaluated for extraction therapy, a positive response was given 11 times with digital models and 4 times for plaster models. In other words, when there was no agreement between treatment decisions made with digital or plaster models, more extraction decisions were obtained with digital models. Similarly, a positive response was given 3 times with digital models and 8 times with plaster models for distalization when a mismatch aroused. According to these findings, the molar relationship seems to be perceived in a more Class II relationship with digital models. Our findings are not compatible with the results of Whetten *et al*.,[5] who reported more extraction decision with plaster models.

The highest agreement was found for functional appliance ($_K$=0.771), which showed substantial agreement. The lowest kappa scores ($_K$=0.222) were recorded in the auxiliary group, although there was agreement 78 of 84 times.

This interesting result may be explained with statistical analysis. A McNemar test was applied to 2 × 2 contingency tables to determine whether the row and column frequencies are equal. Paired observations or outcomes A and B were used, and the hypothesis tested whether AB pairs were as likely as BA pairs (Table 4).[7] In auxiliary treatment decisions, a positive response was given 5 times with the plaster model and only once with the digital

Table 4. McNemar test results

	No	**Yes**	**Total**
No	AA	AB	AA+AB
Yes	BA	BB	BA+BB
Total	AA+BA	AB+BB	AA+AB+BA+BB

model. Thus, the kappa score is low as the discrepancy between AB and BA pairs is greater than that for other groups. In the functional group, the values for AB and BA pairs were 4 and 5.

Patient records, including photographs, radiographs, and findings of clinical examination, are necessary to diagnose and determine the treatment plan.[3] Study models are a three-dimensional representation of a patient's occlusion and provide a detailed evaluation of malocclusion by the clinician.[8] With advances in technology, digital models are available and are now part of an orthodontist's armamentarium. They are accurate, efficient, and easy to use.[1] They also provide accurate measurements and visualization of treatment results.[1] According to the results of a systematic review, the measurements performed on digital models are comparable to those derived from plaster models.[9] But the effectiveness of decision making with digital models has not been evaluated in detail. In this study, we evaluated the consistency of treatment decisions determined using plaster vs digital models.

An orthodontist's treatment planning using the same set of records could show considerable variability.[10] In this study, evaluation of digital and plaster models were made on the same day to minimize intraexaminer reliability.[4] The models were evaluated separately, and no time limitation was applied.

Unlike other studies,[4,5] the photographs or radiographs of the patients were not given to evaluators. As the evaluations and treatment decisions were made on the same day, these visual aids were thought to be a source of error. The evaluators could have remembered the patient and the previous treatment plan, which inevitably affected their decisions. Whetten et al.[5] suggested evaluating the reliability of treatment decisions in a nonclinical setting and without the benefit of photographs and radiographs.

CONCLUSION

- No difference was found between the treatment decisions of orthodontists using digital vs plaster models.
- The level of agreement showed differences among 4 treatment procedures.
- Higher agreement was noted for treatment decisions related to functional appliances.

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