# Evaluation of the Quality of Orthodontic Records in Comparison with the International Guidelines

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**ABSTRACT**

**Background:** *Standardized orthodontic record is a fundamental initial step in orthodontic practice that aid in accurate diagnosis and problem list formulation to get the proper treatment plan.* **Aim of the study:** *To assess the accuracy of pre-treatment orthodontic records as appose to a specific proposed standardized criterion.* **Material and Methods:** *A set of 78 patient records were recruited from a total sample size of 120 patients that fulfilled the selection criteria. A set of study model with the dental radiograph (panoramic and lateral cephalometric) as well as patient photographs were evaluated with certain criteria which were approved by the European and American Board of Orthodontists (EBO), (ABO) respectively, and the level of their acceptance was analyzed by estimating the percentage value of each criterion.* **Results:** *Evaluating results of both study model and intraoral photograph (lateral and occlusal views) showed a high level of non-acceptance, while panoramic radiograph and extraoral photograph (frontal and lateral) and only frontal view of intraoral photograph showed a higher percentage of acceptance. The lack of a required number of the lateral cephalometric radiograph and the absence of oblique and relaxed smile views of facial photographs were prohibiting their evaluation.* **Conclusion:** *The findings of this study indicate that more training courses may be needed for study model fabrication and intraoral photography by providing more facilities that aid in documenting with a total standardization. However, this may not be easily possible, but, it must be remembered that if it is not documented accurately, it is not valuable.*

**Keywords:** Orthodontic records, EBO, Study model, Photograph

## INTRODUCTION

Orthodontic records are a fundamental aid, due to which its value cannot be neglected. Even diagnosis is dependent on standardized, accurate and reliable orthodontic records. The vital information which is required to diagnose a malocclusion and development of an orthodontic treatment plan consists of a comprehensive clinical examination including medical, dental, and social histories, models, photographs, panoramic and/or lateral cephalometric radiographs [1].

Each particular case requires specific types of records to provide certain diagnostic information to the orthodontist to aid him/her in diagnosing and determining the best possible treatment plan. It is important to recognize that records are considered as an adjunct and are not used as a replacement for clinical examination [2,3].

Plaster study model has a long and proven history in orthodontics. They have been the "gold standard" in orthodontics, with advantages ranging from being a dental procedure routinely conducted, easily produced, inexpensiveness and simplicity of measurements to plaster casts being able to be mounted on an articulator for study in three-dimensions [4,5].

The panoramic radiograph is the universally used radiograph for orthodontic patients. However, in many patients with complex dental developmental disturbances and those with skeletal or functional abnormalities, additional radiographs may be necessary. Panoramic radiographs should be of sufficient quality to permit interpretation for diagnosis [6].

Cephalometric analysis and methods of superimposition are useful ij monitoring the changes that are due to growth or a combination of growth and treatment [7]. Cephalograms are usually not required as adjuncts for orthodontic diagnosis and treatment in adults, or for cases involving the correction of a minor problem in children. However, if jaw

relationships and incisor positions are being changed with treatment, one should definitely consider a cephalogram, an integral part of the diagnostic records [3].

Nowadays, in addition to the ordinary orthodontic goals in obtaining well aligned dentition and functionally stable occlusion, smile esthetic with harmonious facial balance emphasis the need for proper clinical photography and become more obvious and essential for proper treatment planning and follow up, as well as for the purposes of the research and publication for lecturing and teaching presentations. Also, the need for such valuable records for medico-legal purposes cannot be neglected [8].

All are crucial in the attainment of an accurate diagnosis, which is a prerequisite for successful orthodontic planning and treatment. The automatic compilation of all diagnostic findings helps the clinician create the list of problems present, from which the treatment plan will be developed. The importance of quality records acquisition needs to be appreciated. Poor-quality records have often been the basis of litigation. All diagnostic records require evaluation-at least qualitative if not quantitative assessment [9]. Therefore, the aim of this study is to assess the accuracy of pre-treatment orthodontic records as appose to specific standardized criteria and to establish a protocol for orthodontic patient's records.

## PATIENTS AND METHODS

**Sample**

In this study, a total of 120 patient records set of both genders including study model, dental radiographs (panoramic (OPG and lateral cephalometric) and photographs (facial and intraoral)) were recruited from the archive of the patient's records treated by postgraduate students in Orthodontic department, at the College of Dentistry, University of Baghdad from the period of 2014 to 2016. For quality assessment, only a sample of 78 records set fulfilled the inclusion criteria which included:

- Patients age 11 years to 36 years
- No fractured teeth
- No missing teeth
- Patients without open bite or complete deep bite
- The presence of all first molars
- No visual problems
- No clefts (lip/palate)

An excel sheet was used to categorize each record type with accepted and non-accepted values according to the specific standardize criteria gathered from European Board of Orthodontists (EBO) with modifications. These criteria are as follow:

**Study models:** The study model is described in Table 1.

Table 1 Assessment criteria of ideal study model as supposed by EBO

| Criteria | Description |
|---|---|
| Correct anatomical details | They should show the correct anatomical detail of all the teeth and the surrounding tissues. |
| Base dimensions | The base dimensions should be 13 mm from the buccal vestibule to the base surface anteriorly and 35 mm posteriorly from the gingival margin of the 1st molar region to the base of each cast. |
| Wax or silicone bites | Wax or silicone bites used preferably to aid in registration of occlusal relation. |
| Judgment of occlusion | The occlusion judged by placing the upper and lower cast together with the backside of the base on the table. |
| Cast identification | By placing a label on the back of the upper and lower casts with: patient's name, operator's name and the stage of treatment (before/at the completion of treatment).* |
| *with modifications from EBO by checking patient's name, stage of treatment and clinician's name | |

**Dental radiographs:** OPG and lateral cephalometric radiographs were evaluated according to the following criteria as shown in Table 2.

**Table 2 Assessment criteria of ideal radiographs as supposed by EBO**

| Panoramic Radiograph | |
|---|---|
| **Criteria** | **Description** |
| Condyles visibility and positioning | The condyles are positioned about equal distance from the inside edges of the image and 1/3 of the way down from the top edge of the image. |
| Properly labeled (right/left) | The radiograph should indicate right/left facial sides properly. |
| "U" shaped mandible | The mandible is "U" shaped from the ramus on one side to the other side. |
| Magnification | Magnification is equal on both sides of the midline |
| Occlusal Plane | The occlusal plane exhibits a slight curve or "smile line," upwards. |
| Teeth distortion | The roots of the maxillary and mandibular anterior teeth are readily visible with minimal distortion |
| Correct exposure | Correct radiation exposure produces an image with good resolution. |
| **Lateral cephalometric radiograph** | |
| **Criteria** | **Description** |
| Scale of magnification | The enlargement can be checked easily by the enlargement scale for linear measurements during analysis. |
| Soft tissue profile | The soft tissue profile should be sharply visible. |
| Head position | Head is in a natural position with Frankfort Horizontal plane parallel to the floor. |
| Patient Occlusion | The patient has the teeth in habitual occlusion. |
| Correct exposure | Strongly recommend occipital region be visible |

**Photographs**

**Facial (extraoral) photographs:** The standardized criteria for the frontal, lateral and oblique views are shown in Table 3.

**Table 3 Assessment criteria of ideal extraoral photograph (frontal, lateral, and oblique) views as supposed by EBO**

| Facial (Extra-oral) photographs | |
|---|---|
| **Frontal** | |
| **Criteria** | **Description** |
| Framing of the shot | Entire head and neck displayed with the approximate center of the frame is the tip of the nose. |
| Head position | Natural head position with the patient looking forward into the camera. |
| Leveling of the eyes | Eyes are opened and looking into the camera with the inter-pupillary line horizontal to the frame. |
| White background | Use white background to avoid shadows. |
| Teeth, jaws, lips posture | Teeth and jaws are held in relaxed (rest position) with the lips relaxed and in contact (if possible). |
| **Lateral** | |
| **Criteria** | **Description** |
| Framing of the shot | Entire head and neck displayed with left eyelash slightly visible and the approximate center of the frame are 1.0 cm anterior to the tragus. |
| Head position | Natural head position with eyes looking forward. |
| Leveling of the eyes | Eyes are opened and fixed horizontally at a specific eye-level point or at the reflection of their own pupils in a mirror. |
| White background | Use white background to avoid shadows. |
| Teeth, jaws, lips posture | Teeth and jaws are held in relaxed (rest position) with the lips relaxed and in contact (if possible). |
| **Oblique** | |
| **Criteria** | **Description** |
| Framing of the shot | Entire head and neck displayed. |
| Head position | Natural head position with the patient turned his/her head to 45° profile (3/4 profile) and keeping the body in the previous profile (i.e: lateral view) position. |
| Leveling of the eyes | The eyes are looking into the camera. |

**Intra-oral photographs:** Frontal, lateral (right/left sides) and occlusal (upper and lower) views are assessed according to the criteria as shown in Table 4.

**Table 4 Assessment criteria of ideal intraoral photograph (frontal, lateral (right and left) and occlusal (upper and lower) views as supposed by EBO**

| Intraoral photograph (in occlusion) | |
|---|---|
| **Frontal** | |
| **Criteria** | **Description** |
| Photo orientation | The vertical line should pass through the upper frenal attachment as a guide for facial midline occlusal plane should be horizontal and bisecting the photograph |
| Shot field depth | There should be equal display of the posterior dentition and all attached gingiva should be visible |
| Teeth in occlusion | Teeth should be in occlusion |
| **Lateral (Right/Left)** | |
| **Criteria** | **Description** |
| Photo orientation | Occlusal plane should be parallel to the frame |
| Shot field depth | Anteriorly-should display the entire ipsilateral maxillary central incisor at minimum Posteriorly-include the entire first molars at minimum All attached gingiva should be visible |
| Teeth in occlusion | Teeth should be in occlusion |
| **Occlusal views** | |
| **Upper** | |
| **Criteria** | **Description** |
| Using dental mirror | Dental mirror is mandatory in this view |
| Photo orientation | Mid-palatal raphe centered the photograph and used as a guide for its correct orientation |
| Shot field | Frame the entire arch with minimal lateral soft tissue displayed at least through the first molars |
| **Lower** | |
| **Criteria** | **Description** |
| Using dental mirror | Dental mirror is mandatory in this view |
| Photo orientation | The midline centered in the frame with the labial surface of the central incisors parallel to the bottom of the frame |
| Shot field | Fill the frame with the entire mandibular arch at least through the first molar |
| Tongue rolled back | Ideally, the tongue should be rolled back or at least not obstructing the view |

To ascertain intraexaminer reliability, 15 of the sample records were re-examined after a period of 2 weeks by the same examiner. The results were tested using kappa-test with the reliability value of a highly significant level ($p \leq 0.05$, kappa=0.857-1.000).

**Statistical Analysis**

By using descriptive statistic to predict the level of the accuracy of recruited patients' records, the percentage was used to evaluate the level of acceptance of the collected data for each criterion within each record. Statistical package for social sciences (SPSS) version 21 was used.

## RESULTS

The results of study model assessment showed a high level of non-acceptance in revealing correct anatomical details (60%), base dimensions (95%), wax or silicon bites (100%) and judgment of occlusion (91%). Whereas, all the examined casts were fully identified (100%) (Table 5).

**Table 5 Percentage values of acceptance level for study model assessment criteria**

| Criteria | Category | N=78 | % |
|---|---|---|---|
| Correct anatomical details | Accepted | 31 | 39.74% |
| | Non-accepted | 47 | 60.26% |
| Base dimensions | Accepted | 4 | 5.13% |
| | Non-accepted | 74 | 94.87% |
| Wax or Silicone bites | Non-accepted | 78 | 100.00% |
| Judgment of occlusion | Accepted | 7 | 8.97% |
| | Non-accepted | 71 | 91.03% |
| Cast identification | Accepted | 78 | 100.00% |

Table 6 shows a high percentage of acceptance for the criterion of assessment of panoramic radiograph regarding condyles visibility (72%), properly labeled (100%), "U" shaped mandible (69%), magnification (71%) and occlusal plane (74%). However, teeth distortion and correct exposure show a higher percentage of acceptance than non-

acceptance level but it is less than other previous criteria (59% and 53% respectively).

**Table 6 Percentage values of acceptance level for panoramic radiograph criteria**

| Criteria | Category | N=78 | %. |
|---|---|---|---|
| Condyle visibility and position | Accepted | 56 | 71.79% |
| | Non-accepted | 22 | 28.21% |
| Properly labeled | Accepted | 78 | 100.00% |
| U Shaped mandible | Accepted | 54 | 69.23% |
| | Non-accepted | 24 | 30.77% |
| Magnification | Accepted | 55 | 70.51% |
| | Non-accepted | 23 | 29.49% |
| Occlusal Plane | Accepted | 58 | 74.36% |
| | Non-accepted | 20 | 25.64% |
| Teeth distortion | Accepted | 46 | 58.97% |
| | Non-accepted | 32 | 41.03% |
| Correct exposure | Accepted | 41 | 52.56% |
| | Non-accepted | 37 | 47.44% |

The percentage of frontal and lateral views of facial photograph showed a high level of acceptance in achieving a photograph with accepted framing of the shot, head positioned in NHP, leveling of the eyes and teeth, jaws and lips posture. On the other hand, in both views, a high percentage of non-acceptance for the examined photographs exhibit shadows as they lack the presence of white background (63% and 76% respectively) (Figures 1 and 2).
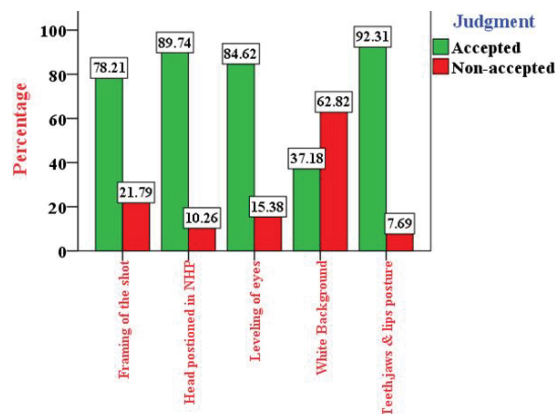


**Figure 1 Percentage distribution of acceptance level of the facial photograph in frontal view**
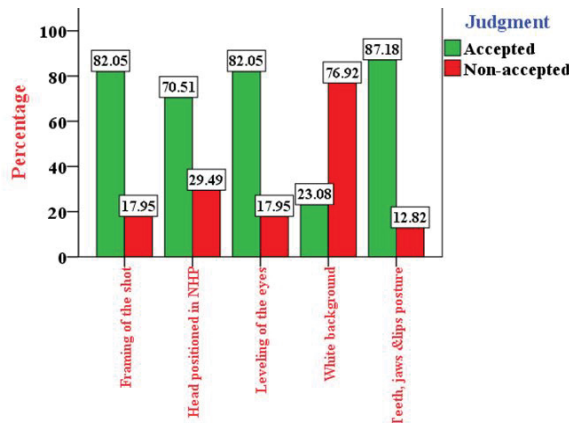


**Figure 2 Percentage distribution of acceptance level of the facial photograph in lateral view**

In Figure 3, the frontal view of intraoral photographs is presented, it was interesting to know that the percentage values of acceptance indicate more than half of the sample was shot with standardizing criteria. Whereas, the photographs in

the lateral views (right and left sides) showed a high percentage of non-acceptance due to the lack of standardization in photo orientation and shot depth field (Figure 4).
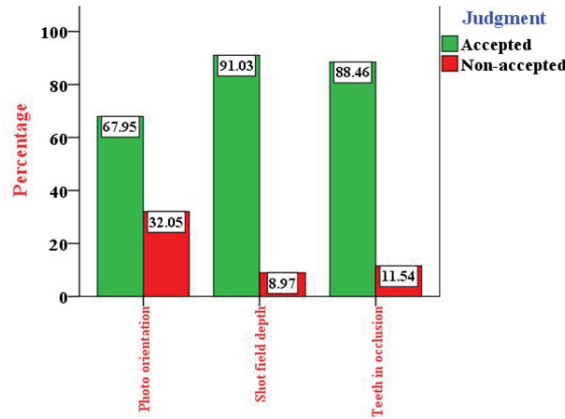


**Figure 3 Percentage distribution of acceptance level of the intraoral photograph in frontal view**
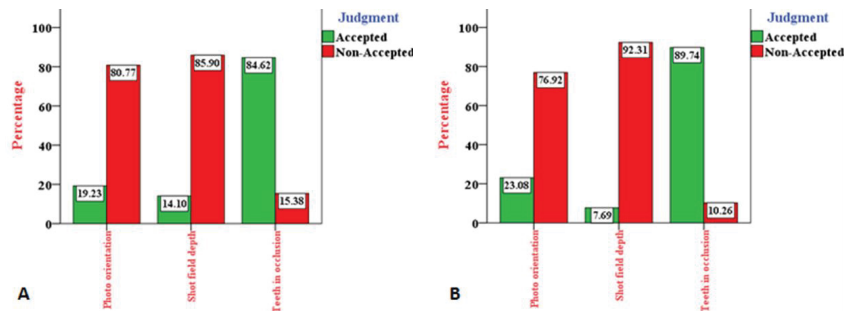


**Figure 4 Percentage distribution of acceptance level of the intraoral photograph in lateral view (A: Right side, B: Left side)**

The results of both occlusal views (upper and lower) of intraoral photographs shows a high percentage of non-acceptance in revealing an image with standardized criteria of shooting with a dental mirror, photo orientation, shot field and tongue rolled back  (Figure 5).
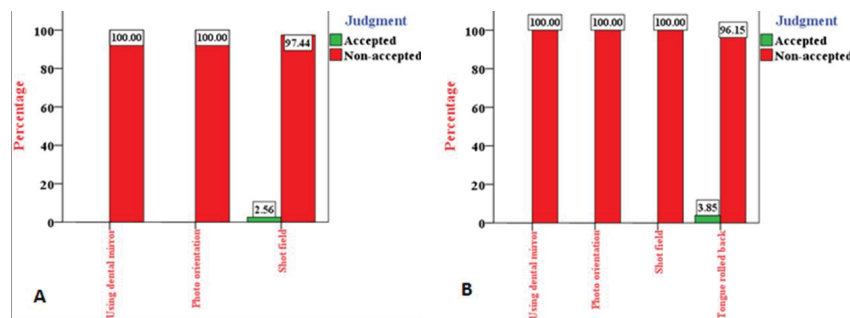


**Figure 5 Percentage distribution of acceptance level of the intraoral photograph in occlusal view (A: Upper, B: Lower)**

## DISCUSSION

Every patient who needs orthodontic treatment should have at minimum diagnostic records which include the medical and dental patient history, clinical findings, TMJ examination, intraoral and extraoral photographs, dental radiographs (panoramic and cephalometric analysis) and study models [10]. In addition to their importance in providing an accurate diagnosis and problem list, from which the treatment plan will be developed, these would help orthodontists to present their treatment outcomes throughout their population as well as will help who so desired to be judged by national examinations around the world. Because of all these reasons, the records must be prepared with standardized

criteria, however, there is no "standard" method that should be followed as a rule in obtaining qualified records, but it can be generally accepted by opinions of many authorities in this field that would enable the clinician to get a maximum benefit and information.

In the past, many issues were concerned in monitoring and improving the quality of care. Latterly and certainly over the past decade or so, self-audit, clinical governance, and peer review have become major issues in all branches of the health industry. Fundamental to these issues is the assessment of quality by peer review. In orthodontics, several systems have been developed and adapted for specific purposes. On a population scale, where statistical procedures are essential, standards and indices were designed and applied to measure quality. In the last decade, the need, effectiveness, and efficiency of orthodontic treatment provided by various groups of care providers became a popular field of research [6].

In this study, the inclusion criteria for sample selection were formulated in order not to affect the procedure of assessment. For study model assessment, no fractured or missing teeth were mandatory during evaluation mainly in the judgment of occlusion. In OPG evaluation, open bite or complete deep bite patients were excluded from the study as these affect the evaluation of the occlusal plane in open bite cases and in deep bite patients, the appearance of double images of the palatal vault with the nasal floor is usually above the apices of maxillary teeth which results in OPG with distorted anterior teeth [6]. For photograph evaluation, the presence of all first molars is mandatory as it was considered as a guide to which the shot depth field should be reached at a minimum. Also, any patient with the visual problem was excluded as this was affecting on measuring the leveling of the eye criteria. In the evaluating the occlusal view of upper arch, the palatal raphe is considered as a guide in photo orientation vertically, therefore, no clefts (lip/palate) patients' record was included in the study.

In this study, EBO standardized criteria of the diagnostic records which are proposed by the council of this board to the specialists in orthodontics who would prefer to present their cases were used with some modifications regarding the assessment of study models, radiographs and photographs. According to EBO, 3 sets of dental casts are mandatory: before treatment, at the completion of treatment and at the (post) retention periods. In this study, before treatment records are only evaluated for the proposed standardized criteria and the results showed high percentage of non-acceptance in all criteria except cast identification, which indicate either more training courses regarding how to prepare study model with good quality may be needed or may be due to the lack of specific facilities that should be available in cast preparation such as wax or silicon bites and in preparing the base of the cast.

According to EBO, dental radiographs needed for orthodontic patients usually are OPG and lateral cephalometric radiographs. Routinely, each orthodontic patient should have panoramic radiograph: before treatment and at the completion of treatment and if necessary during treatment. In the present study, only the radiographs before treatment are evaluated for their quality assessment and the results showed that the examined panoramic radiography provides the dentist with an image of good quality of the whole dentition and adjacent structures. While panoramic radiography is technique sensitive, carefully following the manufacturing instructions and correct patient positioning should be applied, otherwise unclear and distorted radiographs with low diagnostic quality can be consistently obtained.

Also, lateral cephalometric radiograph with their analysis is mandatory for orthodontic patient mainly those with skeletal discrepancy and in monitoring the growth changes of growing patients, but unfortunately one of the limitations of the present study is that only 5 radiographs were available which could not be used for the assessment of the quality. The lack of an adequate number of lateral cephalometric may be due to the unavailability of the facilities required for obtaining cephalometric radiographs or due to the financial causes.

In addition to the importance of the clinical photographs in the documentation of patient status, they are valuable in allowing the clinician to study and monitor the hard and soft tissue patterns during different stages of treatment. Frontal, lateral, and oblique facial color photographs should be taken for each patient in the resting position. Nowadays, an image in frontal view with a relaxed smile is of greater importance in allowing the orthodontist to study the social setting of the patient by regarding various values of smile esthetic [8].

According to EBO, these views should be printed with approximate dimensions of ($5 \times 7$) cm with the specific criteria. The extraoral photographs were considered as the easiest and the ready method, that needed only the proper positioning of the patient and the clinician and of course the proper setup of the camera itself. Therefore, the results of the present study evaluating the facial photographs showed a high level of acceptance with the standardized criteria.

Whereas, the results of intraoral photographs showed high percentage of non-acceptance in lateral (right/left) and occlusal (upper/lower) views, because these are considered more difficult because, in addition, they require dental photography mirror, special cheek retractors and if possible, well-trained assistant to get an accurate image that fills the proposed standardized criteria. Also, the absence of oblique and relaxed smile views of facial photographs prohibits their evaluation.

## CONCLUSION

The orthodontic record is an important part of any orthodontic practice. Documenting with total standardization may not be always possible. But, it must be remembered that if it isn't documented accurately, it isn't valuable. The findings of this study indicate that more training courses may be needed for study model fabrication and intraoral photography steps with providing more facilities that aid in documenting with a total standardization. From this study, by following these proposed standardized criteria which mainly follow the instructions of EBO and considered them as a protocol must be followed in the fabrication of each record, their quality would be more accepted and the clinicians can submit their records to national examinations around the world.

## DECLARATIONS

### Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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