

Quality of clinical photographs taken by orthodontists, professional photographers, and orthodontic auxiliaries

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Introduction: A survey of the members of the Angle Society of Europe showed that 60% of orthodontists took their own clinical photographs, 35% assigned the task to an auxiliary, and 5% hired professional clinical photographers. It is always useful to ensure that orthodontists' time is used to maximum effect. Clinical photography could be delegated to auxiliary staff. In this study, we assessed the quality of photographs taken by orthodontists to see whether those taken by orthodontic auxiliaries and clinical photographers are of comparable quality. **Methods:** Fifty sets of orthodontic photographs were collected from each of 3 types of photographers: orthodontists, orthodontic auxiliaries, and professional clinical photographers. Four assessors scored each set for quality and detailed errors. The results were compared to determine whether there were differences between the quality of the photographs taken by the different groups. **Results and Conclusions:** Most of the photos taken by the 3 groups of photographers were judged to be good or acceptable. The results for extraoral photographs showed no statistically significant differences between the 3 groups for good ($P = 0.398$) and acceptable ($P = 0.398$) images. The results for intraoral photographs did not differ significantly for acceptable and unacceptable photographs, but orthodontists produced significantly more good-quality intraoral photographs ($P = 0.046$). (*Am J Orthod Dentofacial Orthop* 2009;135:657-62)

In dentistry and the wider health care field, we strive constantly to improve the quality of clinical practice. The quality of clinical photographs varies widely, as do opinions regarding what is clinically acceptable. Clinical photography has changed in recent years with the introduction of cameras designed to suit the needs of the dental photographer. High-quality digital cameras are also available, and prices have fallen dramatically, making a digital camera a cost-effective investment for many dentists. Despite all this develop-

ment, clinical photography is often an underused resource. Clinical photographs are not only a useful diagnostic tool, but also are essential for accurate record keeping, case evaluation, and monitoring treatment progress. They are also useful for exchanging information between clinicians and for educational and medical legal purposes.

Pioneering work at the University of Washington in Seattle in the mid-1990s on orthodontic photography has set the gold standard criteria necessary for good clinical photographs. These included requirements for patient positioning, adequate soft-tissue retraction, camera positioning, and field of view as well as technical details such as camera settings including aperture, focal length of lenses, and resulting depth of field. A recent survey of the Angle Society of Europe showed that 60% of the orthodontists took their own photographs, 35% had an auxiliary do it, and 5% used professional clinical photographers.¹

In orthodontic photography, it was recommended to take 4 extraoral standard photographs: full face, full face smiling, right profile, and three quarter views. The 5 standard intraoral photographs are right buccal, front, left buccal, maxillary occlusal, and mandibular occlusal.² For each view, criteria help to define the quality of the image.

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Many errors can occur when taking photographs, including camera positioning errors, poor focusing, over- or underexposure, and overcropping of the field of view when constructing the shot. Patient-positioning errors can include the subject's height relative to the photographer, the Frankfort plane or the natural head position incorrectly assessed, hair covering the ears, the subject's eyes closed, or the soft tissues not in the desired position. Other possible errors include excessive saliva bubbles, a fogged mirror, dark buccal corridors, tongue not sufficiently retracted, distal margin of the first molar not recorded, or the photographic retractors obscuring the field of view.³

In clinical work, it is essential to maximize the use of the orthodontist's time, necessitating consideration of how other members of the orthodontic team can assist. Clinical photography is an area where an auxiliary or a professional clinical photographer can achieve comparable results to those of the orthodontist.

It was suggested that the gold standard for orthodontic photographs should be that the need for retaking photographs because of poor quality is less than 10%.⁴

Four important variables directly affect the quality of photographs. These include training in photography, photographic experience, amount of time available to take the photographs, and the camera and accessory equipment. In this study, we assessed the quality of clinical photographs from various operators. In addition, we assessed whether those taken by orthodontic auxiliaries and dedicated clinical photographers are of similar quality to those taken by orthodontists. We also wanted to determine whether delegation of clinical photography is appropriate.

MATERIAL AND METHODS

Photographs from 3 centers, all with a major interest in clinical photography, were analyzed. The United Kingdom center was Chesterfield Royal Hospital, where the treating orthodontists take all their own clinical photographs, always with the assistance of an orthodontic nurse. The second center was the practice of Vincent Kokich in Tacoma, Washington; a professional clinical photographer took all routine orthodontic photographs at a separate, but nearby, location. The third center in the study was the practice of Richard McLaughlin in San Diego, California, where unassisted dental auxiliaries routinely take clinical photographs.

From each group of photographers, 50 sets of orthodontic photographs were selected randomly. The photographs were selected from the 12-month period before the orthodontic clinics agreed to participate in this study

Table I. Assessors' scores for extraoral photographs taken by the 3 groups

	<i>Good</i>	<i>Acceptable</i>	<i>Unacceptable</i>
Orthodontists			
Assessor 1	27	23	0
Assessor 2	20	30	0
Assessor 3	13	37	0
Assessor 4	28	22	0
Average	22	28	0
Clinical photographers			
Assessor 1	17	33	0
Assessor 2	23	27	0
Assessor 3	6	44	0
Assessor 4	14	36	0
Average	15	35	0
Orthodontic auxiliaries			
Assessor 1	6	44	0
Assessor 2	41	9	0
Assessor 3	9	41	0
Assessor 4	19	31	0
Average	18.75	31.25	0

to ensure that no photographic practices were altered because of this study, thus allowing a fair comparison between the different groups.

The sets of photographs were analyzed by 4 orthodontists (J.D., F.M., A.M., C.O.) who had all been trained in what to look for in high-quality clinical photographs. The assessors were unaware of the purpose of the study and were blinded as to origin of the photographic sets. The assessors were asked to specifically grade the quality of the extraoral and intraoral photographs. They scored each set of extraoral and intraoral photographs as "good" if it had no errors; "acceptable" if there were some errors, but the photographs were still clinically useful; and "unacceptable" if errors limited the usefulness of the photographs. The assessors also noted the specific details of the errors.

RESULTS

No extraoral photograph set was judged unacceptable by any assessor (Table I). The orthodontists were judged to have 22 good and 28 acceptable extraoral photographs, the professional photographers had 15 good and 35 acceptable extraoral photographs, and the orthodontic auxiliaries had 18.75 good and 31.25 acceptable extraoral photographs. The results showed no statistically significant difference between the 3 groups for good ($P = 0.398$) and acceptable ($P = 0.398$) extraoral photographs.

The orthodontists had 16.25 good and 33.75 acceptable intraoral photographs (Table II). The professional photographers had 19 good, 31 acceptable, and 0.5

Table II. Assessors' scores for intraoral photographs taken by the 3 groups

	Good	Acceptable	Unacceptable
Orthodontists			
Assessor 1	27	23	0
Assessor 2	5	45	0
Assessor 3	4	46	0
Assessor 4	29	21	0
Average	16.25	33.75	0
Clinical photographers			
Assessor 1	17	33	0
Assessor 2	31	19	0
Assessor 3	0	50	0
Assessor 4	28	22	2
Average	19	30.5	0.5
Orthodontic auxiliaries			
Assessor 1	6	44	0
Assessor 2	1	49	0
Assessor 3	0	49	1
Assessor 4	6	32	12
Average	3.25	43.5	3.25

Table III. Errors in extraoral photographs taken by the orthodontists

	Anterior facial	Side profile	Anterior smiling
Poorly focused	1.25	0.5	4
Overcropped superior	0	0	0.25
Overcropped inferior	0	0.25	0
Overcropped lateral	0	0	0
Eyes closed	0	0	0
Overexposed	0	0	0
Underexposed	0	0	0
Hair over ears	0	1.25	0
Head tipped	7.25	6.25	7.5
Other	3.5	1.25	2.25

unacceptable sets of intraoral photographs. Orthodontic auxiliaries had 3.25 good, 43.5 acceptable, and 3.25 unacceptable shots. When the results were analyzed statistically, they showed no significant difference between the 3 groups for acceptable and unacceptable scores. The results between the 3 groups of photographers for good scores were statistically significantly different with a P value of 0.046. This shows that the orthodontists in this study produced significantly more good-quality intraoral photographs than did the orthodontic auxiliaries.

Extraoral photographic errors

Orthodontists' errors (Table III) on the extraoral photographs occurred with varying frequency and included poor focusing on the anterior, profile, and smiling photographs. Overcropping was noted both superiorly

Table IV. Errors in extraoral photographs taken by the professional photographers

	Anterior facial	Side profile	Anterior smiling
Poorly focused	5	3.75	6.5
Overcropped superior	0	0	0
Overcropped inferior	0	0	0
Overcropped lateral	0	1	0
Eyes closed	0	0	1
Overexposed	0	0	0
Underexposed	7.5	7.25	10.25
Hair over ears	0	1	0
Head tipped	1.5	4.75	2.5
Other	6.75	2.75	5

Table V. Errors in extraoral photographs taken by the orthodontic auxiliaries

	Anterior facial	Side profile	Anterior smiling
Poorly focused	0.25	0	0.5
Overcropped superior	0	0	0
Overcropped inferior	0	0	0
Overcropped lateral	1	0	1
Eyes closed	0	0	0
Overexposed	0	0	0
Underexposed	1.25	0.25	1.25
Hair over ears	0.75	5.75	0
Head tipped	1	1.25	1
Other	2.25	0.25	4.5

and inferiorly, and hair occasionally covered the patients' ears. The most common error was a tipped head, noted on front profile and smiling views.

The professionals' extraoral photographs (Table IV) were judged as poorly focused slightly more often on the anterior profile and smiling views; 1 profile image was overcropped laterally, and, on a smiling view, the subject had his eyes closed. Exposure appeared to be a slight problem, and some photographs were judged as underexposed on anterior, profile, and smiling. Hair was noted over the ears on 1 profile image, and head tipping was an issue in anterior profile and smiling photographs.

Orthodontic auxiliaries (Table V) had poor focusing on anterior and smiling photographs, and both views were occasionally judged as overcropped laterally. Underexposure was recorded on anterior profile and smiling photographs, and hair covering the ears was a common problem in the profile photographs. The head was judged as tipped on some anterior profile and smiling photographs.

No statistically significant differences in the errors between the 3 groups of photographers were found for anterior facial ($P = 0.580$), profile ($P = 0.304$), or anterior smiling photographs ($P = 0.326$).

Table VI. Errors in intraoral photographs taken by the orthodontists

	<i>Right buccal</i>	<i>Anterior</i>	<i>Left buccal</i>	<i>Maxillary occlusal</i>	<i>Mandibular occlusal</i>
Poorly focused	0	0	0	0	0.25
Overcropped superior	0	0	0	1.75	4
Overcropped inferior	0	0	0	5.75	0.5
Overcropped lateral	1.75	2	1.25	0	0
Overexposed	0	0	0	0	1
Underexposed	0.25	0.25	0.25	8.5	8
Saliva bubbles	4	0	1.75	0.25	1.75
Dark buccal corridors		1.5			
Occlusal plane tipped	4.5	3	4.5		
Tongue not retracted	3.75	1	1.25		0
Distal first molar not visible	11.25		8	0.75	0.5
Retractors obscuring field	0	0	0.25	0.25	1.75
Inadequate lingual or palatal view				0.25	0.75
Teeth resting on mirror				2.5	2.5
Fogged mirror				0.25	3
Other	1.25	1.25	1.25	0	0

Table VII. Errors in intraoral photographs taken by the professional photographers

	<i>Right buccal</i>	<i>Anterior</i>	<i>Left buccal</i>	<i>Maxillary occlusal</i>	<i>Mandibular occlusal</i>
Poorly focused	0	0	0	0	0
Overcropped superior	0	0	0	0.5	10.25
Overcropped inferior	0	0	0	10.25	0
Overcropped lateral	4.25	0	4	0.25	0
Overexposed	1	0.75	1	0	0
Underexposed	4.25	0.25	10.75	7.25	6.75
Saliva bubbles	2.5	1.25	2.25	0.5	0.25
Dark buccal corridors		0			
Occlusal plane tipped	2.25	0.5	0.75		
Tongue not retracted	1.5	0.25	1.5		
Distal first molar not visible	1		1	1.5	0.5
Retractors obscuring field	0	0.5	0	0	0
Inadequate lingual or palatal view				1.5	1.25
Teeth resting on mirror				0	0.25
Fogged mirror				0	0
Other	1.5	0.5	1.25	0.5	0

Intraoral photographic errors

Distribution of errors in the intraoral photographs are shown for orthodontists (Table VI), professional photographers (Table VII), and orthodontic auxiliaries (Table VIII). No statistically significant difference in errors by the 3 groups was found for any intraoral image.

Focusing issues were seen occasionally with orthodontists' mandibular occlusal photographs, but slightly more often with the mandibular and maxillary occlusal photographs taken by the orthodontic auxiliaries.

Overcropping of the occlusal shots was seen more frequently and noted with all 3 groups of photographers as were exposure issues, saliva bubbles in the field of

view, tipped occlusal plane, and inadequate tongue retraction.

On the occlusal images, mirror problems were occasionally noted with all 3 groups of photographers.

There was also an "other" category that included problems with photographs that did not fall into the specific categories. Orthodontists and professional photographers had an equally low frequency of these problems, but auxiliaries had a much greater frequency in their photos.

DISCUSSION

All 3 groups of photographers produced clinically useful extraoral photographs, and no set was judged

Table VIII. Errors in intraoral photographs taken by the orthodontic auxiliaries

	<i>Right buccal</i>	<i>Anterior</i>	<i>Left buccal</i>	<i>Maxillary occlusal</i>	<i>Mandibular occlusal</i>
Poorly focused	0	0	0	2.25	2.25
Overcropped superior	0	0	0	0	1.75
Overcropped inferior	0	0	0	0.75	0
Overcropped lateral	0.75	5.25	0.25	0.5	0.25
Overexposed	0	0	0	0	0
Underexposed	1.25	3.75	3.25	11.75	11.5
Saliva bubbles	1	0.75	0.75	0.25	0
Dark buccal corridors		0			
Occlusal plane tipped	4.25	13	1.25		
Tongue not retracted	2.5	0.5	0.75		1.5
Distal first molar not visible	41		43.5	0.25	0
Retractors obscuring field	0	0	0	0	0
Inadequate lingual or palatal view				1	0.25
Teeth resting on mirror				1.25	0
Fogged mirror				0.75	3
Other	5.75	17.25	5.25	2	1

unacceptable. Each group comfortably surpassed the gold standard of less than 10% of photographs needing to be repeated because of poor quality. The frequency of high-quality extraoral photographs (classified as good) suggests that orthodontists did not obtain significantly better results than professional photographers or orthodontic auxiliaries. With good lines of communication between all 3 groups and regular positive feedback, all should be able to reach equally high standards of extraoral photographs.

Intraoral photography showed a similar number of good images from orthodontists and professional photographers, although a few photographs by professional photographers were judged to be unacceptable. The orthodontic auxiliaries had significantly fewer intraoral photographs classified as good, but there was no statistically significant difference in acceptable and unacceptable groups, thus demonstrating that they could be trained to equal standards with the photographers and the orthodontists.

Once again, the gold standard was reached, thus justifying delegation of the task of photography to others.

Intraoral photographs are invariably more challenging than extraoral photographs. A certain amount of confidence is required to use the large photographic retractors appropriately to ensure sufficient retraction to allow the desired photograph to be taken. Confident communication is also essential if a person is helping with the retraction; this includes praise when the helper is performing correctly but also clear constructive criticism when further effort is required. When the retractor needs to be moved to prevent obscuring the field of view, the assistant or the patient must be told.

Confident communication with patients is also a necessary prerequisite for a high standard of occlusal photography. If a patient is not opening wide enough, he or she must be told in a firm but confident way. Giving instruction to a patient might be easier for the dentist than for the photographer or the orthodontic assistant. These skills can be learned and developed.

The errors with intraoral shots are clustered around particular types—eg, not getting the distal aspect of the first molars in the photograph. It might not be a priority for all groups taking the photographs to include the distal margins of the first molars on all maxillary and mandibular occlusal photographs. Certainly, to consistently achieve this requires a careful technique and perseverance to ensure effective use of both the retractors and the mirrors.

Some errors were more frequently seen in 1 group. This was due to inadequate training in photographic techniques or the less than ideal equipment that the photographers have to work with, such as mirrors or retractors.

Some errors are easier to correct than others: eg, making sure the head is in the correct position or that hair is not obscuring the ears. Head tipping accounted for most of the problems with extraoral photographs; with careful training and communication with patients, this error can be easily avoided. Making sure that the patients' ears are visible on every photograph is simply a matter of formally incorporating that requirement into the sequence of steps when preparing the patient for the photographs.

Other errors might be more difficult to correct instantly. Not photographing the distal surface of the first molars on the buccal view, for instance, can be due to

poor or inappropriate equipment, not using the correctly shaped retractor, or the operator's failure to fully retract the cheek and take the photograph at the same time. A few patients cannot tolerate the necessary retraction to secure the required view or image, and it might be helpful with these patients to use a buccal mirror.

When taking occlusal photographs, the light from the camera flash is never reflected 100%. Correcting potential underexposure on mirror views can easily be done by opening the camera's aperture by at least 1 stop, thus allowing more light into the camera.

Poorly focused images can be prevented with a careful technique: by using as small an aperture as the flash on the camera will allow, focusing on the correct area, remembering that the depth of field is one third ahead and two thirds behind the focal plane, and critically analyzing all photographic results regularly.

Cropping errors can occur when either the area required is not included in the field of view or the photograph is poorly manipulated on the computer. To prevent cropping errors, knowledge of all areas needed in the photograph is essential, followed by careful practice of the correct technique. With a high-quality camera, it is possible to take the photographs from slightly farther away from the subject and then to crop the photographs on the computer. This means that less precise viewfinder cropping is required because the less magnified images can be "zoomed in" with image-editing programs. The disadvantage of computer cropping is that some digital information is inevitably lost.

There could have been slight variations in how the assessors judged the quality of the photographs, although, with 4 assessors, all of whom had been trained to a high standard in clinical photography, these inter-assessor variations should have been minimal.

With the expected expansion of the dental team in Europe, how dentistry is practiced will inevitably change. This is particularly true in orthodontics, where, in many European countries, the orthodontist carried out most clinical procedures. This contrasts greatly with how some orthodontists work in the United States, with dental nurses having a greater role in treatment under the orthodontist's direct supervision. Many orthodontists in America, while monitoring all their patients, personally treat only the more complex or perform intraoral tasks that they can do more efficiently or effectively than their assistants.

If, as is expected, similar developments occur in the United Kingdom and other European countries, it will be important to identify which tasks are appropriate for an orthodontic assistant or a therapist. This could certainly include a greater role in intraoral and extraoral clinical photography. As our results show, the standard of photography by nondentally qualified personnel is high and certainly meets the gold standard. After appropriate instruction and training, orthodontic therapists could undertake this task as a significant part of their clinical role.

The ability to produce high-quality photographs is an important clinical skill that has applications across all aspects of dentistry. Photography is not necessarily covered in sufficient detail in undergraduate training. Its inclusion could be rewarding and would allow the dentist as the leader of the clinical team to "cascade" this skill down to other team members.

CONCLUSIONS

1. Clinical photography of a high standard can be achieved by orthodontists, orthodontic auxiliaries, and clinical photographers.
2. There were no statistically significant differences between the 3 groups for good and acceptable extraoral photographs.
3. There were statistically significant differences between the groups when assessing how many intraoral photographs were classified as good. The orthodontists performed better than the orthodontic auxiliaries.

Communication between all groups involved in photography should allow a consensus view as to the gold standard for intraoral and extraoral photographs, for which we should all strive.

REFERENCES

1. Sandler PJ, Murray AM. Clinical photographs—the gold standard. *J Orthod* 2002;29:158-67.
2. Sandler PJ, Murray AM. Clinical photography in orthodontics. *J Clin Orthod* 1997;XXXI:729-39.
3. McKeown HF, Murray AM, Sandler PJ. How to avoid common errors in clinical photography. *J Orthod* 2005;32:43-54.
4. Rowland H, Atack N, Mitchell N. The quality of clinical photographs. *British Orthodontic Society Clinical Effectiveness Bulletin* 2004; No. 17 p.16.