Patient Photography in Orthodontics*

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The Purpose of this article is to review the literature pertinent to dental clinical photography and to make a critical comparative analysis of the equipment and techniques used.

Basic Aims of Orthodontic Photography

The basic aim of photography in orthodontics, as seen from a review of the literature, is to provide a visual record of a particular object or condition at a particular time. "The photograph records the external manifestations of health, disease or deformity, as related to the teeth, gums, or adjacent tissues, and the development of facial characteristics."[1] As applied by the orthodontist, photography falls into two categories of use:

I. Diagnostic criteria.

II. Records.

There is a broad overlapping of these groups, with photographs that have been used for diagnosis being used also for records, but this classification includes the majority of techniques employed.

Use of Photographic Techniques in Orthodontic Diagnosis

The application of photography to orthodontic diagnosis was a logical outcome of the work of Simon and Lischer. Lischer constantly wrote of the positive correlation between facial features and dental deformities and the interdependence of resultant relations in the determination of prognosis and therapeusis. "Distortion of facial lines constitutes a common complication of oral deformities and in my experience has averaged as high as 84 per cent."[2] He attacked the custom of sending patients to professional portrait photographers "whose knowledge of our requirements is usually meager," the portraits not accurate, nor diagnostically acceptable.[3] With the advent of the Simon technique, the rationale became apparent. The facial lines reflected conditions of malocclusion, and by orienting the head according to anatomic landmarks and photographing it as oriented, the type of deformity could be determined and treated. Serial photographs taken in the same oriented position should show therapeutic progress. Simon explains that it is the aim of photostatics to procure a photographic profile reproduction which fulfills

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[1] Eastman Kodak Company, "Clinical Photography," *Dental Radiography & Photography*, 4:10–11, February, 1931.

[2] Lischer, B. E., "On New Methods of Diagnosing Dental Deformities," *Internat. Jour. Orth.;* 10:521–41, 1924.

[3] *Ibid.;* Idem, "Clinical Photography for Orthodontists," *Internat. Jour. Orth.*, 13:1–12, January, 1927.

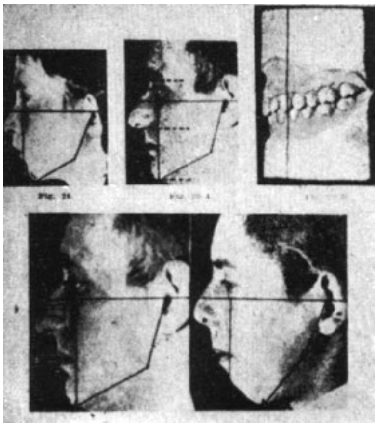

FIG. 1. Simon Photo-Gnathostatic Tracings. (Simon).[5]

FIG. 4. A Famous "Before and After." (Angle, E. H., "Art in Relation to Orthodontia," *D. Items. Int.*, 25:660, 1903).

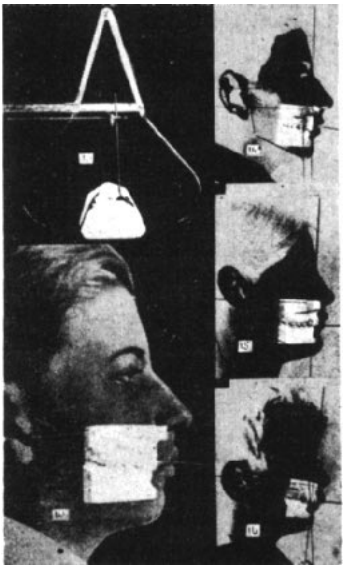

FIG. 2. Gnathophysiognomical projections of Andreson, combining profile photograph with oriented view of casts. (Andreson).[7]

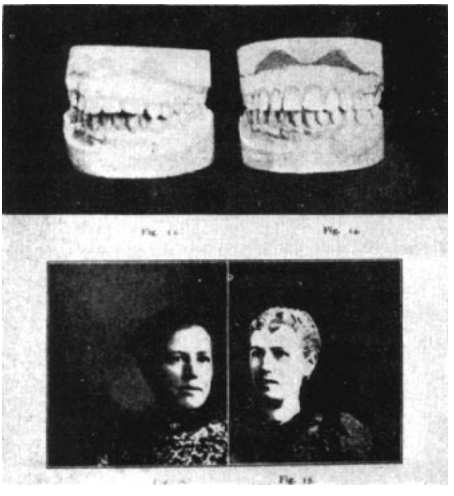

FIG. 5. One of the first photographs of treated cases in Periodical Literature. (Lukens, C. D., "A Few Interesting Cases of Dento-Facial Deformity," *D. Items. Int.*, 22:671, 1900.)

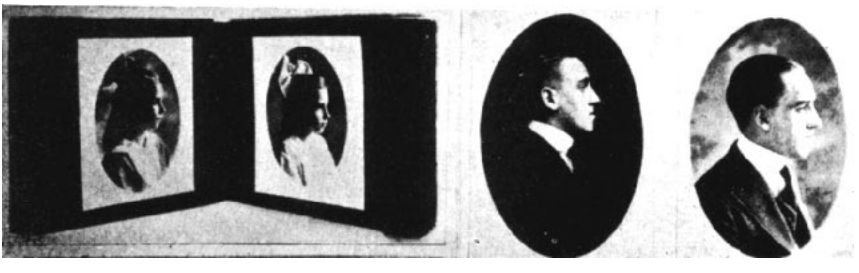

FIG. 3. Album pictures of treated patients for office display. (Burke).[10]

the following requirements: All photographs of the same individual (taken at various intervals) and of different individuals are taken under the same conditions. This is accomplished because (a) the median plane of each head is always the same distance from the object lens, (b) the median plane of the head and the photographic plate or film are parallel to each other and, finally, (c) the line of the lens axis passes through both orbital points. The median plane selected is a plane which passes (a) through a point on the skin corresponding to nasion and (b) is perpendicular to a line passing through the eye points.[4] Figure 1 shows how the photostat is prepared for diagnosis, with the Frankfort plane drawn in from tragion to orbitale, the orbital plane as a perpendicular line from orbitale, and lines connecting tragion, gonion, and gnathion completing the markings.[5]

As shown in the pictures, there is a measurable difference between the normal profile and the dentition in 29-A and 29-B, and the abnormal views in 28 and 30. Ideally, according to Simon, the cheilion and gnathion should lie on the orbital plane, and this plane should pass through the distal third of the cuspid when transposed to gnathostatic models. Photostats that show deviations can be diagnosed, depending on the discrepancy from the norm pattern.[6]

Andreson notes, in setting up his system of gnathophysiognomical photographs, "in spite of different trials regarding the reproduction of topographical and anthropological relations between the jaws and features, we have not as yet both a practical and useful method for orthodontological diagnosis."[7] He drew heavily on the Simon technique in orienting and photographing the patient. Casts were made the conventional way and articulated on a piece of impression compound mounted on a metal arm, called a gnatho-physiognomical indicator (Figure 2). The indicator arm extended through the slit between the lips as the photograph was being made, the patient biting into the compound. The set up was left undisturbed, the cast photographed in the compound bite, and the patient and cast photographs superimposed (Figure 2).[8] Brandhorst and Maller worked out similar techniques to provide rigidly oriented profile views, but with different mechanics.[9] The use of soft tissue counterparts of anthropometric landmarks—orbitale, gonion, gnathion and tragion—provision of a mechanical means of setting the head in the same relative position each time according to these landmarks, and the drawing in of planes on the scale photograph to provide a means of diagnosis; these are the essential points of this group.

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[4] Simon, Paul W., *Fundamental Principles of a Systematic Diagnosis of Dental Anomalies* (translated by B. E. Lischer), Boston: 1926.

[5] Idem, "On Gnathostatic Diagnosis in Orthodontics," *Amer. Soc. Ortho.*, 24:79, 1924.

[6] *Ibid.*

[7] Andreson, V., "Three Contributions to Orthodontological Diagnosis," *Internat. Jour. Orth.*, 12:235–251, 1926.

[8] *Ibid., p. 245.*

[9] Brandhorst, O. W., "A Photostatic-Gnathostatic Combination," *Internat. Jour. Orth.*, 12:361–64, 1926; Maller, J. W., "A New, Simplified Photographic Technique," *Internat. Jour. Orth.*, 16:972–81, 1930.

FIG. 6. A Series of Ketcham progress photographs. (Ketcham, A. H., "Angle's New Pin and Tube Appliance," *Internat. Jour. Orth.*, 1:3, 1915.)

FIG. 7. Front and Profile photographs before and after treatment. (Stein).[11]

FIG. 8. "Before Treatment (Picture on Left). Note the retruded mandible, lack of mental prominence, and poor profile. The straight line, ab, should pass through the nasion, nasal spur and mental prominence. After Treatment. Note well developed mandible in normal position, good profile, and greater length of face due to opened bite, giving harmonious balance to the whole'.' (Hunter).[11]

FIG. 9. Type of photographs used for patient identification. (Noyes).[17]

Photographs as a Part of the Patient's Record

The desire for more adequate records manifested itself early in the so-called "before and after" pictures. The early pictures reflected the philosophy of the orthodontist at the time, and his belief that orthodontic treatment could change the entire facial contour. Burke wrote in 1919:

> Several years ago I became impressed with the importance of having a means of making clear to people what could be accomplished through orthodontic treatment. . . In order to make sure that photographs are preserved in good order, I have for some time made use of an album. These enlarged photographs furnish one a splendid medium of impressing people with the changes that result through treatment. . . But the parent will not be convinced that changing the relative position of the teeth in one arch to those in the other, actually does reshape the chin, lips and cheeks, until she sees photos, showing other cases that have been treated.[10]

(Figure 3.) Photography was seized upon to prove the therapeutic efficacy of orthodontic treatment as manifested in an esthetic external improvement. Most pictures, taken by professional photographers, showed that no attention had been paid to positioning of the head, but the enthusiasm of the day, whether by coincidence or design, had some effect on the photographs of the day. The "after" pictures always managed to show up to better advantage than the "before" (Figures 4, 5, 6). The use of photographs for this sort of record finds expression in current techniques[11] (Figures 7, 8).

> For the dentist whose practice regularly embraces orthodontics or prosthetic cases, photographs of "before and after" models can be assembled in a suitable binder so that the patients can quickly see the effects of treatment or the benefits of certain appliances in cases of a similar nature.[12]

Considerable controversy over the accuracy of soft-tissue measurepoints plus the development of the cephalometric X-ray have led a number of men to agree with Strang when he writes:

> The study of photographs of a patient is more for the purpose of obtaining confirmatory evidence of deductions already reached and to establish added proof in borderline cases, than to obtain positive symptoms of the class of malocclusion with which one is dealing.[13]

Strang echoes the views of those who use photographs only for records when he says,

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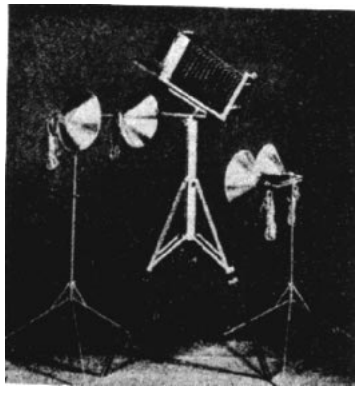
[10] Burke, George, "The Value of Enlarged Photographs of Patients in Practice," *Internat. Jour. Orth.*, 5:20–32, 1919.

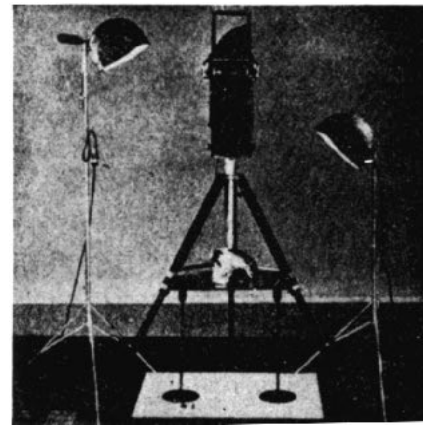
[11] Hunter, G. B., "Orthodontia and the Ordinary Dentist," *South African Dental Journal*, 16:190, June, 1942; Stein, S. H., "Two Cases Requiring Bi-Lateral Distal Movement," *Amer. Jour. Orth. and Oral Surg.*, 31:404, August, 1945.

[12] Eastman Kodak Company, "Photography of Models and Dental Arches," *Dental Radiog. & Photog.*, 14:20–22, 1941.

[13] Strang, Robert H. W., *A Textbook of Orthodontia*, Philadelphia: 1943, p. 95.

FIG. 10. Type of photographs used for patient identification. (Noyes). [17]





FIGS. 11 and 12. Eastman Clinical Camera Outfit with Kodaeflectors and Kodalites.

It is easy for the orthodontist to be misled unless he is fully aware of the confusion that may arise from the deceptive evidence produced by abnormal muscular conditions, particularly those seen in the region of the symphysis of the mandible. Hypertrophied and hypertoned muscles often obliterate all signs of deficiency in the body of the mandible, as recorded on the photographic plate.[14]

In discussing the aims of photography in orthodontics, Sheffer calls attention to the fact that 98% of the left and right profiles do not coincide. This causes a rotation of the patient's true profile away from or toward the camera. Growth of the face produces changes of measurepoints in three planes of space, but photographs record only in two, introducing appreciable inaccuracy, and limiting mensuration.[15] A number of operators have employed standardized techniques, but utilize photographs for records of appraisement of facial features, to be used in conjunction with case histories, height and weight charts, casts, X-rays, etc.[16] Others still refer patients to professional photographers and use photographs primarily for patient identification[17] (Figures 9, 10).

Photographic Equipment and Techniques Available to the Orthodontist

There are five types of cameras available to the orthodontist for clinical photography.

I. Clinical View Cameras.

II. Reflex Type Cameras.

III. Miniature (35mm) Cameras.

IV. Specially Designed Cameras.

V. Stereocameras.

Vogelson lists a number of requirements for an orthodontic clinical camera: i.e. (1) it must allow focusing on an object from 6″ to 12″ from the lens; (2) it must allow the use of a single film; (3) it must provide pin point clarity in focus; (4) it must take a film large enough not to require enlargements; (5) the camera should be adaptable to the use of color film transparencies; (6) it must possess minimum bulk; (7) the lenses must be anastigmatic, but not necessarily fast, with good depth of focus.[18]

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[14] *Ibid.*

[15] Sheffer, W. G., "Photography an Aid to Orthodontics," *The Angle Orthodontist*, 6:248–54, October, 1936.

[16] Curran, B. A., "Photography for the Orthodontist," *The Angle Orthodontist*, 9:67–77, July, 1939; Haggett, Martin, "Clinical Photography for the Orthodontists," *Amer. Jour. Orth. & Oral Surg.*, 25:1085–87, 1939; Hemley, Samuel, "Miniature Photography in Dentistry," *Dental Cosmos*, 77:1224–27, 1935; Dunn, Lawrence, "Photography in Dentistry," *The Leica Manual*, 1935, pp. 357–369; Sheppard, I. M., "A Standardized Technique for Oral Photography," *Dental Cosmos*, 77:490–502, 1935.

[17] Noyes, F. B., "Case Reports," *The Angle Orthodontist*, 9:161–3, October, 1939.

[18] Vogelson, Gabriel R., "Dental Photography," *J. A. D. A.*, 29:1237–44, July, 1942.

Clinical View Cameras

The clinical camera is the oldest and most widely used. The main features of this type of camera, shown in Figures 11, 12, are (1) the long focal length aplanat or anastigmat lens, (2) double or triple extension bellows, and (3) ground glass viewing and focusing back.[19]

By the focal length we mean the distance from the center of the lens or objective to the ground glass back or film, when a sharp image is rendered of an infinitely remote object. The longer the focal length, the larger the image projected on the film. The smaller the focal length, the closer the object has to be to the camera if we want reasonably large pictures. But, as Simon points out, the nearer the object to the lens, the greater the perspective distortion.[20] The advantages of the long focus objective lens are reasonably parallel rays entering the lens to insure minimum distortion, a good size picture, and greater depth of focus.

The extension bellows and ground glass permit focusing the camera on objects at various distances and allow whatever size picture the operator wants—at least up to life size, which requires a bellows over two times the focal length of the largest objective. Where there is a constant variance in object-lens distances, a bellows is imperative. Cotter recommends a triple extension bellows and both Lischer and Voss require an extreme extension bellows, the latter to allow wide variation in image size.[21] The double extension bellows, such as used on the Eastman Clinical Camera, Recomar, Zeiss "Trona" and "Maximar," is the most popular.[22]

The nearer the object is to the camera, the greater must be the distance between the ground glass and the lens for the image to be sharp. Thus the distance of the object from the lens determines the scale of the picture. For large scale pictures, such as intra-oral views, the field of interest is close to the camera but the film is farther away from the lens. The extension bellows

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[19] Clark, Carl D., "Apparatus for Macrophotography," *Jour. Biol. Photo. Assn.*, 2-76-93, 1933.

[20] Simon, Paul, *Fundamental Principles of a Systematic Diagnosis* (Translated by B. E. Lischer), Boston: 1926, p. 118.

[21] Cotter, Harry J., "Oral Photography, Its Technique and Possibilities," *Appolonian*, 4:151–58, July, October, 1929; Voss, Albert E., "An Attempt to Standardize the Technique of Making Clinical Photographs for Orthodontists," *Internat. Jour. Orth. & Oral Surg.*, 20:666–68, July, 1934; Lischer, B. E., "Photography for Orthodontists," *Internat. Jour. Orth.*, 12:191–210, March, 1926.

[22] Sheppard, Irving, "A Standardized Technique for Oral Photography," *Dental Cosmos*, 77:490–502, 1935; Sage, Robert, "Reducing Backs for Cameras," *Jour. Biol. Photo. Assn.*, 12:110–112, 1944; Harding, F. R., "Application of Clinical Photography to Private Practice," *Jour. Biol. Photo. Assn.*, 8:132–34, 1940; Spencer, Harvey M., "Photography for the Dentist," *Jour. Biol. Photo. Assn.*, 6:65–78, 1937; Howard, C. C., "A Simple System of Orthodontic Photography," *Proceed. 1st. Internat. Ortho. Congress*, 1926, p. 718; Payne, William F., "Clinical Photographs in Kodachrome," *Jour. Biol. Photo. Assn.*, 12:26–35, 1943; McCoy, J. D., McCoy, John, "Organizing for a Pleasant and Efficient Practice," *Internat. Jour. Orth.*, 16:38, 1930; Curran, B. A., *op. cit.*; Blaustein, Samuel, "Dental Photography," *Dent. Items. Int.*, 61:158–65, Feb., 1939; Turner, George L., "Photography with Process Films as Positive Prints," *Internat. Jour. Orth.*, 20:569–72, 1934.

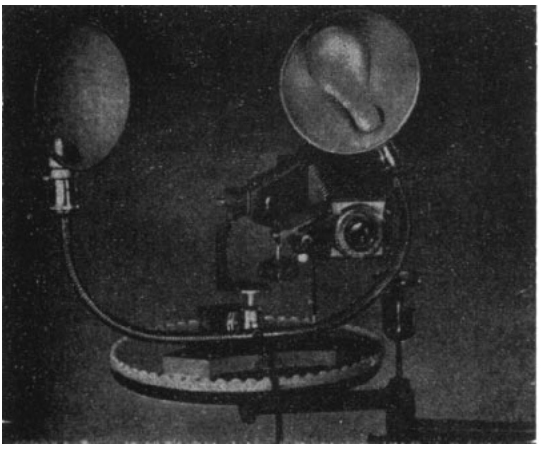

FIG. 13. Kodak Precision Enlarger parts—Tripod Adapter; Bellows Assembly A; Camera Back Adapter A; 4⅛″ Kodak Ektar f/3.7 Lens in Supermatic Shutter mounted on Kodak Precision Enlarger Lens Board; Copying lights. Bantam Kodachrome Adapter A: all mounted by means of a Kodak Tilt-a-pod on a stand especially constructed to fit the bracket table of a dental unit. (Eastman).[27]

FIG. 14. Leica Camera.

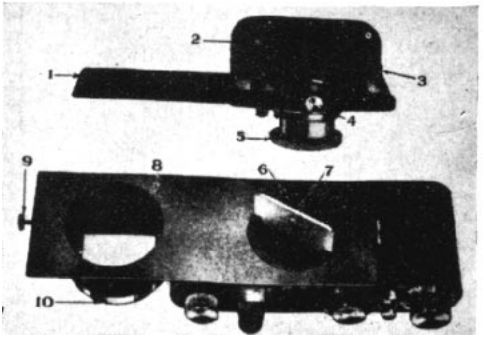

FIG. 15. Leica focusing copy attachment showing method of assembling. (Golden).[35]

permits this change of film-lens distance and the ground glass insures sharp detail focusing for varying patient-camera distances.

The clinical cameras available to the orthodontist have two types of shutters, the "focal plane" and the "between the lens" type. The focal plane shutter is a rolled curtain installed immediately in front of the film. The curtain has different size slits, ranging from 1/8" to 1½" and by altering its spring tension and selecting the size slit, the desired exposure can be obtained. The chief advantage of the focal plane shutter is its great speed. This is neither necessary nor desired in clinical photography. Also the slowest shutter speed is 1/10th second which is frequently too fast for certain intra-oral views. The new cameras are equipped with the "between the lens" shutter which will give 1/5, 1/2 or 1 second exposure as the occasion demands.

The trend has been away from the larger and more unwieldly cameras and plates. Before adopting the Simon technique, Lischer used an 8"x 10" studio camera.[23] The technique worked out by Delabarre in 1910 at the Forsythe Dental Infirmary for Children made use of a portrait camera with a 5"x 7" plate. [24] Simon first used a 5"x 7" Zeiss Clinical camera but later cut the size to 4"x 5". Many still find the 5"x 7" size best suited for biological and clinical photography.[25] The use of a lantern slide back to cut down the film size to 3¼"x 4¼" on the Eastman Clinical camera is suggested by some investigators.[26] At present the most successful cameras are the Recomar 18 (Figure 13)[27], 4"x 5" Eastman, Zeiss "Maximar," Zeiss "Trona," Voigtlander "Avus" and Agfa "Universal." Vogelson lists the Ihagee, Zeiss Ikon, Kodak Recomar, and Kodak Medalist.[28] The last group comes in two sizes, 2¼"x 3¼" and 3¼"x 4¼".

Reflex Type Cameras

There is little difference between the clinical camera and the reflex or view type. A reflex camera may be considered a modified clinical type. Both permit focusing on a screen, showing the operator exactly what the picture composition and size will be. The main advantage of the "see what you take" reflex camera is that there is no pause after setting the bellows and lens, as there is with the clinical camera, to take out the ground glass back and slip in the film and plate holder. By means of a mirror, the image is directed through a viewing window in the top of the camera. After the me-

[23] Lischer, B. E., "Photography for Orthodontists," *Internat. Jour. Orth.*, 12:191–210, March, 1926.

[24] Delabarre, Frank, "Photography as Applied to Orthodontia," *Allied Dental Journal*, 11:654–58, 1916.

[25] Taylor, Edward, "How to Prevent Denlinphobia," *Jour. Biol. Photo. Assn.*, 12:35–40, 1943; Payne, William, *op. cit.*; Turner, George L., *op. cit.*; Voss, Albert E., *op. cit.*; Howard, C. C., *op. cit.*

[26] Sage, Robert, *op. cit.*; Sheppard, Irving, *op. cit.*; Spencer, Harvey, *op. cit.*; Martinsen, William, "Planning and Equipping for Biological Photography," *Jour. Biol. Photo. Assn.*, 9:136–40, 1941.

[27] Eastman Kodak Company, "Intra-Oral Photography with a Kodak Recomar," *Dent. Radiog. & Photog.*, 12:19–22, 1939.

[28] Vogelson, Gabriel, *op. cit.*

chanical details of setting the camera are completed, the shutter is immediately released.

The Graphic View 4″x 5″ camera has a 13″ bellows, permitting 1:1 copying with lenses up to 6½″. Reducing backs permit use of a 3¼″x 4¼″ film, if desired. The Super D Graflex uses this size film regularly, and has a built in "open flash" synchronization. The working distance is as close as 18″, adequate for orthodontic purposes. The 2¼″x 3¼″ Graflex, used by the Department of Justice for fingerprinting, is used by orthodontists whose records require no enlarging and where film cost is an item. The camera comes as a completely self-contained unit, with lights, etc. The Rolleiflex 2¼″x 3¼″ is quite compact, but the initial cost high.

One criticism of reflex cameras is the cost and bulk.[29] Another disadvantage is the problem of parallax, which requires the aiming of the camera one to two inches above the center of the field in close work because of the dual lens system.

Miniature (35mm) Cameras

The chief advantages of the 35mm camera are economy of film, compactness and adaptability to any technique and simplicity of action. By using a short focus lens, and 35 mm film, the lens film distance is quite small. The advantages over larger cameras are depth of critical definition and high correction for spherical and chromatic aberration.[30] The miniature camera must be focused very accurately, for in this size, the circle of confusion is reckoned as 1/750th of an inch.[31] Extension tubes permit sharp focusing at close distances.

The danger in miniature camera technique lies in placing the camera too close to the patient and thus distorting the perspective. Sheffer writes, "The eye seeing a face at three feet away will not notice the geometrical perspective, but upon viewing the photographs with the lens three feet from the face, the mind will perceive the geometrical perspective is false, although the perspective is true but unpleasing."[32] The small size of the film, requiring enlargement of all views, and the fact that 18 or 36 exposures have to be made before removing the film from the camera are disadvantages.

All 35mm cameras are about the same size, use the same film and present similar optical problems. German-made cameras have been superior to their American counterparts, but are more expensive. The Leica finds greatest popularity (Figure 14).[33] The Contax, Kine Exacta, Zeiss Ikon and Voigt-

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[29] Wolberg, Lewis R., "Practical Clinical Photography," *J.A.M.A.*, 108:113–18, January, 1937; Blaustein, Samuel, *op. cit.*

[30] Golden, Eric, "Modern Scientific Photography for Orthodontists Using a Miniature Camera," *Internat. Jour. Orth.*, 20:1043–62, November, 1934.

[31] Fox, Jay T., "Biological Photomacrography with Kodachrome Film," *Jour. Biol. Photo. Assn.*, 11:145–51, June, 1943.

[32] Sheffer, Will G., "Photography as an Aid in Orthodontics," *The Angle Orthodontist*, 6:248–54, October, 1936.

[33] Golden, Eric., *op. cit.;* Dunn, Lawrence, *op. cit.;* Katzin, Herbert M., Carlin, Robert, "A New Clinical Dental Camera," *Dental Outlook*, 30:318–19, August, 1943; Hemley, Samuel, *op. cit.;* Fisher, Bercu, "Orthodontic Photographic Recorder," *Amer. Jour. Orth. & Oral Surg.*, 26:139–48, February, 1940; Lathrop, W. M., "Color Photography for Visual Education," *Dental Digest*, 45:142–43, April, 1939.

lander are also excellent precision cameras. The Eastman Ektra was introduced into the professional field just before the war as a domestic challenge to foreign supremacy. It is similar in workmanship and price to German cameras. A number of men get uniformly good results with the relatively inexpensive Argus C 3.[34]

In place of the ground glass used for critical focusing in the clinical camera, users of the 35mm camera have access to a copying attachment which performs the same function. The Leica accessory is called the Fuldy Slide Focusing Attachment (Figure 15).[35] The lens part of the camera is mounted on a frame while a small square ground glass viewer and the camera back containing the film are mounted on a light tight section which permits shifting either the viewer or the film to a position in front of the lens. After correct focusing is done on the ground glass, the camera back containing the film is slid into place and the exposure made. The Eastman Speed Copy, or rotating helical focusing mount used with a Kine Exacta, works on the same principle.

The 35mm camera may be adapted to close work by using measuring rods and tube extensions. Leica and Argus manufacture focusing devices consisting of metal rods of a pre-determined length that fit into a ring, which in turn screws over the lens and establishes an absolute lens-object distance (Figure 19).[36] Both these attachments are primarily for intra-oral views. Extension tubes between the lens and camera body are analogous to the bellows of the clini-camera and permit sharp focusing at close distances. Different length extension tubes give different size images, ranging from a reduction of 4:1 with a 12mm tube, to a magnification of 1:6 with a 300mm tube, using a 50mm lens.

Specially Designed Cameras

The only camera of note in this category is the Burton Clinical camera, designed by Sterling Mead. It is made of a molded bakelite material, mounted upon a specially designed reflector so that the camera and reflector constitute one unit. The intense light from the combined reflector and photoflash permits considerable stopping down of the f 6.3 Wollensak 50mm lens. The recommended aperture of f 45 gives a depth of focus of 4″. The camera unit is "aimed" at the patient and two pointers of 5″ and 7″ are used to establish the focal plane for the fixed focus camera (Figure 16).[37] The simplicity, compactness and intensity of light are advantages. Flat lighting, perspective distortion from a short focus lens and the method of "aiming" the camera are disadvantages.

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[34] Katzin, Herbert M., Carlin, Robt., *op. cit.;* Older, Lester, "Clinical Dental Photography—Technique," *Hudson County Dent. Soc. Bull.*, 12:10–11, 1943; Silvermann, S. S., "Simplified Color Photography in Dentistry," *Dental Digest*, 48:182–85, April, 1942.

[35] Golden, Eric, *op. cit.*, p. 1058.

[36] Katzin, Herbert M., Carlin, Robert, *op. cit.*, p. 318.

[37] Creer, Ralph P., "The Photography of the Oral Cavity," *Jour. Biol. Photo. Assn.*, 4:71–74, September, 1935.

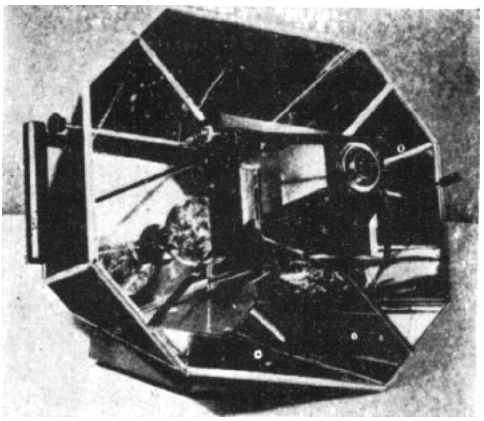

FIG. 16. General view of Burton's Clinical Camera. (Creer).[37]

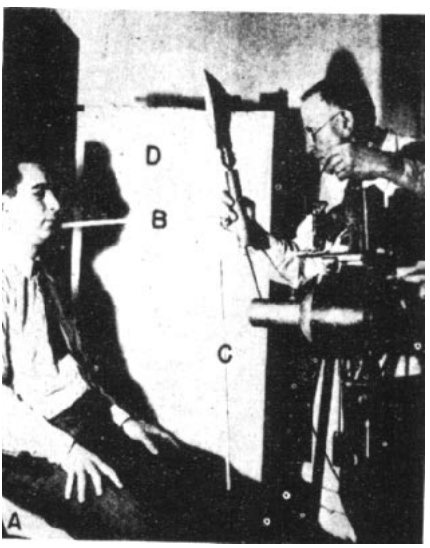

FIG. 17. Improvised patient photography set up. Note folding camera, flash bulb, light screen D, wooden Dowel B for measuring light distance, Dowel C for measuring patient-lens distance. (Clark).[39]

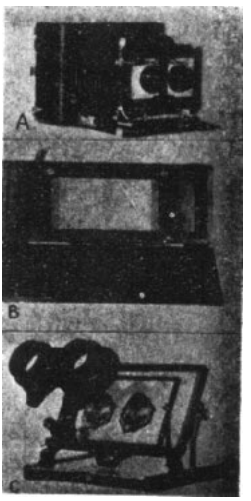

FIG. 18. A. Stereoscopic camera; B. Transposing frame for printing; C, Zeiss stereoscope viewer. (Weingart & Sage, *Archives Path.*, 19:685, May, 1935.)

A number of men have modified existing equipment with the addition or removal of certain accessories.[38] Such modifications seldom alter the basic pattern and usually serve to adapt either the clinical type or 35mm camera to the needs of a particular technique. One example of this is the use of a folding fixed-focus camera, photoflash illumination, and wooden dowels to determine the lens-patient and light-patient distances (Figure 17).[39]

The theory and application of stereophotography to orthodontics will be discussed in detail in a subsequent article. A stereocamera is a modified clinical camera—modified to take two pictures at the same time with all conditions identical, but with a camera lens separation approximating the normal inter-pupillary distance of 65mm.

The wide choice of cameras includes the 5″x 7″ Speed Graphic, Graflex, Bausch and Lomb, 4″x 5″ Recomar and Zeiss stock models, mounted on a special sliding base. Specially constructed stereocameras such as the twin reflex type of Weingart and Sage (Figure 18), the fixed focus twin lens camera of Margolis (Figure 27) and two well standardized single cameras bound together are examples of the operator's ingenuity.[40] In 1935, Leica introduced the Stereoly attachment for 35mm cameras. This is a two prism arrangement, set 70mm apart directing the two images into the single lens of the camera. This forms a two image exposure on a single frame. Each picture is 18mm x 24mm.[41] When viewed together in a stereoscope, the impression of three dimension solidity is as vivid as that conferred by larger stereocameras.

Photographic Techniques

There are a number of intimate details of photographic technique which should be thoroughly understood to allow optimum results from each type of camera. These are:

1. Lens type and aperture.
2. Camera mounting.
3. Lighting, film and exposure.
4. Background.
5. Positioning of the patient.

1. These factors are dependent upon the design and limitations of the camera chosen by the orthodontist for the technique he wants. For example, a clinical, reflex or stereo camera requires a long focus lens for maximum image fidelity and minimum perspective distortion. The photo objective

[38] Sage, Robert, *op. cit.;* Winer, S., "Photography in Dental Surgery," *S. African Dent. Jour.*, 16:366–68, 1942; Levi, Joshua, "A Standardized Technique for Chairside Colour Photography," *Brit. Dent. Jour.*, 76:211, April, 1944; Engstrom, Carl, "A Unique Method of Mounting Photographs," *Internat. Jour. Orth.*, 2:342–43, 1916.

[39] Clark, Carl D., *op. cit.*, p. 79.

[40] Margolis, Herbert, "Technique for Recording Dental Changes and Facial Growth," *Amer. Jour., Orth. & Oral Surg.*, 25:1027–39, November, 1939.

[41] Lester, Henry M., "Stereoscopic Photography," *The Leica Manual*, pp. 249–55, 1935; Harrington, R. H., "Stereophotography Comes to Life," *Leica Photography*, 6:7, 18, Aug., 1937.

should be an anastigmat which provides an aplanatic field, without stopping down the diaphragm, as required in a portrait lens. A Protar Series VIIa is an example of a long focus aplanat lens. The suggested focal lengths vary from the Cooke 6⅞″ lens,[42] Goerz Dagor 8¼″ lens,[43] 12″ Anastigmat,[44] to a 19½″ Celor.[45] The average is about 25 centimeters, or 10½″. As pointed out previously, the 35mm camera makes use of a short focus lens and small size film to give compactness. A long focus would defeat this purpose. The most widely used lenses are the Leitz 50mm or Elmar 50mm (2″) f 3.5, or the 50mm Exacta f 3.5, all aplanatic anastigmats.[46]

Using two matched lenses, the stereocamera poses a problem peculiar to stereophotography—the separation of the lenses. Varying the distance between the lenses affects the viewed image. Less separation than the interpupillary distance gives the appearance of nearby small objects; too much separation, of far-off enlarged objects. The focal length of the lenses should be equal to or greater than the diagonal of the film or plate for the best perspective.

The lens aperture demands are variable but constant in that a fast lens is unnecessary because the objects photographed are not ordinarily in motion. Spencer and Blaustein believe that an f 6.3 lens is as fast as the operator needs; Harding notes that f 8 is the largest aperture conferring sufficient depth of field.[47] Most men prefer to stop down the lens a good deal to provide maximum depth of field. The type and speed of film is a controlling factor, too, and an effective compromise between the lens stop and the exposure time must be reached. In general, 35mm cameras have faster lenses and most techniques call for a wider aperture than with clinical cameras. The Leitz f 3.5 lens, focused at 30″, stopped at f 4.5, has a depth of focus at 5½″.[48] Other techniques call for smaller apertures. Older, Katzin and Carlin recommend from f 12.5 to f 18 depending on the extension tube used.[49] The choice of the extension tube will change the exposure factor and this should be checked with each change in tube. If the operator has no objection to longer exposures, f 18 to f 22 may be used.[50] Going to the extreme, the exceeding small aperture of f 45 is recommended by the manufacturer of the Burton clinical camera. This allows maximum depth of field and is possible because of the high intensity of illumination.

2. Each man has attempted to adapt the photographic setup to his equipment, floor space and inventive ingenuity. The size and weight of

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[42] COTTER, HARRY J., *op. cit.*

[43] TAYLOR, EDWARD V., *op. cit.*

[44] SHEPPARD, IRVING M., *op. cit.*

[45] LISCHER, B. E., "Photography for Orthodontists," *op. cit.*

[46] GOLDEN, ERIC, *op. cit.;* DUNN, LAWRENCE, *op. cit.;* KATZIN, HERBERT M., CARLIN, ROBERT, *op. cit.;* FISHER, BERCU, *op. cit.;* FOX, JAY T., *op. cit.;* LATHROP, W. M., *op. cit.*

[47] HARDING, F. R., *op. cit.;* SPENCER, HARVEY, *op. cit.;* BLAUSTEIN, SAMUEL, *op. cit.*

[48] GOLDEN, ERIC, *op. cit.*

[49] KATZIN, HERBERT M., CARLIN, ROBERT, *op. cit.;* OLDER, LESTER B., *op. cit.*

[50] HEMLEY, SAMUEL, *op. cit.;* CURRAN, MORVEN, "Color Photography," *Dental Items Int.* 62:1154, December, 1940.

most clinical, reflex or stereocameras plus the necessity of absolute stability during time exposure demand maximum strength of support. The heavy tripod is most used. Either a wood tripod with a separate tilt-top head,[51] or a metal one with a Folmer Graflex pan-and-tilt head serve the purpose (Figures 11 and 12).[52] Simon and Lischer use a home portrait or studio type tripod with a crank for raising and lowering the camera and nose board.[53] The X-ray tube stand also furnishes stable support.[54] If the wall permits, a T-shaped shelf or Angle Wuerpel table may be used (Figure 29).

The compactness of the 35mm camera allows greater versatility in mounting for dental uses. Where room is not an object, sturdier bases are used to good advantage. Dunn has adapted an old automobile flywheel as a base, with a pipe centerpiece and a sliding telescope arm for the camera.[55] The bracket table of the dental unit, or the bracket arm minus the table, are frequently used[56] (Figure 13). An old microscope stand with rubber tips on the legs serves to hold the camera and prevents slipping on the bracket table.[57] Silvermann uses a cast metal lamp base with a tilt-top tripod head for bracket table use.[58] A small aluminum base, similar to a radio chassis, also serves to mount the camera and floodlights, the whole unit being placed either on a tripod or on the bracket table (Figure 19).[59] Whether the base be a bracket table or arm, tripod or separate base, emphasis should be placed on rigidity, for vibration invites failure.

3. The lighting, film and exposure form a closely related set of factors. The general quality of lighting for optimum results is of controversial nature. Poser and Vogelson contend that diffused light is essential for the curved surfaces of the face, to prevent the tendency for photographs to exaggerate bones, muscles and furrows.[60] Harding recommends plain unfrosted 1000 watt lamps to accentuate the moulding of the face.[61] The closer the lights are to the camera, the less objectionable are the shadows formed. The consensus is that

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[51] HARDING, F. R., *op. cit.;* SCHWARTZ, RUDOLPH, "Cephalometric methods and Orthodontia," *Internat. Jour. Orth.*, 12:1078–1101, 1926; TURNER, GEORGE L., *op. cit.*

[52] TAYLOR, EDWARD V., *op. cit.*

[53] SIMON, PAUL, *op. cit.;* LISCHER, B. E., *op. cit.*

[54] MCCOY, J. D., MCCOY, JOHN, *op.cit.;* VOSS, ALBERT, *op. cit.*

[55] DUNN, LAWRENCE, *op. cit.*

[56] GOLDEN, ERIC., *op. cit.;* HEMLEY, SAMUEL, *op. cit.;* DUNN, LAWRENCE, *op. cit.;* LATHROP, W. M., *op. cit.*

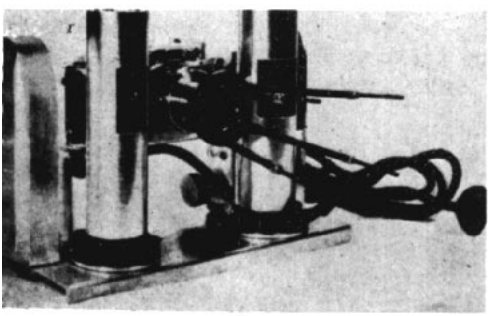
[57] LATHROP, W. M., *op. cit.*

[58] SILVERMANN, S. S., *op. cit.*

[59] KATZIN, HERBERT M., CARLIN, ROBERT, *op. cit.;* OLDER, LESTER B., *op. cit.*

[60] VOGELSON, GABRIEL R., "Photography in Dentistry," *New York Dent. Jour.*, 13:388, December, 1943; POSER, MAX, *op. cit.*

[61] HARDING, F. R., "Application of Clinical Photography to Private Practice," *op. cit.;* IDEM, "The Lighting and Posing of Clinical Photographs," *Jour. Biol. Photo. Assn.*, 6:131–35, 1937.



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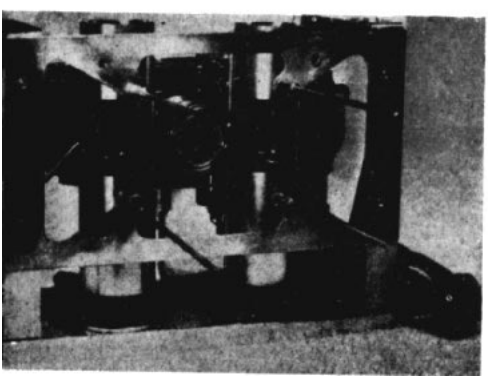


B

FIG. 19. A. Leica 35mm camera, mounted on aluminum chassis. Two 500 watt projection bulbs furnish the light. B. Variation of aluminum chassis, using Argus 35mm camera. Katzin, Carlin). [33]

FIG. 20. The Cutler Lamp. (Creer).[63]

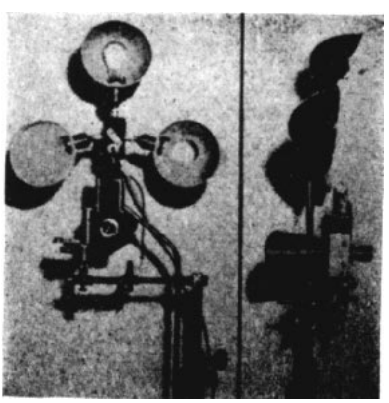


FIG. 21. Compact 35mm camera and light arrangement adaptable to use on the dental unit. (Golden).[56]

artificial light is preferable and more stable than natural light for clinical photography.[62]

The lighting problem can be solved in several ways; an ordinary 500 watt bulb, Dentalscope, Cutler lamp (Figure 20)[63] photofloods or Kodalites (Figures 11 and 12) may fill the bill. The number of lights used varies with the technique, from one to four. Blaustein suggests an ordinary pie plate with three porcelain plugs, holding three No. 1 photofloods, mounted on a music stand.[64] Mackintosh suggests a different method of illumination. He uses a set of four cluster lights, giving a total of 400 watts. For full face views, the four point lights are set 1½ feet in front of the patient's face.[65]

Photoflash bulbs are preferred by some men because of the greater concentration of light without constant eye discomfort to the patient. In line with streamlined compact 35mm camera techniques, photoflash bulbs are the most popular form of illumination. They maintain constant intensity while photofloods become progressively weaker with use. Where photofloods are used, the flexible arm type reflector is quite satisfactory, either in a two arm arrangement as recommended by Eastman (Figure 13) or a cloverleaf design as suggested by Golden (Figure 21).[66] The reflectors may be mounted on each side of the camera base (Figure 22).[67]

Two A-25 3200° Kelvin bulbs provide slightly less intensity than the same number of No. 2 photoflood bulbs, but provide constant illumination for the life of the bulb. This is quite an advantage in color photography. Movie projection bulbs (500 watt) provide sufficient light when used in pairs with reasonably small aperture stops on the camera (See Figure 19).[68]

Stereophotography demands careful attention to the lighting problems. Lighting can help a lot in creating the impression of three dimensional solidity. Flat shadowless lighting, so necessary in color photography, is much less desirable in stereophotography. Harding prefers clear glass 1000 watt lamps because they produce harder shadows and bring out more contrast and modelling than softer light from frosted bulbs. He sets his lights about 3½ feet from the patient. The light should usually fall down on the patient to prevent flat lighting and enhance modelling. For normal lighting, one light may be placed 12″ farther away than the other. Pockets of shadows about the neck and under the chin should be avoided. Slight shadows seen by the eye are increased in contrast by the photographic emulsion. To model the

[62] *Ibid.;* SPENCER, HARVEY, *op. cit.;* HOWARD, C. C., *op. cit.;* MCCOY, J. D., MCCOY, JOHN, *op. cit.;* EASTMAN KODAK COMPANY, "Photography of Appliances and Small Instruments," *Dent. Radiog. & Photog.*, 14:29–31, 1941; IDEM, "Photography of the Entire Face and Facial Profile," *Dent. Radiog. & Photog.*, 13:12–15, 1940; IDEM, "Photography of Models and Dental Arches," *Dent. Radiog. & Photog.*, 14:20–22, 1941.

[63] CREER, RALPH P., *op. cit.*

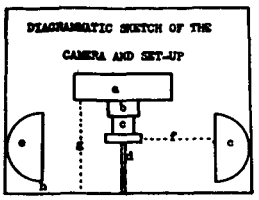
[64] BLAUSTEIN, SAMUEL, *op. cit.*

[65] MACKINTOSH, HARVEY, "A Standardized Technique for Oral Photography," *Brit. Dent. Jour.*, 62:70–77, January, 1937.

[66] GOLDEN, ERIC, *op. cit.*, p. 1049.

[67] OLDER, LESTER B., *op. cit.*, p. 10.

[68] KATZIN, HERBERT M., CARLIN, ROBERT, *op. cit.*, p. 318.



a camera
b extension tube
c lens
d measuring device and adaptor
e light and reflector
f distance from lens to reflector of 2 inches
g distance to front of base of 4½ inches
h distance from reflector to end of base of ½ inch

FIG. 22. Diagram of portable camera set-up. (Older).[67]

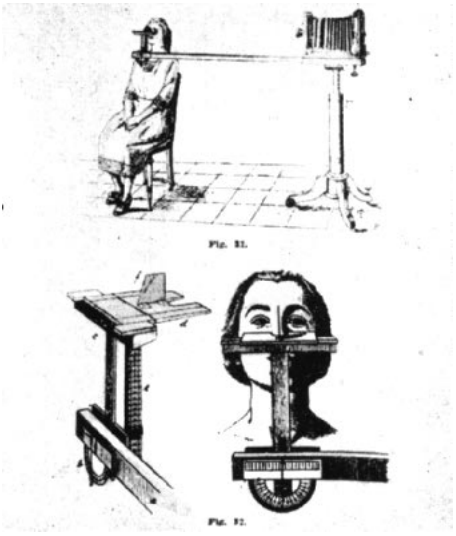


FIG. 23. Simon positioning device, showing method of patient orientation by means of lens board, nose board and nasal aimer. (Simon).[5]

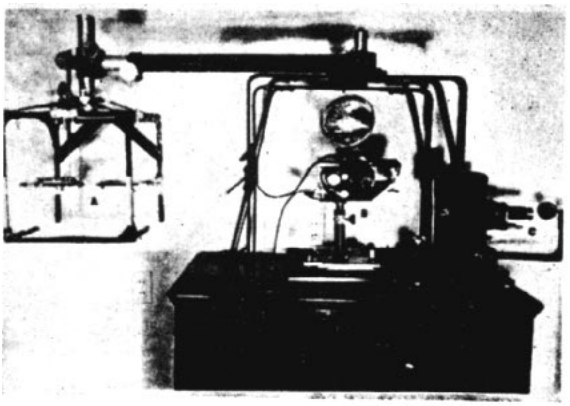


FIG. 24. Orthodontic photographic recorder. A, Cephalophore; B, Photographic Unit; C, Projector. (Fisher).[76]

top of the head, there should always be a permanent light of about 500 watts affixed to the top of the background. For head pictures, lights are placed one foot to each side of the camera, level with the top of the patient's head.[69] Regardless of the limited variations in the demands of photo lighting, the essentials are uniformity of illumination, moulding of the features, reduction of unwanted shadows to a minimum and correlation with positioning of the patient, view desired and type and speed of film used.

Glass plates, cut film or film packs may be used in the clinical camera. Each form has its advantages, cut film being most economical, not subject to breakage and most easily stored. There has been a trend toward the use of adapter backs for smaller sizes of film, lantern slide size, Bantam K828 or 35mm.[70] Either orthochromatic or panchromatic film may be used, but orthochromatic films tend to accentuate blemishes and darken all reds, so panchromatic is the most popular type. Eastman Safety Film, Eastman Portrait Superspeed and Agfa Superplenachrome have the advantage of being adapted to developing in X-ray developing solutions. The development of more sensitive and faster emulsions has relegated slower speed films into the background, where enlarging is not a problem. Super Panchro-Press, Eastman Daylight Emulsion speed of 124, Tungsten 100, has good latitude and moderately fine grain.

The advent of the 35mm camera stimulated the use of more sensitive film. Technical advances in movie film, which is the same size, were incorporated into film released for public use. 35mm film is marketed in three speed categories—25, 50 and 100 Weston emulsion speeds. (Eastman Panatomic X, Plus XX and Super XX). The operator must be careful not to make too large an enlargement with the ultra speed film for grainy prints will likely result.

It is with the miniature camera that color has found its greatest use, primarily as Kodachrome transparencies. The economic factor has been a major consideration. Kodachrome in larger sizes is quite costly. Kodachrome in the 35mm size costs no more than black and white does in the larger sizes. Grain is no longer a problem, because the final color images are made up of dyed gelatin. Latitude is considerably more limited in Kodachrome than in black and white film. There is no room for guesswork. However, in orthodontic clinical photography, where both illumination and exposure can be standardized, uniformly good results can be expected. Kodachrome Type A film has a Tungsten reading of only 12 Weston so more light is necessary.

Exposure is largely determined by the aperture of the lens, quality and quantity of illumination, type and speed of film and the object to be photographed. Here again, there has been a significant trend toward shorter exposures with the development of faster film and more efficient artificial light. The difficulty of preventing patient movement in longer exposures is particularly a problem to the orthodontist, because children form the largest part of his practice. Harding cautions against any exposure longer than ½

[69] HARDING, F. R., "The Lighting and Posing of Clinical Photographs," *op. cit.*

[70] EASTMAN KODAK COMPANY, "Photography of Appliances and Small Instruments," *op. cit.;* SAGE, ROBERT, *op. cit.*

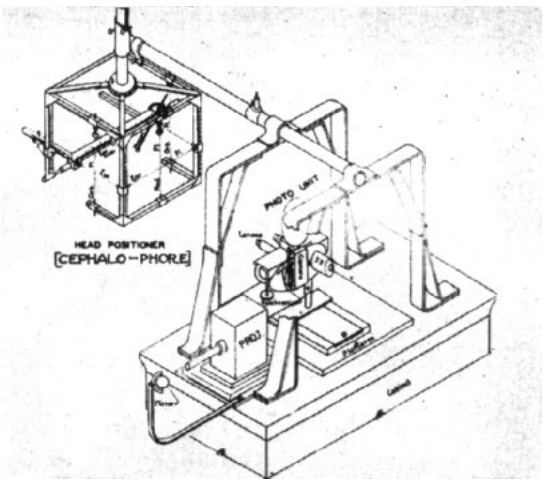


FIG. 25. Diagram of Fisher photographic Recorder. (Fisher).[76]

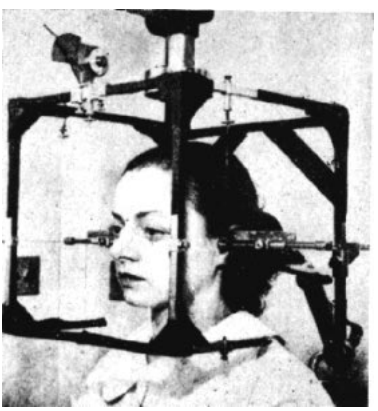


FIG. 26. Cephalophore in position for front view photograph. (Fisher).[78]

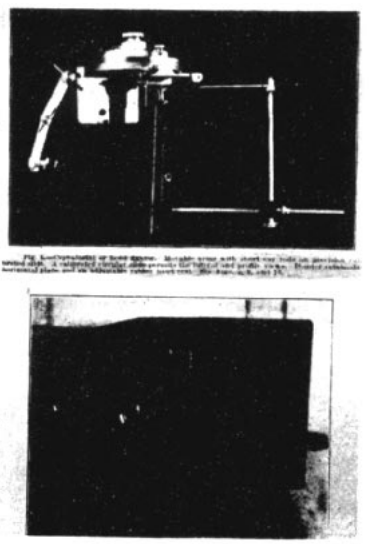


FIG. 27. Top view. Cephalostat or head fixator. Movable arms with short ear rods on precision calibrated slide. A calibrated circular slide permits the lateral and profile views. Pointer establishes horizontal plane.

Bottom view. Stereocamera on fixed attachment, matched lenses, fixed focus. Always in same relation to patient. (Margolis).[79]

second to prevent movement.[71] Even this has been found too long, and techniques using ultra speed film now call for 1/10th to 1/50th second. This is especially true of 35mm techniques. At these speeds, failure because of patient movement is almost nil.

4. Photographs are used for several purposes, and the positioning of the patient will be decidedly different in an artistic "before and after" album-piece (Figure 3) than in a photostatic reproduction used for measurements and diagnosis (Figure 1). There is general agreement on the views required. Ordinarily a straight full face and right and left profile are taken and a fourth view with lips retracted, full face, is often included. Ferris writes, "The laughing pose presents an image of the bilateral or unilateral nerve tone of the muscles in action."[72]

The early techniques called for full or half size negatives. The scale of the picture desired and the focal length of lens determines the distance between the patient and the film. With the long focal length lenses used by Lischer, Delabarre and Ferris, the patient-film distance was close to five feet.[73] The lens of the camera is adjusted on a horizontal line with the anatomic landmark, nasion, in most techniques. In profile views, where depth of focus is a problem, the lens is focused on a point midway between the tragus of the ear and the saggital plane. Figure 23 demonstrates the photostatic apparatus of Simon, attached to a studio tripod. Laterally there is a beam of fixed length with a nose board on the end. The patient is seated on an ordinary chair equipped with casters and headrest, so that the chair may be moved toward the camera. The nose of the patient comes into the cut of the noseboard in such a way that the edges of the board contact the orbital points. The thin plate is the nasal aimer. The median plane is always the same distance from the negative and always parallel to it. The distance is controlled with the help of the median ruler, the millimeter scale of which is distinctly visible in the ground glass of the camera.[74]

The rigid orientation of the Simon photognathostatics was carried over into 35mm techniques. In a report on the use of a miniature camera in 1934, Golden oriented his patients for the picture by marking the facial landmarks, as Simon, and the head position was established by the Simon plane bow. The object-lens distance was set at 30″ by a tape-measure attached to the camera.[75] In the Fisher cephalophore technique, the object-lens distance is 32″. The head is held in a uniform relation to the camera by an orientation device (Figure 24, 25).[76] Wire lines provide the eye-ear plane, median plane and adjustable orbital plane for each picture. The cephalophore is a cube-like frame, 12″ long. The edges are calibrated in 32nds of an inch. The

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[71] HARDING, F. R., *op. cit.*

[72] FERRIS, H. C., "Original Photographic Studies of Orthodontic Cases," *Internat. Jour. Orth.*, 13:627–32, 1927.

[73] LISCHER, B. E., *op. cit.;* FERRIS, H. C., *op. cit.;* DELABARRE, FRANK, "Photography as Applied to Orthodontia," *Allied Dental Journal*, 11:654–58, 1916.

[74] SIMON, PAUL, *op. cit.*, p. 770.

[75] GOLDEN, ERIC, *op. cit.*

[76] FISHER, BERCU, *op. cit.*, p. 141.

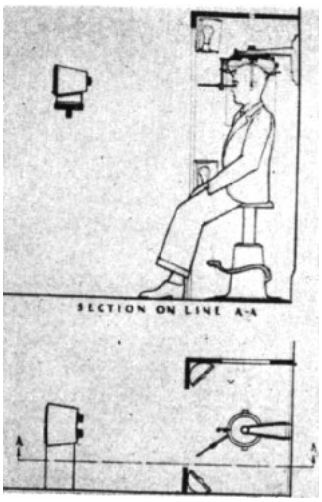

FIG. 28. Diagram of patient positioning in cephalostat. (Margolis).[80]

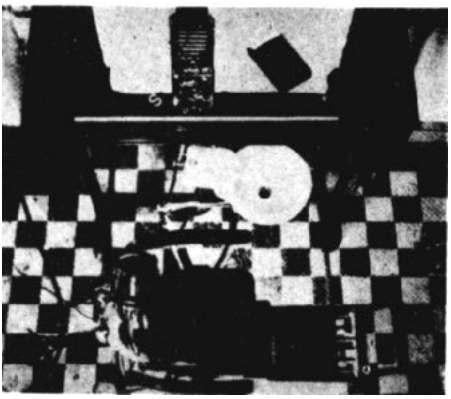

FIG. 29. This illustration shows how the camera, Wuerpel table and chair are oriented to each other by means of the square design in the floor covering. (Curran).[81]

FIG. 30. Illustration of method of background lighting and emphasis. (Turner).[88]

median line of the cephalophore corresponds with the vertical line on the focusing attachment of the camera. The ear rods are adjustable so that the patient can be placed in Frankfort in both frontal and lateral views[77] (Figure 26).[78]

Margolis has adapted the "rigid" orientation technique to stereo work. Patients are positioned by a modified craniostat he calls a cephalostat (Figure 27).[79] An adjustable rubber head rest is attached to the posterior part of the cephalostat and in the same plane as the ear rods, an arm and pointer are placed anteriorily to locate the inferior border of the left orbit, so that the head may be set in Frankfort (Figure 28).[80]

The dental chair frequently serves to position the patient (Figure 29).[81] Schwartz advocates the use of the Bertillon chair.[82] Curran has advanced a novel method for frontal views. He uses a metal tube with legs attached to each end, giving a "saw horse" effect. A metal sleeve, to which the camera and lights are attached, fits over the tube and slides along it. At one end a chin rest holds the head of the patient. The camera is then slid along the tube to a point satisfying the demands of the subject matter and scale of the picture.[83]

5. The failure of early clinical photography has frequently been traced to the lack of a good background. For the best pictures, the background must be uniform; it must set off the object to best advantage; and it must not emphasize shadows caused by artificial lighting. The closer the patient is to the background, the smaller the shadows; the closer the light to the camera, the smaller the shadows on the background. Eastman Kodak contends that the background should be at least three feet away from the patient to cut down on shadows.[84] The proper color and shade for these duties seems to depend on the subject. Voss recommends Canton flannel, black, gray or white placed about three feet from the head.[85] Others find black bristol board or a dark gray background more satisfactory.[86] The majority of operators prefer a neutral light gray or cream color background.[87] White side reflecting boards with a gray background tend to diffuse the lighting (Figure 30).[88] Different color window shades are sometimes hung behind the patient, and neutral tan or cream walls with painted-on scale grids are recommended by

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[77] *Ibid.*

[78] *Ibid.*, pp. 143, 144.

[79] MARGOLIS, HERBERT, *op. cit.*, p. 1033.

[80] *Ibid.*, p. 1034.

[81] CURRAN, B. A., *op. cit.*, p. 71.

[82] SCHWARTZ, RUDOLPH, "Cephalometric Methods and Orthodontia," *Internat. Jour. Orth.*, 12:1078–1101, December, 1926.

[83] CURRAN, MORVEN, *op. cit.*

[84] EASTMAN KODAK COMPANY, "Photography of the Entire Face and Facial Profile," *op. cit.*

[85] VOSS, ALBERT E., *op. cit.*

[86] HARDING, F. R., *op. cit.;* SPENCER, HARVEY, *op. cit.*

[87] TURNER, GEORGE L., *op. cit.;* CURRAN, B. A., *op. cit.;* EASTMAN KODAK COMPANY, *op. cit.;* MCCOY, J. D., MCCOY, JOHN, *op. cit.*

[88] TURNER, GEORGE L., *op. cit.*, p. 571.

Harding.[89] Golden prefers a dull green for a background and places a graduated screen directly before the patient to serve as a double check of positioning and also as a basis of serial comparison. The screen consists of a frame with black thread stretched across at ¼″ intervals, forming a net, oriented by a plumb-bob, with a horizontal line corresponding to the eye-ear plane, or a line joining the orbital points.[90]

55 E. Washington Street

[89] HARDING, F. R., *op. cit.*
[90] GOLDEN, ERIC, *op. cit.*

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