Paparella: Volume IV: Plastic and Reconstructive Surgery and Interrelated Disciplines

Section 2: Disciplines Closely Associated With Otolaryngology

Chapter 26: Photography

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The objective of medical photography is the production of an undistorted image that clearly achieves its intended purpose. The motive may be purely documentary, for use in surgical planning, for educational aims, or for some other purpose. The difference between a successful photograph and a waste of time and effort is generally only a few moments of thought and planning. Faults are often, but not always, evident when the final image is viewed. The ability to previsualize a final image comes only with guided experience. It also should not be forgotten that photograph documentation can as easily convey useful information as it can misrepresent it.

Photographic Guidelines

The following guidelines may be used both to preplan a photograph and to judge the resulting image.

1. The subject should be fully seen and fill the frame. When looking through a camera viewfinder we tend to see only the center of interest and are often blind to the surrounding area. If what is required is a picture illustrating an aphthous ulcer on the gingiva, there is seldom a need to include the full face, neck, and thorax in the image. When viewing the final photographic image, our eye and attention are easily drawn into these distracting surrounding areas. Take a moment to look at the edges of the image in the viewfinder. In nearly every case the image will be improved by moving the camera closer to the subject to exclude irrelevant information. The opposite fault of missing important information by being too close is another potential, though less common, problem. Fill the picture with what you are interested in.

2. The subject should be in sharp focus and without blurring movement. A fuzzy image fails to convey information accurately.

3. Both the shadows and highlighted areas reveal important information and require good illumination and exposure levels for proper depiction.

4. Color rendition should be natural. The film and any filters used must be appropriate for the light source and subject. Lipstick and cosmetics that hide natural skin tones should be removed. Slow films usually produce a more natural rendering of skin tones and better resolution of fine detail than fast, ie, high-speed, films.

5. The orientation and location of the subject may not be evident when the final photograph is viewed. In these situations the inclusion of some surrounding identifiable anatomy as part of the image is desirable.

6. When the size of an object is not evident, a reference scale, such as a ruler, should be part of the image. A common situation requiring a reference scale is in the photography of gross specimens.

7. Avoid distracting objects and background. Surgical clamps, hands, or blood-stained drapes in the field as well as unnecessary objects in the background such as tables, equipment, and people should be excluded from the image. They draw the eye and mind away from the photographic objective.

8. Strive for consistent nondeceptive illumination. This is critically important in photographs illustrating plastic and reconstructive problems. Lighting techniques normally used by professional nonmedical photographers are designed to produced flattering or dramatic images. This is not the goal of a medical photograph. Asymmetric lighting, with its unavoidable deceiving shadows, must be avoided. In addition, identical pre- and postoperative photographic conditions must be used. The only photographic objective achievable in medical portraiture that uses asymmetric lighting and varying techniques is that of deception.

9. Printing and labeling should be legible and present only if critical to an understanding of the illustration. A slide or illustration containing too much information is as counterproductive as one with illegible or unnecessary information. A good rule to follow in designing illustrations is: "Keep it simple and to the point". If you need to communicate a complex idea or collection of data, divide it into multiple images, each conveying a clearly defined portion as well as its relationship to the whole.

10. Improperly selected optics and camera-to-subject distances produce distorted images. For example, wide-angle and normal focal lenses may make objects close to the camera appear unnaturally large. The perspective, ie, the relative size of objects, should appear natural to the viewer. This is as critically important as is proper illumination in photographs illustrating plastic and reconstructive problems and results.

Photographic Controls

Every photograph is created by manipulating five fundamental controls. The ingenuity of our species is certainly expressed in the variety of photographic materials available, all of which are merely a theme and variation on these, and only these, five controls: (1) lens, (2) shutter speed, (3) aperture, (4) film, and (5) light source and exposure.

Lens

One of the objectives of medical photography is the production of an undistorted image. Photographic distortions, whether the result of ignorance or of intention, are often subtle. Examples may be found in many pre- and postoperative cosmetic photographs. One reason for this may simply be that a knowledgeable nonmedical photographer is trying to please the physician who requested the photograph. More often, it is the result of a lack of understanding and a failure to apply a few simple photographic concepts.

Concept: Focal Length. The focal length of a lens is the distance, in millimeters, between the lens and the film when an object at an infinite distance is in focus. By convention, there are three classes of lenses according to focal length.

Normal lens. This lens is commonly thought to produce an image that appears "normal" when viewed in an ordinary fashion. For a 35-mm camera, a normal lens is considered to be one with a focal length of 50 to 55 mm. For medical photography a normal lens is often, but not always, satisfactory. The distortion in image perspective produced by a normal lens is a special problem in presurgical portraiture.

Telephoto Lens or Long Focal Length Lens. This lens has a narrower, or more telescopic, angle of view than a normal lens. Its focal length is greater than that of a normal lens. For a 35-mm camera, a 135-mm lens is considered telephoto. Telephoto lenses are useful in the operating suite in which the photographer and his equipment must remain out of the sterile field.

Wide Angle or Short Focal Length Lens. This lens has a wide or panoramic angle of view. Its focal length is less than that of a normal lens. For a 35-mm camera, a 35-mm lens is considered wide angle. For close work, the perspective and pincushion distortion produced by a wide angle lens is unacceptable. There is practically no known use for a wide angle lens in clinical photography with the exception of endoscopy.

Shutter Speed

Shutter speed is the duration of time that light is allowed to reach the film, expressed in fractions of a second. Each successive fraction represents a halving of the previous fraction. A segment of this sequence is as follows: 1 sec, 1/2, 1/4, 1/8, 1/16, 1/30, 1/60, 1/125, 1/250, 1/500, and so on.

Aperture

The aperture, or F-stop, is the size of the aperture in the lens through which light passes. Its value is the ratio of the diameter of the lens to its focal length when focused at infinity. Each successive F-stop represents a halving of the previous F-stop. A segment of this sequence is as follows: 1.4 (wide aperture), 2, 2.8, 4, 5.6, 8, 11, 16, 32 (small aperture).

Relationship of Aperture and F-stop. If exposure is correct at a given F-stop and aperture setting, the equivalent exposure can be obtained by reciprocally changing the settings. For example, if the correct exposure is 1/60 sec at F/5.6, equivalent exposures would be 1/30 sec at F/8, 1/15 sec at F/16, and so on.

Solving Problems with Lens, Shutter, and Aperture Selection

Close-up Photography and Lens Selection. Clinical photographs are generally taken at close or very close camera-to-subject distances. Focusing at close distances requires movement of the lens away from the film. Ordinary camera lenses are designed for optimal image clarity with subjects at middle and far distances. To avoid the image distortions that occur when these lenses are used for close-ups, manufacturers limit the focusing movements of their lenses. Many normal focal length lenses will not focus closer than 2 to 3 feet from the subject. Close focusing with ordinary lenses is still possible by using one of a number of supplemental devices. These include first, devices that move the prime lens further from the camera: extension tubes and bellows. Second, supplementary lens systems: close-up lens (positioned in front of the prime lens) and a telephoto converted (positioned between the prime lens and camera body). Third, a reversal ring to mount a lens on a camera front to back. This is used when the object to be photographed is so small that its image on the film will be a magnification of its real size.

All of these methods result in various types of image distortion. One such problem is the inability to focus on all parts of a subject simultaneously. Ordinary lenses are designed to focus on a curved field representing the circumference of a circle with the camera at the center. This prevents focusing uniformly on a flat surface. Long focal length lenses with increased camera-to-subject distances have a field curvature that more closely approximates a flat surface. The best results are thus obtained by adapting telephoto lenses for close-up work, and the poorest by using normal and wide angle lenses.

"Macro" lenses, sometimes called "micro" lenses, are designed to produce high-quality images at close and very close distances without special devices. They are designed for high resolution, accurate color rendition, and a flat field of focus. Macro lenses are highly desirable for most clinical photography. They are essential for photographic flat surfaces such as in the copying of charts, graphs, and illustrations.

Portraits and Lens Selection. One of the keys to the production of accurate preoperative and postoperative portraits is the rendition of natural perspective to the size of various parts of the face. Improper lens selection will result in perspective distortion. A portrait taken at a short camera-to-subject distance using a wide angle or normal lens results in an apparent exaggeration of the size of the nose in relation to the rest of the face. A long camera-to-subject distance using a telephoto lens produces the reverse, with the apparent size of the nose smaller than its actual relationship to the rest of the face. It is possible, with lens selection and camera-to-subject distance as the only variables, to make two seemingly different photographs of the same patient a few moments apart, one showing a prominent nose and the other a small one. The principle, restated, is that an object near the camera, or your eye, will produce a larger image than the same object further away. A 105-mm focal length lens is considered the lens of choice for portraits when a 35-mm camera is used. This lens produces images with apparent natural perspective.

Improving the Resolution of Fine Detail in Close-up Work. A shallow depth of field is one of the major, if not *the* major, problem in close-up photography. Photographic "depth of field" is the range between the nearest and furthest objects that can be rendered sharply at a given lens setting. The plane of sharpest focus is not, as one might think, in the middle of the depth of field. It is one-third of the distance from the near focus. For example, if the depth of field is 100 to 160 cm from the camera, the plane of sharpest focus is at 120 cm. Depth of field is influenced by three factors, listed below.

1. Camera-to-subject distance. Depth of field decreases as this distance decreases. In extremely close work, the depth of field may be only a few millimeters.

2. Lens focal length. Depth of field decreases as focal length increases. Wide angle lenses have a greater depth of field than telephoto lenses. Despite this, wide angle lenses are

not usually advisable in close-up work for a number of reasons. These include the perspective distortions they produce, as well as the difficulty in illuminating an object around the lens, which must be very close to the subject and will thus cast a shadow. Some of the loss of depth of field that results when a long focal length lens is used is offset by the increased camera-to-subject distance.

3. Aperture setting. Depth of field increases as lens aperture, discussed earlier, decreases. A small aperture setting will maximize the depth of field. A small aperture setting, which lets only a small amount of light reach the film, requires a more intense light source. Resolution of fine detail in the area of sharpest focus is also influenced by the lens aperture setting. Lens are usually designed to render their sharpest image at two or three F-stops smaller than the maximal aperture available. Minimal or maximal aperture settings result in the poorest image sharpness.

It should be evident at this point that there is no ideal method of obtaining a distortion free, well-exposed image with near and far objects in sharp focus. A practical compromise is to avoid wide angle lenses, increase the intensity of the light source, use long exposures, and select a "fast" film to allow use of a smaller aperture. Each compromise gains and loses something. Fast films have grainier images and less accurate color than slow films. Long exposures, usually over 1 second, produce film reciprocity failure resulting in nonlinear color and exposure changes.

Film

Two types of film exist in both black-and-white and color formats. These are "reversal" or "transparency" films and "negative" or "print" films. Reversal film produces projectable slides or transparencies. Color reversal film names usually end in "chrome": ie, Kodachrome or Agfachrome. Negative films are designed to produce prints. Color negative film names usually end in "color": eg, Kodacolor or Agfacolor. Most black-and-white film is negative film. Instant slide films made by Polaroid are reversal and produce projectable black-and-white or color transparencies.

The sensitivity of film to light is represented by an exposure index, or film speed. In the USA this is represented by a linear ASA or ANSI scale. European standards use a logarithmic DIN scale to indicate film speed. Films that are very sensitive to light are referred to as fast films and have high ANSI or DIN exposure indexes; slow films have lower ANSI and DIN indexes. In general the most accurate color reproduction and the highest resolution of fine detail are obtained with slow films. Special processing can increase the effective exposure index of many films at the expense of color accuracy and resolution of detail.

Most color films are designed for use with light having a spectrum or color temperature of standard daylight. A photograph taken with such a film under fluorescent light may render skin tones as greenish, and under tungsten light as reddish. This effect can be partially corrected by the use of compensating filters places over the camera lens at the time of exposure. A limited number of special films are available for unusual lighting and for scientific and commercial use such as in color photomicroscopy, electron microscopy, and slide duplication.

Light Source and Exposure

Available light, the light that exists in the environment, is usually less than ideal for medical photographic purposes. Available light restricts the selection of film, aperture, and shutter speed to that most suitable for the light rather than that that most accurately records the subject. In most situations, additional light must be provided specifically for the photograph. Electronic flash is commonly used in the clinical and surgical suite. Studio photofloods are useful for pre- and postoperative portraiture.

Light intensity diminishes according to the square of the distance from the light source to the subject. Small distance changes thus produce large intensity changes when a light source is near the subject. This situation has created enormous problems in the past in calculating exposures in close-up electronic flash photography. Many electronic flash units now have automatic exposure circuitry that measures the reflected light and turns off the flash when a correct exposure has been reached. Unfortunately, only a few of these automatic flash units are designed to work properly at very close distances. An additional problem with an ordinary flash unit that sits on top of or to the side of the camera is that at close distances the lens of the camera will cast a shadow on the subject. Increasing the camera- and flash-to-subject distance by using a long focal length lens permits the use of an ordinary automatic flash unit. This is desirable in the surgical suite because it also keeps camera equipment and photographer away from the sterile field. Some 35-mm cameras have a desirable built-in automatic flash circuitry, and measure reflected light at the film plane during exposure. Such cameras require an integrated flash unit controllable by the camera. For close-up photography a ring flash that surrounds the lens will provide shadowless, even illumination for close-up work. In any photograph of a shiny surface, the light source will be reflected as a specular highlight. This highlight will be recorded on the film as a small, bright circle when a ring flash is used. Any flash mounted on the camera, including a ring flash, will produce a large, objectionable highlight when copying a flat surface that is perpendicular to the film plane. An off-camera light source is needed in this situation. One other potential disadvantage of a ring flash is that it eliminates all shadows. In some situations, particularly when black-and-white images are used, surface texture is revealed by shadows and hidden when there are none.

Behind-the-lens light meters are built into most modern 35-mm cameras. They are designed for use with available light and are helpful when flash is not employed. A few behind-the-lens meters are designed to control an electronic flash; these are extremely useful in medical photography.

Camera and Subject Movement. Camera or subject movements result in blurred images. In close-up photography this is troublesome because small movements become magnified. Electronic flash, with its inherent short duration of exposure, stops most motion. The highest camera stability is obtained when a sturdy tripod support is used.

Generic Clinical Photography

The requirements for most head and neck photography are usually straightforward. A macro lens mounted on a single-lens reflex 35-mm camera is preferable. Larger-format cameras such as Hasselblad and large studio cameras produce greater resolution of fine detail on a larger film, but have limited adaptability, are awkward to use, do not produce normally projectable slides, and have other practical disadvantages. Unless otherwise indicated, all references in this chapter are to 35-mm single-lens reflex cameras.

If portraiture is contemplated, a 105-mm lens will provide the best results. Any lens with a focal length between 85 and 135 mm will produce satisfactory portraits. These same lenses can also be used for most clinical photographs. A shorter focal length lens is required only if it is physically impossible to position the camera a few feet away from the patient. Long focal length lenses, even 135-mm lenses, become awkward when the camera is hand-held for close-ups.

Consistent lighting is most easily obtained with a ring flash and behind-the-lens automatic flash exposure control. A flash mounted on top of or to the side of the camera can also be used if the focal length of the lens is long enough to avoid its casting a shadow on the field. Shadows are normally a problem only when a wide angle or normal focal length lens is used with an on-camera flash; they are not seen when a ring flash is used.

Generic Endoscopic Photography

Mounting a camera on an endoscope is often an elegant method of obtaining photographs inside cavities. Most endoscopes can be fitted with camera mounts. On-the-camera optics designed for endoscopic work are easiest to use, although some standard camera lenses can be adapted as well. The endoscopic view and resulting image are generally wide angle with an extended depth of field.

The highest quality images seem to be those obtained with Hopkins rod lenses, and the poorest those with fiberoptic endoscopes. The small Hopkins rod lens telescopes used in pediatric bronchoscopy may not allow adequate illumination for photography unless a very bright light source is available.

A special focusing screen within the camera is required because of the unusual optical and lighting conditions that obtain during endoscopy. The intense light source needed may produce excessive heat. The fiberoptic bundle carrying the light to the subject blocks some of this heat, as do special glass heat filters. Cooler light sources such as electronic flash or xenon specifically designed for photography are preferable. Exposure calculation may initially be a matter of trial and error. Each lens and subject combination has its own best exposure that, when known, can be used repeatedly. Some endoscopic light sources and camera adapters have automatic exposure meters built in.

Generic Operating Microscopic Photography

Any area that can be visualized with the operating microscope can be photographed through it. Many strategies have been devised for camera mounting and focusing, as well as illumination, using the operating microscope. A standard method that produces consistently good results involves the use of a beam splitter positioned between the body of the microscope and the eyepieces.

Some unique problems requiring special solutions are listed below.

1. A camera with a self-winding feature and remote control or cable release will permit photography with the least surgical disruption.

2. The light source for photography must be more intense than that used purely for surgery. High-speed film may be required even with an intense light source.

3. The color temperature of the film must match the light source or be used with a correcting filter.

4. A special within-the-camera focusing screen is needed for microscopic work.

5. The surgeon's view through the microscope and the camera must be adjusted for simultaneous focus.

6. The surgeon's view through the microscope may be more panoramic than the camera's view. Special optics are available that will frame the camera's view in the eyepiece in these situations.

Generic Intraoperative Photography

The taking of good intraoperative photographs prolongs anesthesia and surgical time. The surgeon may take the photograph himself when endoscopic or microscopic techniques are used, but seldom does so in procedures that would require him to "break scrub". In these situations the surgeon should prepare the operative field and then direct the photographer.

To prevent contamination of the surgical field by the photographer or equipment, a long focal length lens and electronic flash are desirable. The surgical lights should be directed away from the field or turned off for the photograph to ensure an unambiguous color temperature. To prevent confusion regarding orientation and scale, a single best camera position and most appropriate lens should be established, and most photographs taken utilizing that setup. It may be necessary to change for a few shots in order to point out some special feature not otherwise clearly illustrated.

Before taking any photograph, clean the field. This involves meticulous hemostasis followed by irrigation to remove all traces of blood. Next, place clean towels or drapes over the old ones. Take several photographs to be sure at least one will be suitable. This process is repeated for every photograph.

Gross Specimens

Most pathologists have a miniphoto studio with lighting and background designed for the photography of gross specimens. This usually involves placing the specimen on a plate of clean glass suspended well above a neutral uniform background. The specimen and background have independent lighting designed to produce an image in which the specimen appears to be floating in space.

At times it is advantageous to take these pictures in the surgical suite while tissue colors and textures are still natural. Wash all blood from the specimen and place it on a clean drape or towel, which is the same as used for the surgical photographs. It may be helpful to open a specimen such as the larynx or a tumor for better visualization and orientation. A ruler or other object indicating scale should be placed next to the specimen for this photograph. To maintain a uniformity of results, use the same camera and lighting setup employed for the surgical photographs. Move the camera close enough to fill the frame with the specimen and scaling object.

Intraoral Exposures

Solving exposure and lighting problems inside any hollow space is seldom easy. The oral cavity presents fewer problems than most with standard photographic techniques. Endoscopic photographs of the oral cavity are possible but generally result in disorientation and marked perspective distortion. A nonreflective or burnished, curved, metal tongue blade will place the hand holding it out of the photographic field. Clear plastic cheek retractors and stainless steel palate mirrors, designed specifically for photography, are available in multiple sizes from most dental supply houses. These devices can be held by an assistant or the patient.

Perspective distortion, with apparently gigantic teeth and tiny tonsils, can be avoided by using a moderately long focal length (85 to 135) macro lens. A ring flash with behind-the-lens automatic flash exposure is desirable. This combination of lens and light source also produces a more even front-to-back illumination.

Adequate illumination is needed to focus the camera inside the oral cavity, and is often a problem. An external light, even a flashlight, will do the job. Some ring flash units have supplementary focusing lights built in.

Intranasal Exposures

The nasal cavity is the most difficult of all hollow cavities to photograph in a living patient. This narrow deep space with its multiple convolutions cannot be rendered in a single image. The best results (and these can be surprisingly good) are obtained with Hopkins rod lens nasal endoscopes to visualize discrete portions of the cavity. Fiberscopes can also be used but produce inferior images. These techniques are described in the section on generic endoscopic photography. A scrupulous record of the film number and location of the endoscope is necessary, since the orientation and position of the resulting image is seldom evident on viewing. Direct photographs of the nasal vestibule and anterior nasal cavity are possible using a nasal speculum with a macro lens and flash.

Nasopharynx

This area can be photographed from either the nasal or pharyngeal side. Endoscopes with sharply angled views are useful in both situations. This technique is described in the section on generic endoscopic photography.

It is also possible, although awkward, to take a photograph by means of a nasopharyngeal mirror. The camera setup is the same as that used for intraoral photography, with the camera moved close enough to fill as much of the frame as possible with the mirror.

Topical anesthesia permits the use of a large mirror and self-retaining palate retractor. The focus must not be on the mirror but on the reflected image. It takes practice and ingenuity to manage the mirror and camera simultaneously.

Larynx

Four general methods are used to photograph the larynx: indirect, direct, endoscopic, and microscopic.

Indirect laryngeal photography is similar to the mirror technique described in the section on the nasopharynx. The resulting image is inferior to that obtained with other methods.

Photographing the larynx directly through a laryngoscope can produce good images. Most laryngoscopes used for microlaryngoscopy provide a wide enough orifice for photography. A long focal length lens (135 mm) with extension tubes or bellows, a tripod, and cable release are needed for close focusing and stability. The normal endoscopic light is used, requiring both long exposures and a filter to correct the color balance. This setup, unfortunately, is awkward and time consuming.

Endoscopic images of the larynx can be obtained in both the clinic and operative suite. Fiberscopes can be used in either setting but produce an image inferior to that obtained with optical endoscopes. In a clinical setting the angled endoscopes, normally used diagnostically, can be adapted for photography. A sufficiently intense light source must be available. In the operative suite Hopkins rod lenses produce the best endoscopic images. This technique is described in the section on generic endoscopic photography.

Placing the camera on the operating microscope, as when photographing the ear, is another viable technique for microlaryngoscopy.

External Ear Canal, Middle Ear, and Mastoid

There is no simple, inexpensive method of effectively photographing the external ear canal, middle ear, or mastoid bowl. The camera must be mounted either on an operating microscope or on an endoscopic telescope. Both of these techniques are described above.