Colpophotography Systems: A Review

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Colpophotography and video colposcopy systems are useful for pathology documentation purposes, patient education, and colposcopy training. A wide variety of colposcopic visual media components are available to enhance routine colposcopy.

Colpophotographic systems supplied by eight colposcope manufacturers were critically evaluated by a colposcopist and a medical photographer. Components were independently and objectively analyzed. Photographic examination considered color, illumination uniformity, and coverage of illumination at all possible colposcopic magnifications. Photographs were developed by a standardized technique.

The investigation results clearly demonstrated variability between different colpophotographic systems.

Quality colpophotography is dependent on certain colposcope features and potential modifications. Colpophotography and video colposcopy systems complement the standard colposcopic procedure.

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Colpophotography and video colposcopy systems enhance routine colposcopy. A colpophotograph permits documentation of clinically observed pathology and complements anatomical diagrams drawn by the colposcopist. Oftentimes the colpophotograph provides greater detail of abnormalities found in the atypical transformation zone. Frequently, characteristics useful to estimate the pathologic severity of cervical lesions may be noted. The precise lesion location, unusual findings, and posttreatment results may also be recorded. The use of colpophotographs and particularly colposcopic video monitors facilitates patient education and colposcopist-patient interaction. Concomitant observation by the patient enables self-awareness and visualization of typically nonaccessible anatomy. Patient anxiety is also frequently alleviated by the co-observation technique.

Physician colposcopic education and training are improved by use of colpophotography and video colposcopy systems. Colposcopists are familiar with the excellent colpophotographic work of Drs Cartier[1] and Stafl and Kolstad.[2] Their photographic images of gynecologic disease have helped create the necessary framework for pathologic feature pattern recognition used by all practicing colposcopists. A colpophotograph retrospectively renders feedback data that may be used to reinforce appropriate diagnostic or therapeutic techniques. The feedback may help correct improper estimation of disease severity and misconceptions about distinctions between gynecologic normal and abnormal epithelium. In summary, colpophotography creates a permanent record of what the colposcopist visualizes during the colposcopic examination but at reduced magnification.

A wide variety of colposcopic visual media systems are available to enhance routine colposcopy. This selected review of colposcope photographic components complements a previously published review of the same colposcopes.[3] Colpophotographic systems supplied by eight colposcope manufacturers were critically evaluated by a colposcopist and a medical photographer. All systems analyzed were standard equipment and commercially readily available. The investigation considered only photographic systems designed for integration with specific colposcopes. The colpophotographic system of cervicography was not evaluated. The purpose of the selective review was to compare the quality and photographic variability of several colpophotographic systems.

Colpophotography and Video Colposcopy Systems Components

Colpophotography and video colposcopy systems complement the standard colposcopic procedure. Both accessory features are useful for pathology documentation purposes, patient education, and colposcopy training. The colposcopic visual media components are outlined here.

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Beam Splitter

Beam splitters are useful, particularly when one incorporates a video system with a monitor. When a beam splitter is used, the colposcopic image seen by the colposcopist is equivalent in magnification to the image visualized on the monitor. The target image is actually split in half and diverted to two independent observation points. Image clarity is always better when viewed through the colposcope. The provision of equal magnification is useful, and imperative in educational settings. The video system with a beam splitter allows the instructor to critically observe the learner's technique and to assess the learner's recognition of pathology. Furthermore, it permits the novice colposcopist to stay with the colposcope while allowing the instructor to simultaneously observe various anatomical and pathologic features seen on the monitor. A video system allows the nurse to visualize the procedure and thus anticipate the colposcopist's needs. With the addition of a videocassette recorder, the system can also be used to document colposcopic findings. The colposcope equipped with a beam splitter and video system facilitates contemporary teaching of colposcopy and related skills.

Teaching Heads, Monitors, and Cameras

Monocular and binocular teaching heads can be attached to accessory portals. The equipment allows simultaneous observation by the novice colposcopist and the instructor. The viewer must be in close proximity to the colposcopist, however, and patients and other individuals do not benefit from this system. A monocular teaching head does not permit realistic depth of field. The high-resolution video monitors used in conjunction with the colposcope provide a greater resolution than that of a typical television set. Modern video systems provide remarkable image clarity. Monitors are best positioned elevated on a wall support and placed at the side or foot of the examination table in full view of all individuals. Recent advances in video cameras include miniaturization. Video cameras are attached at a colposcope accessory portal and should be positioned in such a way that they will not interfere with the procedure. Video monitors are not essential for the private practice colposcopist, but are excellent teaching tools in centers of education.

Many colposcopes permit the use of a 35-mm camera to document clinical pathologic findings. Some of these cameras have data systems so that proper patient identification can be determined following the photographic examination. Some systems use a flash, others do not. A Polaroid camera can also be used to document cervical pathology. The advantage of using a Polaroid camera is that it provides near instantaneous photographic documentation that can be shared with the patient or observers. The print can be easily attached to the patient's record. The resolution of a Polaroid photograph, however, is not as high as that obtained by using 35-mm film.

Colpophotography

Colpophotography is dependent on certain colposcope features and potential modifications. A permanent camera portal ensures that the colposcopic system will always be ready for photography. The need to stop an examination in order to attach a camera to one of the binocular eyepieces will most likely result in many missed photographic opportunities.

A reticled eyepiece ensures that the visual and photographic focus are coincident. If the instrument does not have a reticled eyepiece, the examiner must focus through the camera rather than through the binocular eyepieces to be sure of correctly focused photographs. Reticled eyepieces are highly recommended for photocolposcopy.

Colposcopic photographs are generally made between 2× to 16× life size. One of the most vexing problems associated with photography in this magnification range is undesired movement of the subject relative to the film. The problem is exaggerated in photocolposcopy because colposcopes are designed to allow smooth, effortless motion of the instrument during focus and composition. This design feature almost ensures that the camera will not be absolutely stationary during photography. Motion of the subject relative to the camera during exposure precludes critically sharp photographs.

Very high effective shutter speeds (>1/500th second) are required to cancel the deleterious effects of camera or subject movement. Photography at lower shutter speeds will inevitably result in blurred photographs.

A flash provides a very short duration discharge of high-intensity, daylight-quality illumination. The extremely short duration negates all of the problems associated with high magnification photography and comfortably allows for photography from unsteady platforms. The daylight quality of flash illumination also allows for the use of daylight color films. Accurate color reproduction is more easily obtained with daylight balance color films, such as Kodak EPN ASA/ISO 100. A flash and camera system that allows for through-the-lens (TTL) flash metering ensures accurate exposure regardless of image magnification, flash-to-subject distance, or any other factors that might affect film exposure. Flash capabilities (with TTL exposure control) are highly rec-

ommended if photography is an important consideration in selecting a colposcope.

The stereo perception of the object is a combination of the visual fields of the two eyes. Usually, one of the eyes predominates, and most of the visual information in a stereo view is from the dominant eye. All of the scopes evaluated provided true stereo vision by allowing observation through two separate objectives.

Camera placement is critical when photographing through a stereo optical instrument. Ideally, the photographic objective should be between the two observation objectives. In this case, there will not be any discrepancies between visual and photographic composition. Compositional discrepancies between the observed and photographic fields will occur if the camera is attached to one of the observation objectives. If the camera is photographing through the same objective as the dominant eye, there will be only minor differences in composition between the stereo view and the monocular camera photograph. If the camera is photographing through the objective that the nondominant eye is using, however, there will be major differences in composition between the stereo view and monocular camera photograph.

If an optical instrument does not have a separate, centrally located photographic objective, it is imperative that the instrument allow for photography through both the right and left objectives. This will permit the photographer to focus the camera through the objective on his or her dominant side.

A camera with an autowinder and foot-switch release allows colposcopists to keep their hands on the instruments and concentrate on the examination.

Photographic Evaluation

An evaluation of the photographic capabilities of representative colposcopes was performed. Photographic observations were made at all possible magnifications. The photographic examinations also considered color, illumination uniformity, and coverage of illumination. These evaluations were made from photographs taken of an 18% gray card and a Macbeth colorchecker. Photographs were made at all available colposcopic magnifications. Photographs were made on either Kodak EPN, an ISO 100 speed daylight slide film, or Kodak ET, an ISO 160 speed tungsten slide film. Each photograph was developed by a standardized technique. Photograph examples are shown in Figure 1. Eyepiece reticles, position of the photographic objective, and presence of a flash were also considered in final photographic recommendations (Table 1).

Cabot 6000

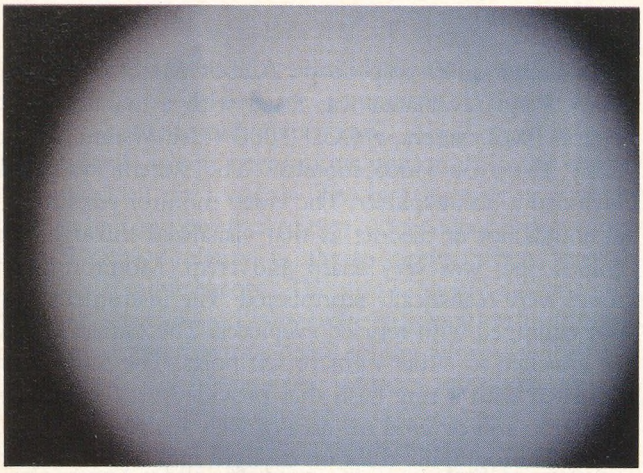
The Cabot 6000 colposcope (Cabot Medical, Langehorn, Penn) evaluated was fitted with a manual wind Nikon FM2 camera, a CCD 1000 video system, and a Sony Trinatron video monitor. The system evaluated included a beam splitter. The video monitor resolution, although not as distinct as that visualized through the colposcope, was very sharp and crisp. Monitor color tones were realistically represented. The instrument was not equipped with reticled eyepieces. The camera could be attached to either right or left ports. The scope was outfitted with a ring flash that provided very even illumination and covered the area of view for all magnifications. Photographic color on daylight film was excellent. The shutter release cable for the 35-mm camera was somewhat difficult to locate while observing the subject through the colposcope. Yet the shutter release functioned smoothly and did not compromise the colposcope stability while photographing. The Cabot colposcope photographically was very acceptable. The addition of reticled eyepieces would make the scope an excellent photographic choice.

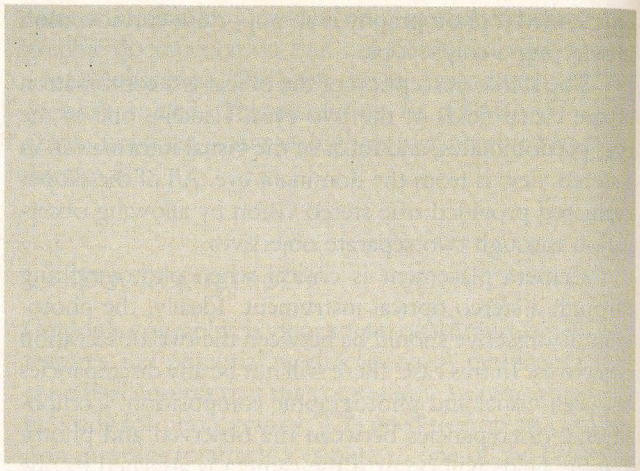
Olympus OCS-2

The Olympus system (Olympus Corporation, Lake Success, NY) contained a video unit that provided excellent monitor detail for educational purposes. The Olympus colposcope does not allow a teaching head, but this was not considered a true weakness. The modern 35-mm Olympus camera photographed through a separate, optimally centered objective. There was no shutter release cable included. On tungsten film the photographs were striated, very uneven, and markedly cool. Also, very disturbingly, the photographs were mirror imaged.

Jedmed SOM 2/5

The Jedmed SOM 2/5 system (Jedmed Instrument Co, St Louis, Mo) evaluated included a video monitor and camera that provided excellent resolution and detail. The included beam splitter made this model an attractive package for residency training programs. The video system had a CCD camera with a Panasonic CT1381Y monitor. The hooded eyepieces were not reticled. The 35-mm camera could photograph through either the right or left objectives. Photographically, the illumination was even and of sufficient area except at the lowest magnifications. The photographic color was neutral on tungsten balanced film.





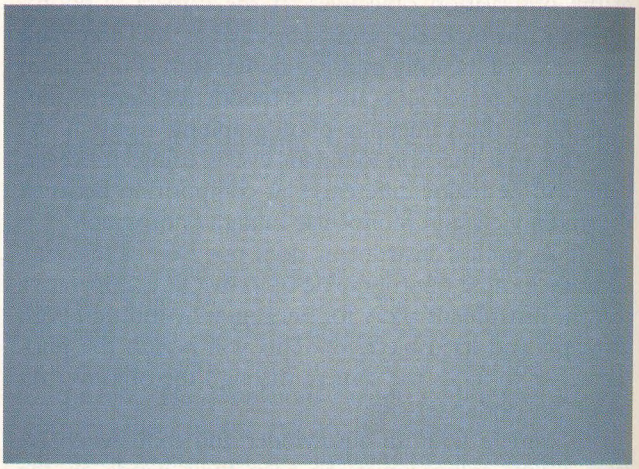


Figure 1. The colposcope photographic evaluation examples. Top, left. Zeiss (model ZMS 506-11) colpophotograph demonstrating cool color, uneven illumination, and insufficient illumination coverage. Top, right. Wallach colpophotograph demonstrating cool color, uneven illumination, and sufficient illumination coverage. Bottom. Frigitronics (model 280) colpophotograph demonstrating warm color, even illumination, and sufficient illumination coverage.

Frigitronics Zoom 310

The Frigitronics colposcope (Frigitronics, Shelton, Conn) lacks a permanent camera portal and a flash. The 35-mm camera is attached to one of the eyepieces, which makes the scope an unsuitable choice for routine colposcopic photography. Photographs on daylight film (which tend to have yellow tones) were almost perfectly neutral. The light source provided a circle of illumination that was not quite large enough for photography at the lowest magnifications. The light was mildly uneven at all magnifications.

Frigitronics 280

The eyepieces are not reticled. The unit is specifically designed for photography, with the 35-mm camera photographing through a separate centrally located objective and equipped with a flash. The flash provides adequate coverage and even illumination. Photographic color on daylight film was slightly cool. The operation of the flash unit was cumbersome: one hand was needed to swing a half-silvered mirror into place, another hand was needed to work the camera, and a third hand was required to keep the scope in focus. The power cord available for the flash unit was considered too long and the synchronization cord was too short. The 35-mm camera system was somewhat awkward and cumbersome to install and probably affected the colposcope's stability.

Zeiss ZMS 501-11

The Zeiss scope (Carl Zeiss, Inc, Thornwood, NY) is equipped with an outstanding video system positioned in a large, movable metal cabinet. The monitor resolution was superb. The complete, comprehensive video unit

Table 1. Colpophotography Specifications and Evaluation

Variables	CABOT 6000	OLYMPUS OCS-2	JEDMED SOM 2/5	FRIGI-TRONICS ZM310	FRIGI-TRONICS 280	ZEISS ZMS-501-11	ZEISS ZMS-506-11	WALLACH ZOOMSCOPE	LEISEGANG 3BD	MEDGYN AL-102
Illumination Source	Tungsten	Halogen	Xenon	Halogen	Incan-descent	Halogen	Halogen	Halogen	Halogen	Incan-descent
35 mm Camera	$2,345	$500	$850	NO	$1,045	$2,000	$2,000	$626	Included	$750
Polaroid Camera	$2,650	$720	$998	NO	$1,780	NO	NO	$565	$1,195	$689
Video System	$5,750	$4,200	$5,515	NO	$4,995	$6,000-$25,000	$6,000-$25,000	$6,810	$5,385	$4950
Beam Splitter	Included	Included	$1,195	NO	Included	$1,800	$1,800	NO	NO	NO
Photo Position	R or L	Center	R or L	R or L	Center	Center	R or L	R or L	Center	R or L
Photo Illumination	BOTH	Tungsten	Tungsten	Halogen	BOTH	Tungsten	Tungsten	Tungsten	NA	Tungsten
Flash	RING	NO	NO	NO	YES	NO	NO	NO	NA	NO
Reticles	NO	YES	NO	NO	NO	YES	NO	NO	YES	YES
Teaching Head	$1,626	NO	$1,995	NO	$1,675	$4,000-$8,000	$4,000-$8,000	NO	$1,395	NO
Factory/Repair	Japan/PA	Japan/NY	Germany/MO	Japan/CT	Japan/CT	Germany/ On-site	Germany/ On-site	/CT	Germany/FL	Japan/IL
Photo Coverage	GOOD	GOOD	LOW POWER BAD	LOW POWER BAD	GOOD	NOT AT ANY MAG	NOT AT ANY MAG	LOW POWER BAD	GOOD	GOOD
Photo Uniformity	EVEN	UNEVEN	EVEN	UNEVEN	EVEN	UNEVEN	UNEVEN	UNEVEN	EVEN	EVEN
Photo Color	NEUTRAL	VERY COOL	WARM	NEUTRAL	WARM	WARM	COOL	COOL	NEUTRAL	COOL
Recommendation	★★★★	★★	★★★	★★	★★★	★★★	★★★	★★	★★★★	★★

LEGEND	
★★★★★	Superior
★★★★	Excellent
★★★	Good
★★	Fair
★	Poor

would be a splendid addition to any operating room or residency training program.

The instrument was equipped with reticled eyepieces. The camera is mounted on the bottom center of the scope, a very comfortable position. Unfortunately, the 35-mm camera can photograph only through the right objective lens. The light source did not cover the photographic field of view at any magnification. Photographic color on tungsten film was neutral.

Zeiss ZMS 506-11

The Zeiss ZMS 506-11 scope was supplied with nonreticled eyepieces. The Contax 35-mm camera can be attached to either right or left ports. The illumination source photographed very unevenly and did not cover the field of view at any magnification. The photographs taken using tungsten film were cool.

Wallach Zoom Scope

The 35-mm camera attaches to one of the binocular eyepieces of the Wallach Zoom scope (Wallach Surgical Devices, Inc, Milford, Conn), significantly changing the weight distribution of the scope and making it cumbersome to use. This feature also makes the scope an unsuitable choice for routine colposcopic photography. The photographs shot on tungsten film had a marked blue cast and were unevenly illuminated at all magnifications.

Leisegang 3BD

The Leisegang 3BD colposcope (Leisegang Medical Inc, Boca Raton, Fla) is well adapted for photodocumentation and video systems. The video system evaluated did not have a beam splitter and, therefore, magnification was not the same as that seen through the scope. The eyepieces were reticled. The camera has a permanent attachment and the image is photographed through a centrally located objective. The unit was supplied with a flash, which on daylight film produced evenly illuminated, neutral color photographs. The scope was supplied with a Canadian Leica MP4, an unsurpassed camera. The Leisegang scope is photographically an excellent, beautifully designed scope, but the design of the camera system left much to be desired. The Leica is difficult to load and unload; in fact, it had to be removed from the scope to do either. There were many bothersome cords by the eyepiece: a cable release, a flash synchronization cord, a data imprinter cord, and a cord that moved a neutral density filter in front of the eyepieces prior to flash discharge. The Leisegang colposcope also accommodates a stereoscopic 35-mm camera. The stereoscopic three-dimensional image is re-created when viewed through an illuminated hand-held device.

Medgyn AL-102

On the Medgyn AL-102 (Medgyn Products, Inc, Downer's Grove, Ill), the 35-mm camera is mounted on one of the binocular eyepieces, rather than attached to a permanent camera portal. This feature makes the scope an unsuitable choice for routine colposcopic photography. Photographic color on tungsten film was slightly cool. Photographically, the illumination was even and of sufficient area.

Recommendations

Quality colpophotography complements sophisticated contemporary colposcopy. A colposcope video system brings new beneficial dimensions to the colposcopic examination. Either imaging technique makes routine colposcopy pleasurable and educationally practical.

The success and relative ease of colpophotography is dependent on the effective integration of certain colposcopic and camera system features. These design features are reasonably evenly split between the two. In our opinion, an ideal colpophotographic system, used for producing 35-mm projection slides or negatives, should be designed as follows:

- The system should have a permanent camera attachment portal. The scope should be designed specifically to allow for the additional weight that camera attachment produces, without affecting the overall balance or feel of the scope.
- One of the binocular observation eyepieces should contain a focusing reticle.
- The system should contain two illumination sources: an observation source (either tungsten or halogen) and a flash photographic source. The flash and camera system should be integrated to allow for TTL metering of the flash exposure.
- The camera should focus through a centrally located (relative to the two binocular objectives), independent photographic objective.
- The camera should also have autowind capabilities with a foot-switch triggering mechanism. A camera with databack facilities would also be recommended for patient identification.

Most of the colposcope/camera systems reviewed contained some of these recommended design features. It should be noted that many of the colposcopic systems allow for point-of-sale modification, which can make them more appropriate for routine colpophotography.

Every colpophotographic system evaluated enabled photographic documentation of colposcopic observations. A few systems provided better colpophotographs than others. Some systems were designed to better facilitate easy photography while performing colposcopy. In the future, computer-aided colposcopy such as that described by Crisp et al[4] may be widely available and used to archive, enhance, and analyze colposcopic images.

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