PHOTOGRAPHY AND PROSTHODONTICS

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Introduction

At some time in our lives we have all used a camera, but clinical dental photography doesn't lend itself well to the concept of "point and shoot." The nature of the environment, the small sizes and distances involved and the difficulty of access make dental photography an art as well as a science. And like science, there are rules that have to be obeyed, such as focus, exposure and composition. But as with art, results improve with practice and experience. As an adjunct to the practice of dentistry, clinical photography brings rewards such as a sense of satisfaction in a job well done, the ability to share one's work with colleagues and patients, and a great opportunity to advance our dental practice. It would be difficult to imagine any form of our existence that is not associated with photography. Its century and a half long history represents a turning point in the development of society, making life of people more rich and comprehensive. The opinion of the majority prevails that photography has influenced the conscience of people so much that the saying "an image is worth a thousand words" is accepted as an irrefutable fact.

According to Basics of Photography in Oro-facial science and its applications in Prosthodontics by Dr. Krishna Prasad D.,et al:

1) Photography is an art which is appreciated by many and has paved its way in Dentistry today. Photographs have become an integral part of specialty training programmes and have proved to be. an unparalleled tool to assist in the learning process. Today they are used for patient education, group presentations, published illustrations, maintaining records and for displaying an array of cases. It is important to understand how to take proper photographs pertaining to clinical work for diagnostic aid, learning, self- assessment and improvement.

2) Photography is considered a priceless tool in dental education. Without the proper knowledge or the proper equipment in photography, it is almost impossible to achieve quality results. Clinical photography has its greatest applications as it aids in record -keeping and also as an aid in displaying and conveying information. Furthermore it proves as an indispensable tool in self- evaluation, patient education, and communication with other colleagues.

Digital photography has today, quite sure, penetrated into all segments of life, providing new facts and perceptions in the field of science, medicine, industry, fashion design, communications and arts. The reasons for the above are probably implied, on the one hand, in its numerous advantageous features, an enviable level of technical – technological development, as well as numerous advantageous features in comparison to conventional photography on the other hand, particularly when it concerns medical documentation. Instant access of digital images to the user, promptly after shooting and possibility of efficient control of their exposition; optimal choice of illuminating the object of shooting which spares the photographer from supplying costly accessory equipment for lighting; photographing may be adjusted to different color temperatures; technical data of each photograph are automatically recorded, which makes its adequate reproduction possible; possibility of fast printing, filing, copying and sending by electronic mail to any part of the world; possibility of fast reviewing and removing of spotted errors as well as the possibility of instant deleting and repeating shooting procedures until obtaining the result desired and, eventually, economy feature of digital photography due to excluding costs for the film and its processing in the laboratory in spite of significant financial expenditure about purchasing modern photographic equipment.

According to Digital Photography in Dentistry: Techniques and Clinical importance by Carlos Henrique Theodoro Batista et al, Dentistry has benefited from the trends and advances in digital photography, and a well designed protocol of dental photography may be a great contribution for the orthodontic practice. Digital records may be used for several purposes, including patient records, treatment evaluation, patient counseling, didactic and medico-legal uses, as well as to present the quality of procedures for marketing purposes. A good for dental photography protocol may greatly enhance the dental practice. This article describes scientific and technical information in detail to provide a guide for dentists

who wish to use photography more effectively. This article also addresses some relevant questions for the selection and applicable settings of semiprofessional and compact digital camera systems to enhance the achievement of good-quality and well-focused photographs.

Intraoral photography is a part of contemporary dental practice. Intraoral conditions which in the course of dental treatment are subject to change can be recorded in detail by means of photographs. These provide an improved documentation and the option of monitoring particular situations over longer periods of time. With the right skills and photographic methods, the clinician enhances communication with the patient regarding treatment planning. This article emphasizes types of camera and the accessories for intraoral photography which enables the practitioner to make standardized photographic documentation of cases.

THE VARIOUS IMAGES TAKEN IN PROSTHODONTICS ARE:	
Full-Face (Smiling)	Full-Face (repose)
Smile	Full-Face (smiling)
Right Smile	Profile
Left Smile	Anterior (retracted)
Anterior (retracted)	Right Buccal (retracted)
Right Anterior (retracted)	Left Buccal (retracted)
Left Anterior (retracted)	Maxillary Occlusal
Anterior Close-up (retracted)	Mandibular Occlusal
Right Anterior Close-up (retracted)	
Left Anterior Close-up (retracted)	
Maxillary Occlusal	
Mandibular Occlusal	

Each particular patient or clinical circumstance may dictate the need for a specific intraoral or extraoral image. In general, practitioners should capture 8 basic views to record a patient's clinical condition during the initial patient visit. Additional views may be captured as needed based on the patient's clinical findings or treatment provided. The 8 basic views are:

Full-face smiling

Full – face profile

Full – smile

Anterior (frontal view retracted)

Right buccal retracted

Left buccal retracted

Maxillary occlusal

Mandibular occlusal.

The purpose of this article is to present tips and tricks to help capture these 8 basic views with a focus on the use of point and shoot and DSLR cameras. Exact camera settings will vary by type or camera used. Knowing how to capture each image consistently and predictably will help practitioners increase efficiency and reduce wasted chair time.

HISTORY OF DIGITAL PHOTOGRAPHY

The coining of the word "photography" is usually attributed to Sir John Herschel in 1839. It is based on the Greek, (genitive: phōtós) meaning "light", and graphê, meaning "drawing, writing", together meaning "drawing with light".

Photography is the result of combining several different technical discoveries. Long before the first photographs were made, Greek mathematicians Aristotle and Euclid described a pinhole camera in the 5th and 4th centuries BCE. In the 6th century CE, Byzantine mathematician Anthemius of Tralles used a type of camera obscura in his experiments .

Ibn al-Haytham (Alhazen) (965 in Basra – c. 1040 in Cairo) studied the camera obscura and pinhole camera, Albertus Magnus (1193/1206–80) discovered silver nitrate, and Georges Fabricius (1516–71) discovered silver chloride. Daniel Barbaro described a diaphragm in 1568. Wilhelm Homberg described how light darkened some chemicals (photochemical effect) in 1694. The novel Giphantie (by the French Tiphaigne de la Roche, 1729–74) described what could be interpreted as photography.

In 1614, Angelo Sala demonstrated that "powdered silver nitrate is blackened by the sun",as was paper that was wrapped around it. This discovery of the sun's effect on powdered silver nitrate was not supported and was subsequently disregarded by then-respected scientists who said that his discovery "had no practical application."

Around 1717, Johann Heinrich Schulze, a German professor of anatomy and physics, set down a bottle containing silver nitrate and chalk by the window and unintentionally in the path of incoming light from the sun. The mixture, unsurprisingly, turned dark. But what he noticed and found to be strange was that part of it remained white and formed a line across the bottle. He then observed a cord hanging down and going across in front of the window, which he found out to be the cause. On further examination, he found that the entire mixture inevitably reverted to its original white color. Experimenting further, Schulze succeeded in transferring words he pasted on the bottle printed into the substance.

Describing his achievement, Schulze wrote that “the sun’s rays, where they hit the glass through the cut- out parts of the paper, wrote each word or sentence on the chalk precipitate so exactly and distinctly that many who were curious about the experiment but ignorant of its nature took occasion to

attribute the thing to some sort of trick." He put the silver nitrate in an oven, which had no effect on its color. This proved to him, definitively, that heat had not facilitated the transformation, as popularly suspected. Rather, it was the light.

In 1777, the chemist Carl Wilhelm Scheele was studying the more intrinsically light-sensitive silver chloride and determined that light darkened it by disintegrating it into microscopic dark particles of metallic silver. Of greater potential usefulness, Scheele found that ammonia dissolved the silver chloride but not the dark particles. This discovery, which could have been used to stabilize or "fix" a camera image captured with silver chloride, was little-noticed at the time and unknown to the earliest photography experimenters.

It was not until around the year 1800 that Thomas Wedgwood made the first known attempt to capture the image in a camera obscura by means of a light-sensitive substance. He used paper or white leather treated with silver nitrate. Although he succeeded in capturing the shadows of objects placed on the surface in direct sunlight, and even made shadow-copies of paintings on glass, it was reported in 1802 that " the images formed by means of a camera obscura have been found too faint to produce, in any moderate time, an effect upon the nitrate of silver." The shadow images eventually darkened all over because "no attempts that have been made to prevent the uncoloured part of the copy or profile from being acted upon by light have as yet been successful. Wedgwood may have prematurely abandoned his experiments due to frail and failing health; he died aged 34 in 1805.

In 1816 Nicéphore Niépce, using paper coated with silver chloride, succeeded in photographing the images formed in a small camera, but the photographs were negatives, darkest where the camera image was lightest and vice versa, and they were not permanent in the sense of being reasonably light-fast; like earlier experimenters, Niépce could find no way to prevent the coating from darkening all over when it was exposed to light for viewing. Disenchanted with silver salts, he turned his attention to light-sensitive organic substances.

Color Process

A practical means of color photography was sought from the very beginning. Results were demonstrated by Edmond Becquerel as early as 1848, but exposures lasting for hours or days were required and the captured colors were so light-sensitive they would only bear very brief inspection in dim light.

The first durable color photograph was a set of three black-and-white photographs taken through red, green and blue color filters and shown superimposed by using three projectors with similar filters. It was taken by Thomas Sutton in 1861 for use in a lecture by the Scottish physicist James Clerk Maxwell, who had proposed the method in 1855. The photographic emulsions then in use were insensitive to most of the spectrum, so the result was very imperfect and the demonstration was soon forgotten. Maxwell's method is now most widely known through the early 20th century work of Sergei Prokudin-Gorskii. It was made practical by Hermann Wilhelm Vogel's 1873 discovery of a way to make emulsions sensitive to the rest of the spectrum, gradually introduced into commercial use beginning in the mid-1880s.

Two French inventors, Louis Ducos du Hauron and Charles Cros, working unknown to each other during the 1860s, famously unveiled their nearly identical ideas on the same day in 1869. Included were methods for viewing a set of three color-filtered black-and-white photographs in color without having to project them, and for using them to make full-color prints on paper.

The first widely used method of color photography was the Autochrome plate, a process inventors and brothers Auguste and Louis Lumière began working on in the 1890s and commercially introduced in 1907.[33] It was based on one of Louis Ducos du Hauron's ideas: instead of taking three separate photographs through color filters, take one through a mosaic of tiny color filters overlaid on the emulsion and view the results through an identical mosaic. If the individual filter elements were small enough, the three primary colors of red, blue, and green would blend together in the eye and produce the same additive color synthesis as the filtered projection of three separate photographs.

Autochrome plates had an integral mosaic filter layer with roughly five million previously dyed potato grains per square inch added to the surface. Then through the use of a rolling press, five tons of pressure were used to flatten the grains, enabling every one of them to capture and absorb color and their microscopic size allowing the illusion that the colors are merged together. The final step was adding a

coat of the light capturing substance silver bromide after which a color image could be imprinted and developed. In order to see it, reversal processing was used to develop each plate into a transparent positive that could be viewed directly or projected with an ordinary projector. One of the drawbacks of the technology is an exposure time of at least a second was required during the day in bright light and the worse the light is, the time required quickly goes up. An indoor portrait required a few minutes with the subject not being able to move or else the picture would come out blurry. The reason for this is due to the fact that the grains absorb the color fairly slow, and that a filter of a yellowish-orange color was added to the plate to keep the photograph from coming out excessively blue. Although necessary, the filter had the effect of reducing the amount of light that was absorbed. Another drawback was that the film could only be enlarged so much until the many dots that make up the image become apparent.

Competing screen plate products soon appeared and film-based versions were eventually made. All were expensive and until the 1930s none was "fast" enough for hand-held snapshot-taking, so they mostly served a niche market of affluent advanced amateurs.

A new era in color photography began with the introduction of Kodachrome film, available for 16 mm home movies in 1935 and 35 mm slides in 1936. It captured the red, green and blue color components in three layers of emulsion. A complex processing operation produced complementary cyan, magenta and yellow dye images in those layers, resulting in a subtractive color image. Maxwell's method of taking three separate filtered black-and-white photographs continued to serve special purposes into the 1950s and beyond, and Polachrome, an "instant" slide film that used the Autochrome's additive principle, was available until 2003, but the few color print and slide films still being made in 2015 all use the multilayer emulsion approach pioneered by Kodachrome.

ADVENT OF DIGITAL PHOTOGRAPHY

The history of photography has roots in remote antiquity with the discovery of the principle of the camera obscura (a dark room) and the observation that some substances are visibly altered by exposure to light. As far as is known, nobody thought of bringing these two phenomena together to capture camera images in permanent form until around 1800, when Thomas Wedgwood made the first reliably documented although unsuccessful attempt. In the mid-1820s, Nicéphore Niépce succeeded, but several days of exposure in the camera were required and the earliest results were very crude. Niépce's associate Louis Daguerre went on to develop the daguerreotype process, the first publicly announced photographic process, which required only minutes of exposure in the camera and produced clear, finely detailed results. It was commercially introduced in 1839, a date generally accepted as the birth year of practical photography.

The metal-based daguerreotype process soon had some competition from the paper-based calotype negative and salt print processes invented by William Henry Fox Talbot. Subsequent innovations reduced the required camera exposure time from minutes to seconds and eventually to a small fraction of a second; introduced new photographic media which were more economical, sensitive or convenient, including roll films for casual use by amateurs; and made it possible to take pictures in natural color as well as in black-and-white.

The commercial introduction of computer-based electronic digital cameras in the 1990s soon revolutionized photography. During the first decade of the 21st century, traditional film-based photochemical methods were increasingly marginalized as the practical advantages of the new technology became widely appreciated and the image quality of moderately priced digital cameras was continually improved.

In 1981, Sony unveiled the first consumer camera to use a charge-coupled device for imaging, eliminating the need for film: the Sony Mavica. While the Mavica saved images to disk, the images were displayed on television, and the camera was not fully digital. In 1991, Kodak unveiled the DCS 100, the first commercially available digital single lens reflex camera. Although its high cost precluded uses other than photojournalism and professional photography, commercial digital photography was born. Digital imaging uses an electronic image sensor to record the image as a set of electronic data

rather than as chemical changes on film.[31] An important difference between digital and chemical photography is that chemical photography resists photo manipulation because it involves film and photographic paper, while digital imaging is a highly manipulative medium. This difference allows for a degree of image post-processing that is comparatively difficult in film-based photography and permits different communicative potentials and applications.Digital photography dominates the 21st century. More than 99% of photographs taken around the world are through digital cameras, increasingly through smartphones.

DIGITAL CAMERA MEASUREMENTS

Digital cameras capture images as elements, known as pixels. A megapixel is equal to one million pixels. The more pixels contained in an image, the higher the image resolution. Resolution relates primarily to print size and the amount of detail in an image when viewed on a computer monitor at 100% magnification.

Images with more megapixels yield better print images. Many amateur and professional digital photographers crop their photographs, sometimes reducing them dramatically in size, to focus on the key element of the image. Obviously, the more pixels in an image, the more can be cropped while retaining a useful image.

I consider that six megapixels is sufficient for use in clinical digital photography. It gives one the ability to use the images for presentation to patients and for lectures using software such as Microsoft Power Point (www.microsoft.com) or open-source software that can be obtained from the Internet, such is Open Office (www.openoffice.org), and to print reasonable size images (300 X 450 mm) for poster presentations.

The images are stored on a Compact Flash card (CF card) or Secure Digital card (SD card), for example. There are many file types (RAW, JPEG and TIFF) that all serve different purposes. A RAW file is comparable to the latent image contained in an exposed but undeveloped piece of film. This means that the photographer is able to extract the maximum image quality possible, whether now or in the future. This format is mostly used in professional photography.

A JPEG file is a file that is compressed and when saved loses its quality. This results in a lower quality and smaller image file. For, many applications, the image quality is more than sufficient. The smaller files also make it easier to transmit electronically. A TIFF file is also compressed but the file does not lose quality upon being saved; therefore, TIFF files are larger than JPEG files. TIFF format images can be utilised in presentation software, the only drawback being that the software may run more slowly owing to a larger file format. I am inclined to use the JPEG Fine format to save the images, as they are easily transferred to the computer and can be used for presentation purposes.

TERMINOLOGIES

The camera is the image-forming device, and a photographic plate, photographic film or a silicon electronic image sensor is the capture medium. The respective recording medium can be the plate or film itself, or a digital magnetic or electronic memory.

Photographers control the camera and lens to "expose" the light recording material to the required amount of light to form a "latent image" (on plate or film) or RAW file (in digital cameras) which, after appropriate processing, is converted to a usable image. Digital cameras use an electronic image sensor based on light-sensitive electronics such as charge-coupled device (CCD) or complementary metal- oxide-semiconductor (CMOS) technology. The resulting digital image is stored electronically, but can be reproduced on a paper.

The camera (or 'camera obscura') is a dark room or chamber from which, as far as possible, all light is excluded except the light that forms the image. The subject being photographed, however, must be illuminated. Cameras can range from small to very large, a whole room that is kept dark while the object to be photographed is in another room where it is properly illuminated. This was common for reproduction photography of flat copy when large film negatives were used.

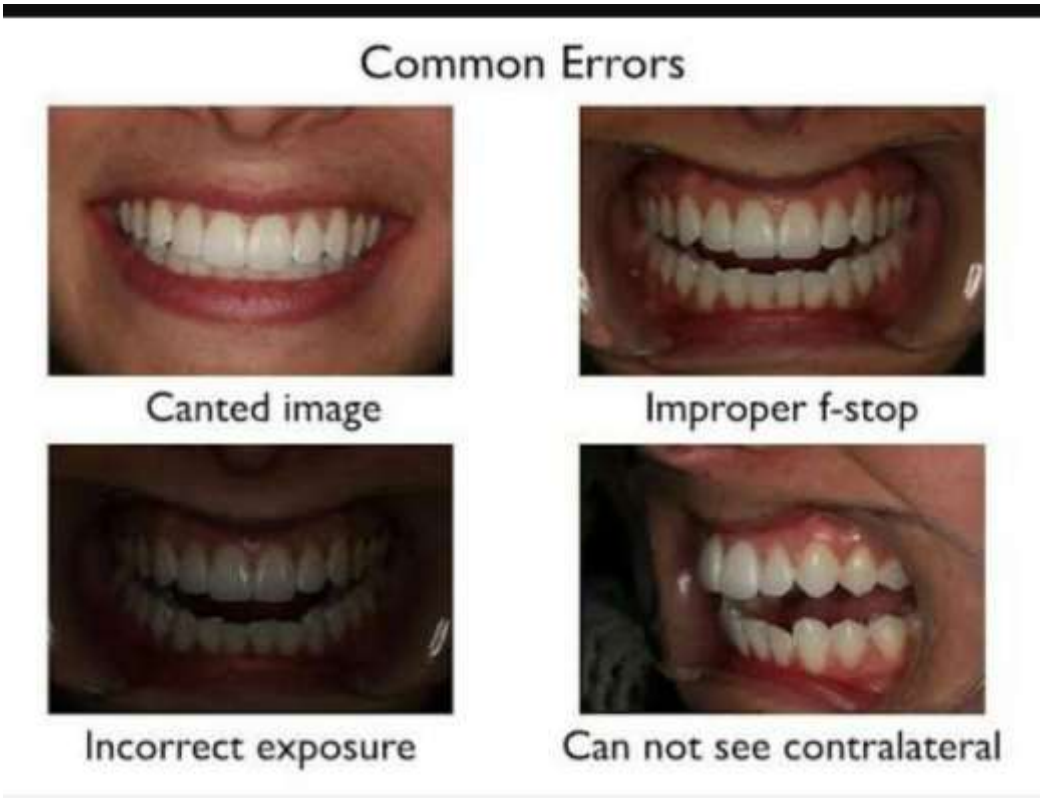
As soon as photographic materials became "fast" (sensitive) enough for taking candid or surreptitious pictures, small "detective" cameras were made, some actually disguised as a book or handbag or pocket watch (the Ticka camera) or even worn hidden behind an Ascot necktie with a tie pin that was really the lens.

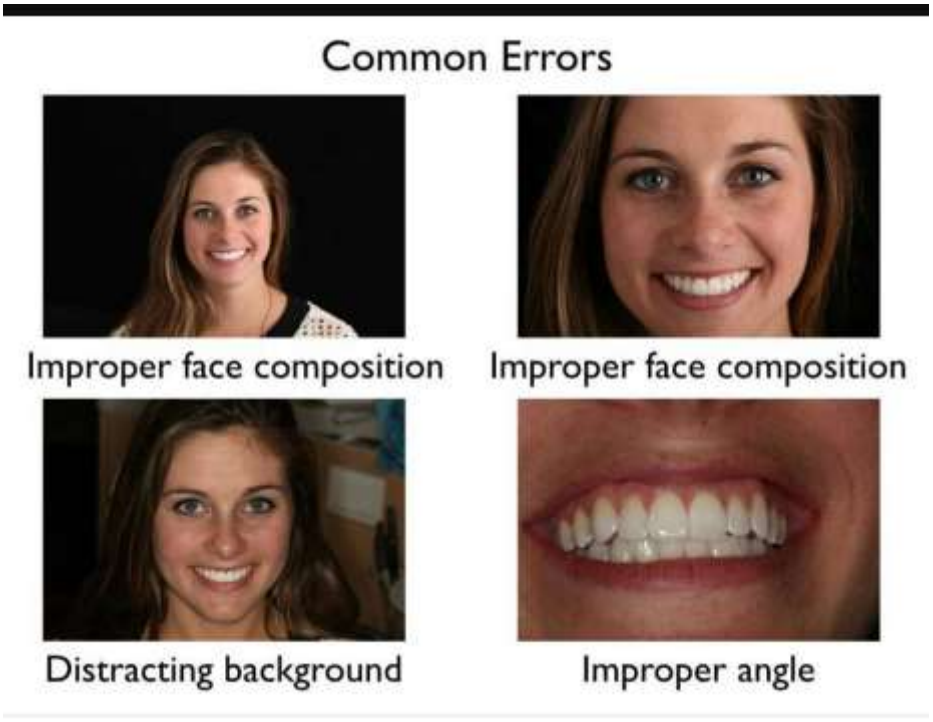
The movie camera is a type of photographic camera which takes a rapid sequence of photographs on recording medium. In contrast to a still camera, which captures a single snapshot at a time, the movie camera takes a series of images, each called a "frame". This is accomplished through an intermittent mechanism. The frames are later played back in a movie projector at a specific speed, called the "frame rate" (number of frames per second). While viewing, a person's eyes and brain merge the separate pictures together to create the illusion of motion.

Many other elements of the imaging device itself may have a pronounced effect on the quality and/or aesthetic effect of a given photograph among them are:

Focal length and type of lens (normal, long focus, wide angle, telephoto, macro, fisheye, or zoom) Filters placed between the subject and the light recording material, either in front of or behind the lens Inherent sensitivity of the medium to light intensity and color/wavelengths.

UNDERSTANDING DSLR CAMERA CONTROLS





When they were first introduced, digital SLR cameras were enormously expensive and a tool for professionals only. Since then, they have come down in price into the consumer price range. Because

of this, many people buy digital SLRs without understanding how they work and, consequently, not making use of most of the features in the camera.

In this article, I will take you through the most common functions the DSLRs have, and teach you the different features and how to use them. The principles are the same for any camera, irrespective of the make.

After you have bought a DSLR and, on unpacking if from the box, you are intimated by the number of buttons and dials, and by the thickness of the manual, it can be very tempting to put the manual down, flick it onto 'Auto' and start shooting. Whilst that is fine for some, it may not be long until you crave the creative control that inspired you to purchase a DSLF in the first place, but where do you begin?

If you consider yourself a beginner and not sure of how to make the most of your camera, understand your camera well. You have to take your camera off the 'auto' mode, and take control of our DSLR. This article isn't a replacement for your camera manual and it will not explain every in great detail, but will highlight the basics and give you the key topics to go back to your annual to read.

Shooting modes

To start with let us discuss the shooting modes. The shooting modes are found on a dial labeled with 'auto,Av, Tv, P,M' and may be more. The shooting mode will decide how your camera behaves when you press the shutter. When 'auto' is selected, the camera will determine everything to do with the exposure, including the aperture and shutter speed. The other modes, 'Av, Tv, P,M', are for your to set the controls as per your requirement.

Aperture Priority (Av or A)

Aperture priority can be a useful shooting mode. When this is selected, you set the aperture and the camera will automatically select the shutter speed. The aperture is the size of the opening in the lens through which light is allowed to pass whenever the shutter is opened- the larger the aperture, the more light passes through.

The aperture is measured in ‘f-stops’ and is displayed using an ‘f-number’ e.g., f/2.0, f/2.8/4.0,f/5.6, f/8.0 etc, which is a ratio of length over diameter of the opening. Therefore, a larger aperture (a wider opening) has a f-number (e.g. f/2.0) and smaller aperture (a narrower opening) has a larger f-number (e.g. f/22).

Shutter Priority (Tv or S)

Similar to aperture priority, this is another popular shooting mode. Here you set the shutter speed and the camera will take care of the aperture. The shutter speed, measured in seconds is the amount of time the shutter stays open when making a photograph. The longer the shutter stays open, the more light passes through to the sensor to be captured.
Program (P)

Program mode is almost a halfway between the aperture or shutter priority and full manual control. In program mode, you are able to set either the aperture or shutter speed, and the camera will maintain the correct exposure by adjusting the other one accordingly, i.e., as you change the aperture, the shutter speed will automatically change, and vice versa.

Manual (M)

Manual mode is something you should try after some experience, where you decide on both the aperture and shutter speed yourself.

ISO

ISO is a measure of how sensitive the sensor of your camera is to light. The term originated in film photography, where film of different sensitivities could be used depending o the shooting conditions, and it is no different in digital photography. The ISO sensitivity is represented numerically fro ISO 100 (low sensitivity) up to ISO 6400 (high sensitivity) and beyond, and controls the amount of light required by the sensor to achieve a given exposure.

At ‘low’ sensitivities, more light is required to achieve a given exposure compared to high sensitivities where less light is required to achieve the same exposure. For example, if shooting outside, on a bright

sunny day there is a lot of available light that will hit the sensor during an exposure, meaning that the sensor does not need to be very sensitive in order to achieve a correct exposure. Therefore, you could use a low ISO number, such ISO 100 or 200. If shooting in low light conditions, such as inside a dark cathedral or museum for example, there is not much light available for your camera sensor. A high ISO number, such as ISO 3200 will increase the sensitivity of the sensor, effectively multiplying the small amount of available light to give you a correctly exposed image. This multiplication effect comes with a side effect of increased noise on the image, which looks like a fine grain, reducing the overall image quality. The noise will be most pronounced in the darker/shadow.

What is ISO?

In traditional (film) photography ISO (or ASA) was the indication of how sensitive a film was to light. It was measured in numbers (you've probably seen them on films – 100, 200, 400, 800 etc.). The lower the number the lower the sensitivity of the film and the finer the grain in the shots you're taking.
In Digital Photography ISO measures the sensitivity of the image sensor. The same principles apply as in film photography – the lower the number the less sensitive your camera is to light and the finer the grain.

Higher ISO settings are generally used in darker situations to get faster shutter speeds. For example an indoor sports event when you want to freeze the action in lower light. However the higher the ISO you choose the noisier shots you will get. I'll illustrate this below with two enlargements of shots that I just took – the one on the left is taken at 100ISO and the one of the right at 3200 ISO (click to enlarge to see the full effect).We can see larger sized images of both shots here for the 100 ISO and here for the 3200 ISO.

100 ISO is generally accepted as 'normal' and will give you lovely crisp shots (little noise/grain).

Most people tend to keep their digital cameras in 'Auto Mode' where the camera selects the appropriate ISO setting depending upon the conditions you're shooting in (it will try to keep it as low as possible) but most cameras also give you the opportunity to select your own ISO also.

When you do override your camera and choose a specific ISO you'll notice that it impacts the aperture and shutter speed needed for a well exposed shot. For example – if you bumped your ISO up from 100 to 400 you'll notice that you can shoot at higher shutter speeds and/or smaller apertures.

ISO 200 and ISO 3200 comparison

The difference is clear – the image on the right hand side at ISO 3200 has a lot more noise in it, than the one on the left at ISO 200.Every camera has something called "Base ISO", which is typically the lowest ISO number of the sensor that can produce the highest image quality, without adding noise to the picture. On most of the new Nikon cameras such Nikon D5100, the base ISO is typically 200, while most Canon digital cameras have the base ISO of 100. So, optimally, you should always try to stick to the base ISO to get the highest image quality. However, it is not always possible to do so, especially when working in low-light conditions. Typically, ISO numbers start from 100-200 (Base ISO) and increment in value in geometric progression (power of two). So, the ISO sequence is 100, 200, 400, 800, 1600, 3200, 6400 and etc. The important thing to understand is that each step between the numbers effectively doubles the sensitivity of the sensor. So, ISO 200 is twice more sensitive than ISO 100, while ISO 400 is twice more sensitive than ISO 200. This makes ISO 400 four times more sensitive to light than ISO 100, and ISO 1600 sixteen times more sensitive to light than ISO 100, so on and so forth. It means when a sensor is sixteen times more sensitive to light ,it needs sixteen times less time to capture an image.

ISO Speed Example:

ISO 100-1 second

ISO 200-1/2 of a second ISO 400-1/4 of a second ISO 800-1/8 of a second ISO 1600-1/16 of a second ISO 3200-1/32 of a second

In the above ISO Speed Example, if your camera sensor needed exactly 1 second to capture a scene at ISO 100, simply by switching to ISO 800, you can capture the same scene at 1/8th of a second or at 125 milliseconds! That can mean a world of difference in photography, since it can help to freeze motion.

Black Skimmers

Black Skimmers. 1/200th of a second at ISO 800.

1) Capturing these Black Skimmers at 1/2000th of a second at ISO 800.Camera sensor only needed 1/200th of a second to fully capture this photograph. If only ISO 100 is there then it would have needed 8 times more time to capture the same scene, which is 1/250th of a second. At that speed, it would have introduced motion blur into a picture, because the birds were moving faster than that.
2) When to use low ISO of your camera, which is typically ISO 100 or 200. When there is plenty of light, you should always use the lowest ISO, to retain the most detail and to have the highest image quality. There are some cases where you might want to use low ISO in dim or dark environments – for example, if you have your camera mounted on a tripod or sitting on a flat surface. In that case, bear in mind that your camera will most likely need more time to capture the scene and anything that is moving is probably going to look like a ghost.
3) When to increase ISO. We should increase the ISO when there is not enough light for the camera to be able to quickly capture an image. Anytime we shoot indoors without a flash, we set our ISO to a higher number to be able to freeze motion. Other cases where you might want to increase ISO are when you need to get ultra-fast shots.

   On many of the newer DSLRs, there is a setting for "Auto ISO", which works great in low-light environments. The beauty of this setting, is that we can set the maximum ISO to a certain number, so when the ISO is automatically increased based on the amount of light, it does not cross the set barrier. So, if we want to limit the amount of grain in pictures, we typically set the maximum ISO to 800.

Focussing

Regardless of what shooting mode you are using, or what ISO you define, the chances are there will be a subject of your image that you want to have in focus. If that focus is not achieved, the image will not be what you wanted.

Autofocus modes

DSLRs come with a range of autofocus modes, however, for simplicity; the two that are most important to understand are AF-S and AF-C.
AF-S is autofocus-single used when taking photos of stationary subjects such as portraits of people, landscapes, buildings etc. AF-C is autofocus-continuous used when taking photos of action or moving subjects such as sports and wildlife.

Focus Points

Both of those focus modes rely on what are known as focus points. When you look through the viewfinder, you should see a number of squares/dots overlaid across the screen. When you half-press the shutter, you should see one of these squares be highlighted in red. That is the active focus point, and it is that position within the frame that the camera is focusing on.

File type and size

In the menu, there is the option of choosing whether to record the images as ‘raw’ or ‘jpeg’ file type. A raw file is uncompressed, and so contains a lot of image data that allows for a lot of flexibility during post-processing but also comes with additional complications such as the need to ‘process’ every file using dedicated editing software and a larger file size. A jpeg is a compressed file type that is automatically processed by the camera. They will be ‘print ready’ straight out of the camera, and are much smaller files, meaning you can fit more images per memory card.

You also have the option to be able to change the size of the images that your camera records, and in which file type. You want to set the file size to the largest possible (whether it is ‘large’ or ‘fine or‘super fine’) to ensure that you are making the most of the mega pixels that you have just invested in. The cameras also tell you how many images you would get for the storage card you are using depending on the type and size of the file.

White Balance.

If you are shooting in jpeg, you will need to make sure you set your white balance before taking a picture. The white balance can significantly impact colour tone of your photographs. Different light sources (such as the sun, light bulbs, etc) emit light of different wavelengths, and therefore colours, which can be described by what is known as colour temperature. There are a number of presets built into your camera that help to overcome the different colours of light and to make sure the camera will capture the colours of the scene accurately. The 'auto' feature (auto WB or AWB) will attempt to predict the colour of the light by detecting the predominant colour of the scene and then countering it, however it may not necessarily make a correct decision, leaving you with inaccurate colours. Therefore it is best to set the colour balance as per your choice before you take your image.

Auto	**Daylight**	**Shade**	**Cloudy**
AWB			
Custom	**Flash**	**Fluorescent light**	**Tungsten**

Day light-To be used on clear sunny days.

Cloudy-To be used when shooting on a cloudy day. Adds warm tones to daylight images.

Shade-To be used if shooting in the shade, as handed areas generally produce cooler, bluer images, so need warming up. Tungsten-Used for shooting indoors, under in-..andescent light bulbs, or under street lights, to cool down the yellow tones. Fluorescent-Compensates for the green/blue tones of fluorescent light strips when shooting indoors.Flash-the flash will add a cool blue cast to the image, so used to add some warmth.

DIGITAL EQUIPMENT

The advent of digital technology allowed the popularization of digital cameras thanks to the technological developments that allowed the commercial availability of equipments of different brands, models, features and price. Since the costs of these equipments have been reducing, a good cost-benefit relationship may be achieved. Consequently, selection of the most suitable equipment for clinical photographs became more difficult and doubtful. Selection among the hundreds of models available in the market requires knowledge on digital photography, which changes rapidly yet maintains similar characteristics with conventional photography.

Machado et al investigated the accuracy of orthodontists in differentiating conventional and digital photographs as well as checking their quality. For that purpose, ten digital and ten conventional photographs of excellent quality were printed on photographic paper with a resolution of 400 dots per inch (DPI) in a professional digital lab. The examiners indicated if the images had been obtained by conventional or digital cameras and judged the quality of each photograph. The authors concluded that the quality of digital photography is well acceptable for application in Orthodontics.

No specific photographic equipments are available for use in dentistry, yet the knowledge on the resources of either conventional or digital cameras is important for the achievement of high- quality photographs. It should be noted that the same equipment should allow the achievement of extraoral and intraoral photographs with the same standard.

Compact semiprofessional and professional equipments are commercially available, yet the latter are the most suitable for application in clinical practice because they are equipped with single lens reflex (SLR) lenses, macro lenses of 50 mm or preferably 100 mm, and external ring flash for perfect illumination of the field. These sophisticated equipments require training and knowledge on photographic techniques to ensure satisfactory results. Nevertheless, semiprofessional and compact equipments may also allow the achievement of photographs with acceptable quality, provided some prerequisites and knowledge on photography are available.

In digital systems, image capture is performed by an electronic device called charge- coupled device (CCD), in which the thinner the dimensions of the CCD, the greater will be the amount of details in the image.(1) The CCD is used instead of conventional films and has the function to convert light into

electrical energy. It consists of a grid of electrodes and a silicon layer comprising a chip, i.e. the sensors are in charge of capturing the image. It is related to the digital camera as the microprocessor is related to the computer, constituting the heart and mind of this system.

Conversion of the image known as one pixel, which is the basic unit of image detail, is derived from the abbreviation of picture element.Pixel is a single point that forms the image, corresponding also to the grain on the conventional paper images. The greater .the number of pixels, the higher the image resolution or its fidelity, in which all photographs are the same size, but have different resolutions in pixels.

BASIC FUNCTIONS

There are four exposure settings (modes) in the majority of DSLR cameras and all employ a through-the-lens metering system:

APERTURE PRIORITY

The aperture is the lens opening. So the aperture control allows the photographer to control how far the lens is opened when a picture is taken. The farther the lens is opened, the greater the amount of light that is allowed into the camera and the lighter the exposure. Once the aperture value has been selected, the camera automatically selects the correct shutter speed to produce an acceptable exposure. By setting the aperture value, the photographer decides on the depth of field (the plane of sharp focus) in the image. One can select a small aperture value (a high f-number) for a larger plane of sharp focus and a large aperture value (a small f-number) for a narrow plane.

A depth of field problem is that the entire dentition can only be photographed completely in sharp focus if the focal plane is positioned carefully. Therefore, do not focus on the anterior teeth .For a frontal view, the point of focus should be around the canines.

SHUTTER PRIORITY.

The shutter speed controls the amount of light that enters the lens when the picture is taken. The more light desired, the slower the photographer should set the shutter speed. Once the shutter speed has been

selected, the camera automatically selects the correct aperture value to produce an acceptable exposure. This mode is not used for the purpose of intra-oral photography.

PROGRAM

The camera automatically selects both the aperture and shutter speed based on a built-in program.

MANUAL

The photographer selects both the aperture and shutter speed, but the camera's built-in-meter can still be used to calculate the correct exposure. For dental photography, it is important to be in control of the exposure features. Therefore, either the aperture priority or manual exposure settings are preferable.

SELECTION OF EQUIPMENT

Most of the dental specialists today have a fair idea on how to take a photograph. The difference lies in selection of the right equipment. With the recent advances in photography, from manual to digital the decision becomes very complicated. Not only can the wrong choice give poor results, such as distortion of the image's perspective, poor lighting, lack sharpness but it could also cost a lot of money.

In general, there are 3 components to consider when it comes to dental photography : the lens, the flash and the camera itself. These 3 components comprise the standard setup. In the case of a point and shoot camera all 3 components are in one package; by comparison, a DSLR camera will require an additional lens and flash.

Additional equipment required for the basic dental photographic series includes a solid-color non-distracting background, cheek retractors buccal mirrors and occlusal mirrors.

CAMERAS

Types of cameras
Cameras are broadly divided into three main types:

Those based on the single lens reflex (SLR camera) design with interchangeable lenses.

Those based on a compact design where the lenses are not interchangeable - Digital camera and intraoral camera.

Digital SLR camera (combination of Digital and SLR camera). Because of the need for photography to be done on-site, most camera systems are kept chair side or in close proximity within the clinic. The camera system could include (in most instances), a 35mm s ingle lens reflex system (SLR) camera, a lens capable of close-up photography, an electronic flash, mirrors and retractors. The specific brand of camera is not important, but rather the camera system capable of doing the required functions and being simple to operate is most important. Most dental photography is done with 35mm SLR camera systems, and of course digital cameras.

Digital SLR (single-lens reflex) cameras are high-end cameras designed for semi professionals to professionals .Recently, most of the major camera brands have developed a range of affordable DSLRs, allowing us to develop our clinical photography skills over time to achieve higher standards in our practice.

DSLR cameras have the advantages of interchangeable lenses, including macro and telephoto, metered lenses, and ports for accessory flashes, such as ring flash or a dual flash system. One can also choose between manual focus and autofocus cameras. Although the modern camera can control a number of key settings relating to the exposure and flash levels, these can normally be set manually.

These types of cameras can be expensive and bulky to use for clinical photography. A good number of the point-and shoot style of digital cameras are available at reasonable prices and take excellent clinical photographs even at a macro level. I have been using a Nikon Coolpix 4500 (Figs 2 & 3) since 2003, which allows macro images up to 2 cm from the object and with which I have obtained good results (Figs. 6-14). The advantages of the smaller point and – shoot style cameras over DSLRs is that they are less bulky, lightweight and compact, and work well for most clinical cases. There is also no need for multiple lens changes.

Single Lens Reflex (SLR) camera system:

SLR camera used in dental photography has two main parts, its body and lens. The camera body can influence the ease in which good results of photography can be obtained; by offering the photographer additional features such as auto-exposure and auto advance. Cameras that are manual will function perfectly adequate, however cameras with auto exposure allow for more concentration on the patient and not photography. The use of a SLR is valuable for several reasons i.e. there are a variety of films to choose, it is compact and easy to use, but probably the most important is that they can utilize

interchangeable lenses. Obtaining the highest quality photographs is facilitated with a close-up lens that is inscribed with reproduction numbers. Good quality lenses come inscribed with these numbers allowing for standardization of views, magnifications and exposure information.

Digital Camera system:

Digital photography has become very popular and its application to dentistry offers many advantages. This allows photographic freedom, immediate review of pictures and most cost effective. They have a LCD screen so that the pictures can be reviewed and poor quality pictures can be deleted. The digital photographs can be directly placed in continuing education presentations without having to wait for them to be processed by a photolab. In the near future, dentists will likely to be involved in teleconsulting and teleconferencing. The consultants can be e-mail the pictures and radiographs for review, without the referring dentist having to travel to the consultant's office. Choosing the right digital camera is not an easy task.

Digital cameras are more computer-centric than conventional cameras. In comparison with the latter cameras, digital cameras use chargecoupled device (CCD) or complementary metal oxide semiconductor (CMOS), instead of the conventional film. It is this chip that converts the light entering the camera into an electrical signal, which eventually ends up as the digital image. The recorded image can be viewed on a LCD screen on the rear of the camera. Subsequently, it can be downloaded to a computer to edit, print, send as email, or post in albums to share with others on the Internet. However, the quality of images shot with digital cameras is lower than of images recorded on chemical films.The heart of any digital camera is the CCD.

The individual areas on the CCD, which register the light falling onto them, are photodiodes, otherwise known as pixels. Megapixels are therefore millions of such pixels. So the resolution of the camera, is a measure of how many pixels or tiny bits of information the camera's image sensor uses to split up and then reassemble the picture. The higher the MP (MegaPixel) number, the smaller the pixels, the better the resolution. A chip with 1600 pixels x1200 pixels will be a 2 megapixel camera, whilst a camera with 3200x 2400 pixels on the chip will be 4 megapixels and so on. A digital zoom is not a true zoom lens, it merely crops the image throwing away the information at the edges and increasing the apparent magnification of the lens. Optical zoom implies the actual change in focal length. It

functions by using a system of lenses to refract light and magnify the image on the CCD. Optical zoom magnifies the image quality along with the resulting details and clarity unlike digital zoom.

Intraoral camera:

An intraoral camera is a tiny device with a video camera that moves around inside the mouth and generates a surface video examination of the teeth. The images can be stored, and later enlarged and printed. As it is nearly impossible to see inside your own mouth, intraoral cameras provide a proper view. The pen-sized camera features a disposable cover to prevent contamination.

As the camera moves around the mouth, it sends video images to a computing unit where the images are enlarged and transmitted to a television screen. With the images produced by the intraoral camera, patients can see each of his/her teeth and dentists can indicate problems such as fractured tooth, plaque, decay, gingival disease, defective fillings and so on. Since the intraoral camera generates images that are stored, enlarged and analyzed, often dental problems are caught in the early stages and sometimes even problems that dentists might otherwise miss with a visual examination are seen.Once treatment options are discussed and agreed upon, intraoral cameras can be used to effectively track treatment progress.

A digital SLR-camera used for extra- and intra-oral photographs.

Digital SLR camera:

These cameras combine the features of the SLR system with the digital camera. These include:

i) An interchangeable lens which gives the option of taking extreme telephoto images that would be difficult or impossible with a compact digital camera. Add-on lenses are available for extending to reach of such cameras, but the quality of add-on lenses cannot be compared with that of an interchangeable lens.

ii) Digital SLRs with large sensors will have much less noise than compact cameras. This will give better fine detail, better shadow detail, and more flexibility to recover from exposure errors. When you examine a shot from a digital SLR at full size, it will look smooth and have pure colors. At the same MP rating, you will get more flexibility to crop and enlarge with images from a digital SLR.

iii) Digital SLRs use the faster and more accurate phase detection autofocus method and generally have shorter shutter lag times, making it easier to capture the action.

Digital cameras, either point-and-shoot or DSLR, become obsolete almost as fast as they are introduced into the consumer market. The Nikon D1 DSLR was introduced in 1999 and featured a 2.7 mega-pixel sensor. This camera cost approximately $ 5,000, and at the time of this writing the latest Nikon D800 DSLR has a 36 mega-pixel sensor and costs $2,999. Similar histories exist for Canon and other camera manufacturers.

How the digital camera and resulting images are used may held determine which camera setup to purchase. For example, if the camera is needed for “quick snaps” to capture patient images that are only for use in communication with a laboratory or consulting practitioner, a point-and-shoot camera may be ideal. However, if the images are to be used for marketing purposes, case presentations, or when more creative flexibility is needed, a DSLR may be indicated.

The advantages of a DSLR include improved image quality, speed of operation, increased depth of field and adaptability compared to a point-and-shoot. Disadvantages include cost size of the setup and wight. Advantages of a point-and-shoot camera are size and weight cost and the ability to frame the image in the camera’s LCD screen.

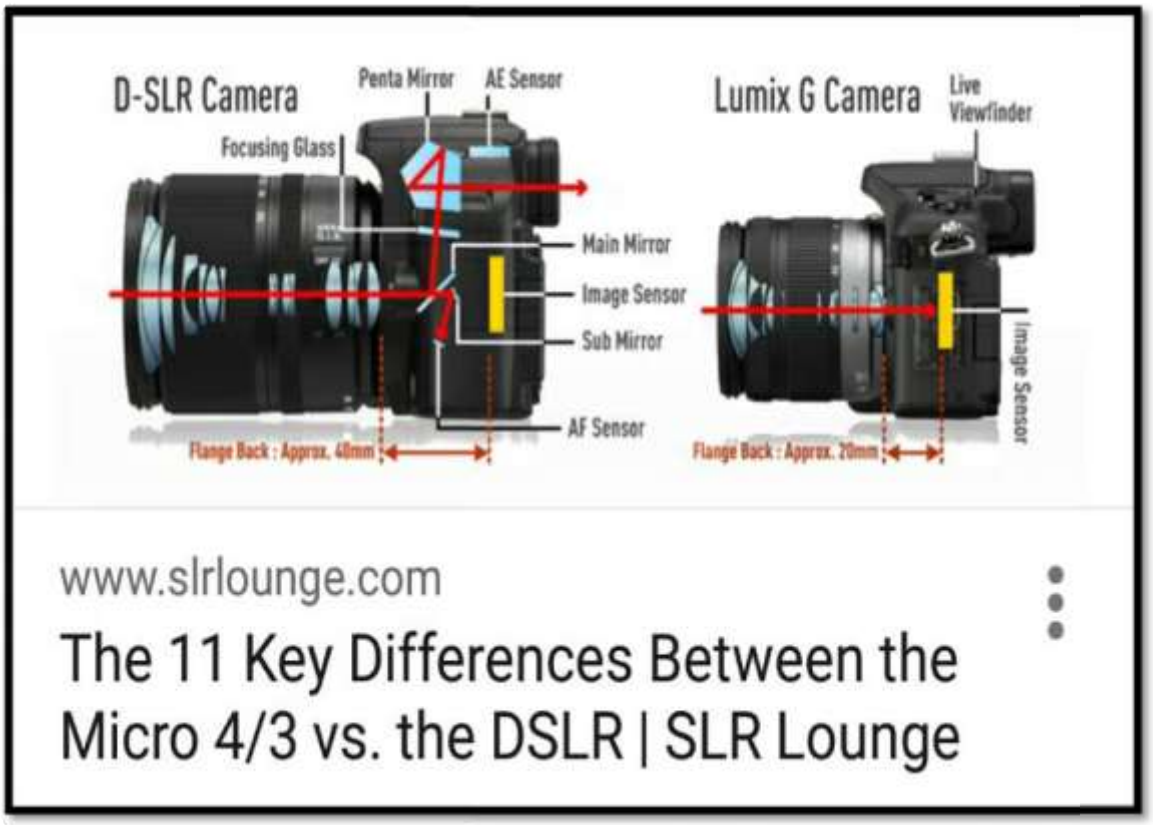
Disadvantages include the potential for poorer image quality limited lens and flash choices, and slower opration when compared to DSLRs. Both point-and-shoot and DSLR cameras offer more than enough resolution (ie, megapixels) for dental use.

There is a new type of camera called an interchangeable lens camera that is a hybrid of the point-and-shoot and DSLR (such as the Sony Alpha NEX, Lumix G Micro [Panasonic] and Nikon N1). These cameras feature the flexibility of interchangeable lenses, a hot shoe flash attachment (see

Flashes on next page) and a larger sensor than point-and-shoot cameras. Unlike DSLRs, interchangeable cameras are referred to as mirrorless because they do not have a mirror-based viewfinder; shots are composed on the rear LCD display. As a result the term digital single lens mirrorless (DSLM) is used to refer to this new type of camera.

ADVANTAGES AND DISADVANTAGES -POINT-AND-SHOOT AND DIGITAL SINGLE LENSE (DSLR) CAMERAS

POINT AND SHOOT CAMERAS		DSLR CAMERAS	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Smaller size	**Slower operation, shutter lag**	**Fast operation,little / no shutter lag**	**Larger size**
Less weight	**Possibledecreased image qualitybecause of smaller sensor, DSLM cameras may partially solve this problem**	**Increased image quality, larger sensor**	**Setup including lens and flash expensive**
Can be less expensive than aDSLR setup	**Limited lens choices, limited macro capability**	**Unlimited lens choices, many macro lens options**	**Setup including lens and flash expensive**
Images can beframed in the rear LCD screen	**Limited flash choices may or may not have hot shoe attachment possible indication for use of a ring light**	**Several flash options (eg, ring flash, dual-point flash, wireless ring flash)**	**Generally image framed through however, some cameras allowed the rear LCD**



PARTS OF A CAMERA

Body - Made of high grade plastic or metal, this holds all the other parts together as well as provides protection to the delicate internal parts of the camera.

Lens - A proper term for this part should be Lens Assembly, this consists of several layers of lenses of varying properties providing zoom, focusing, and distortion correction. These lenses are mechanically interconnected and adjustment is controlled either manually or electronically through the camera's body.

Shutter Release Button - This is the "trigger" of the camera. In most cameras, a half-press activates and locks the auto-focus, and a full press initiates the image capturing process.

Mode Dial - Contains several symbols (slightly different on various camera models), this dial allows you to select a shooting mode, automatic or manual or a choice between one of the pre-defined settings.

Viewfinder - A small viewing window that shows the image that the camera's imaging sensor sees. This can either be an optical view finder, which shows the actual image in front of the camera through a peep hole or through mirrors, or an electronic view finder which is simply a small LCD display.

Aperture Ring - Found around the old manual lens of SLR camera this is used to select an aperture opening. In modern lenses, the aperture is controlled electronically through the body.

Focusing Ring - This can also be found around the lens of a DSLR camera. This is turned to manually focus the lens.

LCD Display - In some compact cameras this acts as the viewfinder. This is a small screen (usually 1.8" diagonally or bigger) at the back of the camera which can be used for framing or for reviewing the recorded pictures.

Flash - Built-in on the body of most compact and some DSLR cameras this can either be fixed or flip type, it provides an instantaneous burst of bright light to illuminate a poorly lit scene.

Control Buttons - Usually includes a set of directional keys and a few other buttons to activate certain functions and menus, this is used to let users interact with the camera's computer system.

Power Switch - Turns On or Off the camera. This may also contain a Record / Play Mode selector on some cameras.

Zoom Control - Usually marked with W and T, which stands for "Wide" and "Tele" respectively, this is used to control the camera's lenses to zoom-in or zoom-out. For DSLR cameras, the zoom is usually controlled by a zoom ring in the lens.

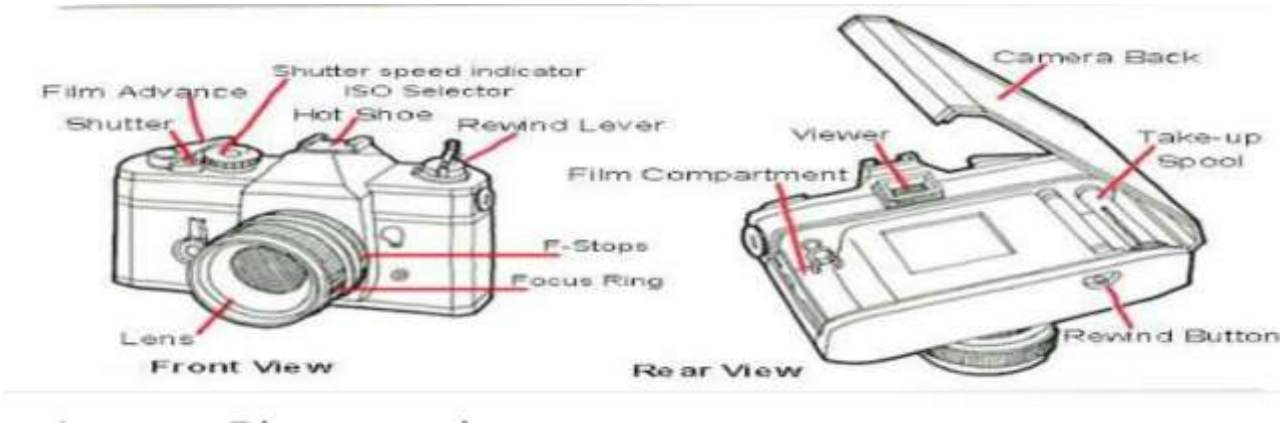
Battery Compartment - Holds the batteries. Depending on the camera model, this varies in size and shape.

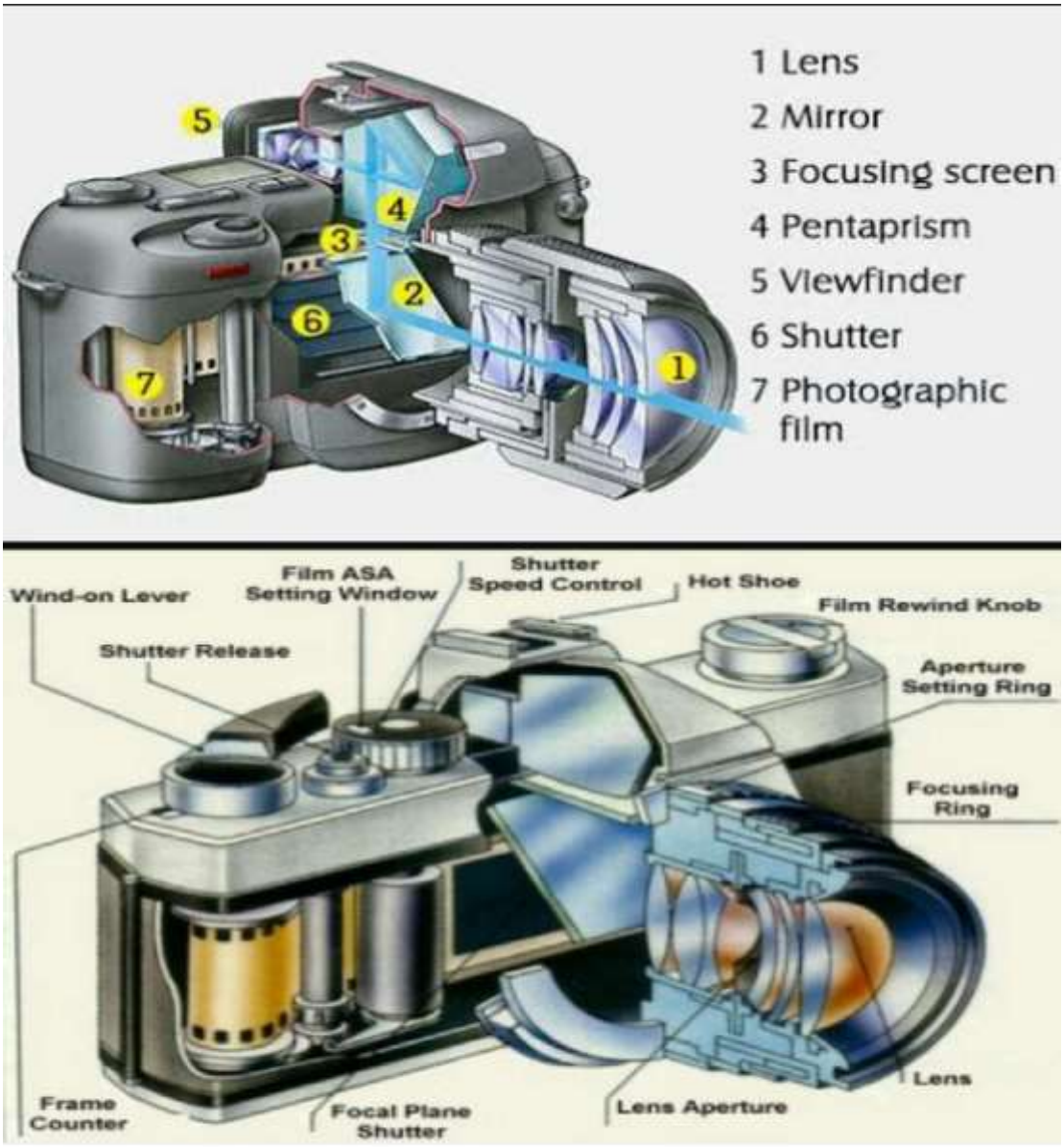
Memory Card Slot - This is where expansion memory cards are inserted. The proper position of the card are often indicated. A mechanical catch usually holds the card in place and a spring helps it eject.

Flash Mount (Hot-Shoe) - Standard holder with contact plates for optional Flash accessory.

Diopter Adjuster - Usually available in mid to high end sub-compact cameras and DSLRs located besides the viewfinder. This varies the focal length of the lens in the viewfinder to make even people wearing eyeglasses to see clearly through it even without the eyeglasses.

Tripod Mount - Here is where your standard Tripod or Monopod is attached for added stability.





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SLR Diagram

CAMERA CONTROLS

In all but certain specialized cameras, the process of obtaining a usable exposure must involve the use, manually or automatically, of a few controls to ensure the photograph is clear, sharp and well illuminated. The controls usually include but are not limited to the following:

Control	Description
Focus	The position of a viewed object or the adjustment of an optical device necessary to produce a clear image: in focus; out of focus.[35]
Aperture	Adjustment of the lens opening measured as f-number, which controls the amount of light passing through the lens. Aperture also has an effect on depth of field and diffraction – the higher the f-number, the smaller the opening, the less light, the greater the depth of field, andthe more the diffraction blur. The focal length divided by the f-number gives the effective aperture diameter.
Shutter speed	Adjustment of the speed (often expressed either as fractions of seconds or as an angle, with mechanical shutters) of the shutter to control the amount of time during which the imaging medium is exposed to light for each exposure. Shutter speed may be used to control the amount of light striking the image plane; 'faster' shutter speeds (that is, those of shorter duration) decrease both the amount of light and the amount of image blurring from motionof the subject and/or camera. The slower shutter speeds allow for long exposure shots that are done used to photograph images in very low light, including the images of the night sky.
White balance	On digital cameras, electronic compensation for the color temperature associated with a given set of lighting conditions, ensuring that white light is registered as such on the imaging chip and therefore that the colors in the frame will appear natural. On mechanical, film- based cameras, this function is served by the operator's choice of film stock or with color correction filters. In addition to using white balance to register natural coloration of the image, photographers may employ white balance to aesthetic end, for example, white balancing to a blue object in order to obtain a warm color temperature.
Metering	Measurement of exposure so that highlights and shadows are exposed according to thephotographer's wishes. Many modern cameras meter and set exposure automatically. Before automatic exposure, correct exposure was accomplished with the use of a separate light metering device or by the photographer's knowledge and experience of gauging correct settings. To translate the amount of light into a usable aperture and shutter speed, the meter needs to adjust for the sensitivity of the film or sensor to light. This is done by setting the"film speed" or ISO sensitivity into the meter.
Film speed	Traditionally used to "tell the camera" the film speed of the selected film on film cameras, film speed numbers are employed on modern digital cameras as an indication of the system's *gain* from light to numerical output and to control the automatic exposure system. Film speedis usually measured via the ISO system. The higher the film speed number the greater the film sensitivity to light, whereas with a lower number, the film is less sensitive to light. Acorrect combination of film speed, aperture, and shutter speed leads to an image that is neither too dark nor too light, hence it is 'correctly exposed', indicated by a centered meter.
Autofocus point	On some cameras, the selection of a point in the imaging frame upon which the auto-focus system will attempt to focus. Many Single-lens reflex cameras (SLR) feature multiple auto- focus points in the viewfinder.

CAMERA ACCESSORIES

In addition to the camera some accessories are also required for a good quality photograph:

a) Ring Flash –The ring flash on the SLR type camera produces excellent images.
b) Memory card – the digital camera usually comes with a s mall card, which will hold relatively few images. Memory cards are available in different formats such as Compact Flash, Smart Media, XD cards and Microdrives. They can reach upto 8 GB in size and can store thousands of images dependent on the image format (eg TIFF,JPEG) that is used at the time the picture is taken. Not all cameras take all cards, but some will accept more than one type.

Transferring Images

The ideal solution for maintaining orderly records is to transfer images from the memory card after each patient. These can be transferred using a card reader or directly from the camera via a cable (e.g. USB) into the clinic's image storage program that should preferably be connected to the clinic's administrative software. Wireless electronic transmission is another option.

c) Filter - If there is an internal thread on the lens it is worth buying a screw-on filter in order to protect it. This serves the dual purpose of lens protection and reducing the brightness of the image. Although the SLR cameras have removable lenses they are very expensive and worth protecting with a relatively inexpensive filter.

d) Batteries – one feature common virtually to all digital cameras is their avid use of battery power. It is therefore worth buying an additional set, of the correct size, NiMH rechargeable batteries and a quick charger, so that you always have a fresh set of charged batteries. The Lithium batteries are more expensive cameras and are not rechargeable and so it is worth carrying a spare.

e) Camera pouch this is useful to protect the camera when not in use.


Canon
EOS
PROSPEED
32GB
Canon

PHOTOGRAPHIC ACCESSORIES:

Cheek Retractors

They are used to retract the lips, labial and buccal mucosa out of the area to be photographed so that the maximum amount of light enters oral cavity which improves the visibility. Cheek retractors are available in clear plastic or metal. Metal retractors are less attractive but can be autoclaved. The transparent plastic retractors are aesthetically more acceptable and natural tissue colour shows through them, limiting the potential for distraction. Retractors are either single or double-ended. Double-ended retractors provide both a small and large curvature. This allows adaptability to a variety of mouth sizes. The end of the retractors acts as a handle to aid retraction. Single-ended plastic retractors have longer, tapered handles. The curved end is larger for excellent lip retraction. Strict aseptic measures are important during intraoral photography as in any other dental procedures in which infectious pathogens can be transmitted to the dental personnel or between patients. Since plastic retractors cannot be autoclaved, chemical sterilization is necessary. After sterilization, the retractors should be rinsed well to remove all traces of the chemical, which could be irritating to the patient.

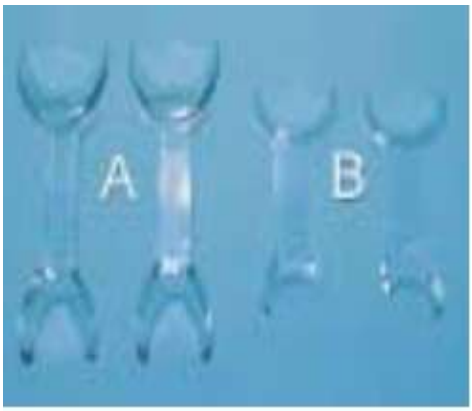
Lip Retractors

There are two types of lip retractors commonly in use: the type which has to be held in place by the subject or an assistant, and the type which has a spring incorporated to keep it in position. The latter often means that the lips rest against the buccal surface of the teeth, which is why this type might not be the optimal choice.

Mouth Mirrors

The mouth mirrors that should be used in clinical photography are the “metal film plated glass mirrors.” When purchasing mouth mirrors, buy the best you can afford to ensure good optical properties and freedom from distortion. Treat your mouth mirrors as precision optical instruments when handling them, avoid finger marks and ensure that your dental surgery assistant realizes that they need to be handled carefully to avoid scratching. Remember that cold metal placed in a warm mouth will almost certainly cause the surface of the mirror to mist up. This can be remedied by warming the mirror before use. A steady stream of air from the syringe blown gently across the surface of the mirror

can help, but only if it is gentle enough to avoid the production of excess saliva. Asking the subject to hold his/her breath just before taking the shot can also help avoid misting.



Most situations that arise in clinical photography can be handled with retractors (A). Retractors that are adjusted and cut down will add flexibility in photographing occlusal views (B).

Technique for inserting retractors:

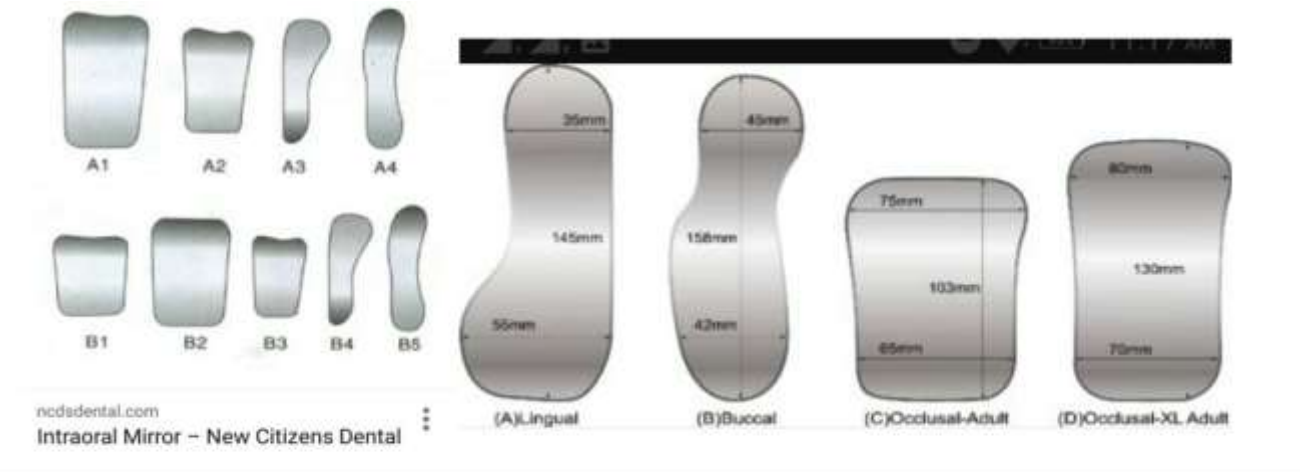
a) Moisten the retractors in water.
b) Ask the patient to relax the lips and open the mouth slightly.
c) Place the rim of the retractor onto the edge of the lower lip.
d) Rotate the handle of the retractor until it is parallel to the corner of the mouth.
e) Repeat this for the other side of the mouth if necessary.
f) Instruct the patient to bite down on the posterior teeth. Pull out the retractors laterally and slightly forward. Avoid pulling the retractor handles toward the ears. This will cause the buccal mucosa to be pressed onto the buccal surfaces of the teeth, as well as cause the patient discomfort when the retractor is pressed against the gingiva and alveolar process.

INTRAORAL MIRRORS:

Intraoral mirrors are used to provide a reflected image when areas of difficult access are photographed. Glass mirrors that have been rhodium plated on both sides create an excellent reflective surface. Intraoral mirrors are available in several sizes. The mirrors allow flexibility with minimal equipment for general adult photography. For photography of the pediatric patient smaller mirrors are recommended especially a child -size occlusal mirror. The large end of the mirror provides an excellent surface for capturing occlusal views, and the smaller end can be placed for palatal and lingual views. The mirror is easy to hold and keeps fingers from being too close to the scene. Mirrors can be washed with detergent and water. Care must be taken when using mirror as they are easily scratched or broken. They should be wiped with a soft paper napkin or cloth and wrapped in cloth or felt for safe keeping.

Biocompatibility:

Pashley et al. compared the biological effects of mild and strong NaOCl solutions and demonstrated greater cytotoxicity and caustic effects on healthy tissue with 5.25% NaOCl than with 0.5% and 1% solutions.



Technique for inserting mirrors:

a) Place the mirror in warm water before use to prevent fogging. A small heating pad could also be used to keep mirrors warm.
b) Insert the appropriate cheek retractors.
c) Select the mirror and the appropriate end for the desired view.
d) Place the mirror flat into the mouth. As you retract with your fingers, rotate the mirror into position. Take care not to hit the teeth or press into the alveolar process, as this is annoying and uncomfortable for the patient.
e) Hold the mirror securely at the opposite end while maintaining retraction.
f) If fogging occurs, blow a gentle stream of compressed air onto the mirror. Even full-time medical photographers have difficulty achieving high-quality dental photographs. There are cameras now which require minimal adjustments in routine clinical use and put outstanding intraoral and extraoral photography within the reach of every dentist.

LENSES

It is a good idea to buy the best lenses available. Choose lenses that are specially designed for macro photography (close-ups). Macro lenses with a focal length between 55 and 110 mm are the best and most widely used with 35 mm cameras. Note that the digital system models available today have smaller image sensors than a camera designed for 35 mm film. A 60 mm lens on a 35 mm camera, for example, can often be compared to a 90 mm lens on a digital camera.Under certain conditions, autofocus can simplify photography, but may cause problems when taking close-up shots. One option is to turn off the autofocus function and use the fixed focus set-up on the lens for a more uniform composition, such as 1:2 or 1:1, then move the camera toward or away from the subject to find the right focus and composition.

The digital camera setup selected for intraoral and extraoral use must have one basic feature.The ability to focus up close, commonly referred to as macro focusing or close focus. Macro photography is close-up photography; the classic definition involves capturing an image on the film or digital sensor that is close to the actual size of the subject. For point-and-shoot cameras the macro setting is usually donoted by the flower icon (or MF for macro focus) and enables the camera to focus at closer distances. For example the Canon G1Xin macro mode will focus at a distance fo approximately8 inches but in standard mode the minimum focus distance is approximately 16 inches. Macro capability for DSLRs is a function of the individual lens chosen. Rather than listing a minimum focusing distance as with point-and-shoot cameras, macro capability is defined by the magnification where 1:1 indicates that the object size captured on the digital sensor equals the actual life size.

Many interchangeable lenses for DSLR cameras arelisted as “macro” however, true macro lenses offer 1:1 magnification or greater. For example the Tamron 7. – 300 mm f/4.0 – 506 interchangeable lens for Canon or Nikon is listed as a “macro zoom” however its maximum magnification is 1:2 (the object size captured on the digital sensor is one half the actual life size). Dedicated macro lenses (such as the Nikon 105 mm f2.8 or Canon 100mm f2.8) are capable of 1:1 magnification and are better suited for dental use.

OPTICAL VIEWFINDER VS. LCD DISPLAYS (DIGITAL CAMERAS)

To guarantee consistent excellent quality, an SLR (single-lens reflex camera) should always be used. With this type of camera, one can see the image being composed through the optical viewfinder. Other types of viewfinders may not be so precise when focusing and with reproductions. A digital camera with an LCD display may seem like a tempting option, but this type of camera is difficult to use in a clinical environment when it comes to accuracy in positioning and focusing. Another important aspect is to choose a camera where you can set the aperture yourself, as the depth of field (the distance in front of and behind the point of maximum clarity that is in focus) is very limited at the ranges involved when executing macro photography. Depending on the power of the flash and the distance from the subject, you should always choose the minimum size aperture possible, such as F22 or F32 (the higher the F-stop number, the smaller the lens opening). This reduces the risk of distortions and blurred shots.

FLASHES

Always use a ring or point flash that is intended for close-up photography. Choose a flash/camera combination that permits TTL (Through The Lens) control of the flash, which will make perfect exposure easier to achieve. If you are using automatic focus, the autofocus may not work accurately at certain light thresholds, especially in low-light situations. Modern close-up flashes usually have auxiliary lights that simplify focusing. You can also use the dental operating lights if additional light is required.

The third essential component of the standard setup for successful dental images is flash illumination. In most cases dental images (both intraoral and extraoral) will be taken using a flash. Point and shoot cameras typically have an on –board flash; however, DSLR cameras allow for a hot shoe mounted flash (the hot shoe is a mounting point on top the camera that allows attachment of a external flash unit or other accessories). The most common hot shoe mounted flash used for dental photography is a ring flash. A ring flash is a circular-shaped electronic flash unit that fits around a lens and provides shadowless uniform frontal lighting, especially useful in close-up photography.

The 2 principal means of flash illumination are via on board flash (built-in flash on a point and shoot or pop-up flash on a DSLR) or external hot shoe mounted flash. The use of on-board flash illumination for dental images is convenient but usually inadequate. In the case of point and shoot cameras use of

the on- board flash generally provides inconsistent results caused by both overexposed and shadowed areas within the same image. A flash diffuser (a frosted or white plastic attachment on the front of the lens) may help to more evenly distribute the light and illuminate the entire image.

There are 2 types of external flashes commonly used for capturing dental images:

1) Ring flash
2) Dual-point flash.

Figure 5: A typical ring flash system

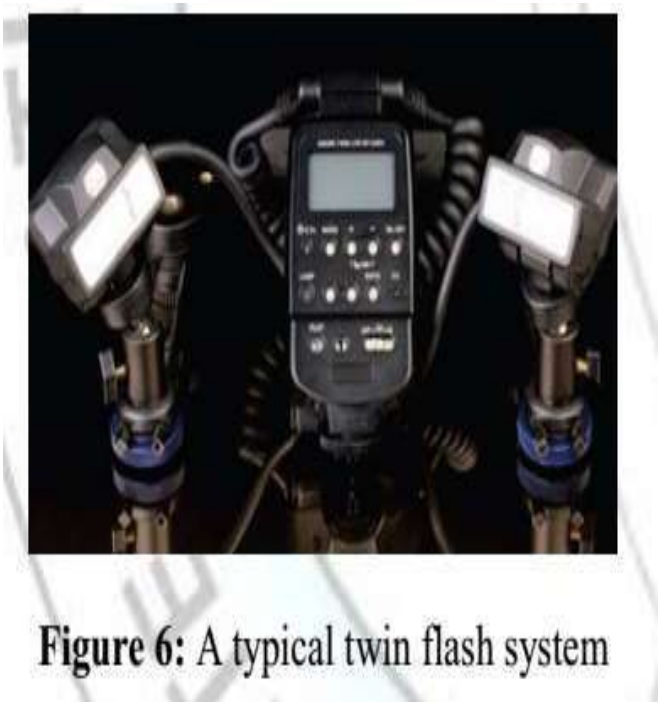


Figure 6: A typical twin flash system

Either flash system will provide acceptable results for dental images and choosing one over the other may be personal preference. Ring flashes provide uniform, flat and shadowless illumination; however the disadvantages of a ring flash may be that surface texture and characterization are not easily captured and reflection on facial surfaces may occur. A dual point flash is composed of 2individual point flashes positioned at the front of the lens barrel. For creative control one or both point flashes can be fired to produce a more 3 dimensional representation of texture and topography. The disadvantage of a dual point flash is that images of posterior teeth can be more challenging.

Two variations on the above described flash units are the wireless ring flash system by Metz (Metz MS-1 Wireless Macro Flash) and ring lights. Ring lights are very similar to ring flashes but instead of

a flash firing when the shutter button is depressed they are made up of LED lights that stay on continuously. An example is the Promaster RL50 Macro ring light that also attaches to the front of the lens barrel and can provide adequate lighting for dental images.

Other available methods of digital photography:

Table 4. Additional Resources for Digital Photography in Dentistry
Photomed. Net- Camera supplies accessories, cheek retractors mirrors instructional materials. Links to continuing education courses on digital dental photography.
Normancamera.com- Camera supplies accessories cheek retractors mirrors, instructional materials
Doctorseyes.com- Ring lights, mirrors, cheek retractors tube adaptors and close-up lenses, instructional materials
Dinecorp.com- Camera supplies accessories cheek retractors, mirrors, educational materials

EXPOSURE AND RENDERING

Camera controls are interrelated. The total amount of light reaching the film plane (the 'exposure') changes with the duration of exposure, aperture of the lens, and on the effective focal length of the lens (which in variable focal length lenses, can force a change in aperture as the lens is zoomed). Changing any of these controls can alter the exposure. Many cameras may be set to adjust most or all of these controls automatically. This automatic functionality is useful for occasional photographers in many situations.

The duration of an exposure is referred to as shutter speed, often even in cameras that do not have a physical shutter, and is typically measured in fractions of a second. It is quite possible to have exposures from one up to several seconds, usually for still-life subjects, and for night scenes exposure times can be several hours. However, longer shutter speeds blur motion, and shorter shutter speeds freeze motion. Therefore, moving subjects require fast shutter speeds.[37]

The effective aperture is expressed by an f-number or f-stop (derived from focal ratio), which is proportional to the ratio of the focal length to the diameter of the aperture. Longer focal length lenses will pass less light through the same aperture diameter due to the greater distance the light has to travel; shorter focal length lenses will transmit more light through the same diameter of aperture.

The smaller the f/number, the larger the effective aperture. The present system of f/numbers to give the effective aperture of a lens was standardized by an international convention in 1963 and is referred to as the British Standard (BS-1013).[38] Other aperture measurement scales had been used through the early 20th century, including the European Scale, Intermediate settings, and the 1881 Uniform System proposed by the Royal Photographic Society, which are all now largely obsolete.[39]:30 T-stops have been used for color motion picture lenses, to account for differences in light transmission through compound lenses, are calculated as T-number = f/number x √transmittance.

If the f-number is decreased by a factor of √2, the aperture diameter is increased by the same factor, and its area is increased by a factor of 2. The f-stops that might be found on a typical lens include 2.8, 4, 5.6, 8, 11, 16, 22, 32, where going up "one stop" (using lower f-stop numbers) doubles the amount of light reaching the film, and stopping down one stop halves the amount of light. Seen in the given table:

Table 2. The 8 Basic Shots Recommended for an Initial patient Photographic Set (ISO Should Be set at 80 to 200 for all Shots							
Shot	**Approximate Magnification**	**Aperture**	**Shutter Speed**	**Point of Focus**	**Cheek Retractors**	**Reflected Image**	**Horizontal Midline ofthe Photo**
Full-Face (Smiling)	1:10	f/506-8	1/125 1/160	Eyes	No	No	Patient's Nose
Profile	1:10	f/5.6-8	1/125 1/160	eyebrows	No	No	Patient's Nose
Full-Smile	1:2	f/18.29	1/125 1/160	Centrals or laterals	No	No	Occlusal Plane
Anterior (Retracted)	1:2	f/22.29	1/125 1/160	Centrals or laterals	Yes	No	Occlusal Plane
Right Buccal	1.2	f/22.29	1/125 1/160	Canine or premolars	Yes	Yes / No	Occlusal Plane
Left Buccal	1:2	f/22.29	1/125 1/160	Canine or premolars	Yes	Yes / No	Occlusal Plane
Maxillary Occlusal	1:2	f/22.29	1/125 1/160	Premolars	Yes	Yes	Canine or premolars
Mandibular Occlusal	1:2	f/22.29	1/125 1/160	Premolars	Yes	Yes	Canine or premolars

Image capture can be achieved through various combinations of shutter speed, aperture, and film or sensor speed. Different (but related) settings of aperture and shutter speed enable photographs to be taken under various conditions of film or sensor speed, lighting and motion of subjects and/or camera, and desired depth of field. A slower speed film will exhibit less "grain", and a slower speed setting on an electronic sensor will exhibit less "noise", while higher film and sensor speeds allow for a faster shutter speed, which reduces motion blur or allows the use of a smaller aperture to increase the depth of field.

For example, a wider aperture is used for lower light and a lower aperture for more light. If a subject is in motion, then a high shutter speed may be needed. A tripod can also be helpful in that it enables a slower shutter speed to be used.

For example, f/8 at 8 ms (1/125 of a second) and f/5.6 at 4 ms (1/250 of a second) yield the same amount of light. The chosen combination affects the final result. The aperture and focal length of the lens determine the depth of field, which refers to the range of distances from the lens that will be in focus. A longer lens or a wider aperture will result in "shallow" depth of field (i.e., only a small plane of the image will be in sharp focus). This is often useful for isolating subjects from backgrounds as in individual portraits or macro photography.

Conversely, a shorter lens, or a smaller aperture, will result in more of the image being in focus. This is generally more desirable when photographing landscapes or groups of people. With very small apertures, such as pinholes, a wide range of distance can be brought into focus, but sharpness is severely degraded by diffraction with such small apertures. Generally, the highest degree of "sharpness" is achieved at an aperture near the middle of a lens's range (for example, f/8 for a lens with available apertures of f/2.8 to f/16). However, as lens technology improves, lenses are becoming capable of making increasingly sharp images at wider apertures.

Image capture is only part of the image forming process. Regardless of material, some process must be employed to render the latent image captured by the camera into a viewable image. With slide film, the developed film is just mounted for projection. Print film requires the developed film negative to be printed onto photographic paper or transparency. Prior to the advent of laser jet and inkjet printers, celluloid photographic negative images had to be mounted in an enlarger which projected the image onto a sheet of light-sensitive paper for a certain length of time (usually measured in seconds or fractions of a second). This sheet then was soaked in a chemical bath of developer (to bring out the image) followed immediately by a stop bath (to neutralize the progression of development and prevent the image from changing further once exposed to normal light). After this, the paper was hung until dry enough to safely handle. This post-production process allowed the photographer to further manipulate the final image beyond what had already been captured on the negative, adjusting the length of time the image was projected by the enlarger and the duration of both chemical baths to change the image's intensity, darkness, clarity, etc. This process is still employed by both amateur and professional photographers, but the advent of digital imagery means that the vast majority of modern photographic

work is captured digitally and rendered via printing processes that are no longer dependent on chemical reactions to light. Such digital images may be uploaded to an image server (e.g., a photo-sharing website), viewed on a television, or transferred to a computer or digital photo frame. Every type can then be produced as a hard copy on regular paper or photographic paper via a printer.

Prior to the rendering of a viewable image, modifications can be made using several controls. Many of these controls are similar to controls during image capture, while some are exclusive to the rendering process. Most printing controls have equivalent digital concepts, but some create different effects. For example, dodging and burning controls are different between digital and film processes.

Other printing modifications include:

• Chemicals and process used during film development.

• Duration of print exposure – equivalent to shutter speed

• Printing aperture – equivalent to aperture, but has no effect on depth of field

• Contrast – changing the visual properties of objects in an image to make them distinguishable from other objects and the background

• Dodging – reduces exposure of certain print areas, resulting in lighter areas

• Burning in – increases exposure of certain areas, resulting in darker areas

• Paper texture – glossy, matte, etc.

• Paper type – resin-coated (RC) or fiber-based (FB)

• Paper size

• Exposure shape – resulting prints in shapes such as circular, oval, loupe, etc.

• Toners – used to add warm or cold tones to black-and-white prints.

RESOLUTION

This characteristic is directly related to the final quality of images obtained 6 and depends on the ability of the CCD in capturing the pixels, thus the higher the capacity of the CCD, the greater the number of pixels captured.It is relevant to explain that selection of the resolution is directly related to the ultimate goal of images. The higher the captured file, the lower the number of images that can be stored in a computer hard drive or on the memory card of the camera because it will result in larger files.The high resolution produces images with larger dimensions that occupy a higher number of bytes in the hard drive, typically leading the system to load them slowly, mainly on didactic presentations as those prepared on the Microsoft ® PowerPoint ® software.

Machado et al (11) have emphasized that the resolution in megapixels (MP), which is often the main aspect advertised by manufacturers, is only one among several features that should be considered when choosing a digital photographic equipment. They concluded that the resolution in the MP per itself does not assure high-quality images, but rather only when associated with lenses with excellent optical quality and a proper lighting system.

Currently, there are digital cameras with 28MP resolution, allowing users to print images with high resolution of 300 DPI and sizes up to 52 x 39 cm.(6) The quality of images produced is the same when it refers to or more MP, yet the final size of the image influences the file size. Therefore, if these photographs are printed, the resolution of the camera will be related to the maximum size that the image can be enlarged on photographic paper.16 Thus, the resolution of photographs used for printing, scientific posters or publications will be directly related to the image size used. Seen in the table below:

Resolution and size of image printing in centimeters (Machado et al, 2004[11]).

Resolution	Size		
(PIXELS)	**10x15**	**13x18**	**20x25**
	Excellent	Good	Poor
lMP	Photo Quality	Excellent	Good
(1,	Photo Quality	Photo Quality	Very good
28	Photo Quality	Photo Quality	Excellent
0	Photo Quality	Photo Quality	Photo Quality
X			
96			
0)			
2			
M			
P			
(1,600 X 1,200)			
3MP			
(2,048 X 1,536)			
4MP			
(2,240 X 1,680)			
SMP			
(2,560 X 1,920}			

The actual resolution in which the image is captured may not be important if there is no need for photo-quality printing, thus setting the camera to record at lower resolutions can be helpful. Machado has suggested the purchase of digital cameras compatible with the current market standard (10 to l SMP), yet the equipment should be set to work at lower resolutions (SMP, for example), meeting the routine needs with high quality. The camera may be set to the highest resolution possible when printing in larger sizes is necessary. The images displayed on computer screens present average resolution of 72 DPI. Conversely, digital projectors have a resolution of 0.8 MP or 1024 x 768 pixels. Therefore,

when photographs are obtained to be displayed on the internet, sent bye- mail and viewed on a computer screen or in multimedia presentations, a resolution of up to 2 MP (1600 x 1200 pixels) may be used. However, Hutchinson and Williams1 reported that these projected images do not lose details when they are created at resolutions greater than 1.3 MP. Accordingly, Machado6 in 2010 reported that images with resolution of 3 to SMP meet those needs with good quality, while Morriss suggested a minimum resolution of 6 MP.

FOCUSING AND FRAMING

Good composition and focus guide the story told by images and influence the emotional responses of patients. Images are tools that capture emotion, help the patients in making decisions and give rise to feelings of confidence, enhancing the treatment acceptance.

Knowledge about the artistic arrangement and correct framing in intra- and extraoral photographs is fundamental, so that the image may actually reflect what the photographer aims to capture.

The focus is reached moving the camera forward and backward to adjust the required distance, then the shutter button should be partially pressed to ensure the correct focusing by the camera. The macro mode should be enabled in intraoral photographs. The correct framing is achieved with the aid of references according to the type of photograph desired.

Many errors can occur when taking photographs, including camera positioning, wrong focusing, under or overexposure of the field of view and positioning errors as the patient height in relation to the photographer, wrong Frankfurt plane, head positioning, hair covering the ears, eyes closed or soft tissues in incorrect position. Other possible errors include excess saliva, fogged mirror, dark buccal corridor, tongue not sufficiently retracted, non-observation of the distal margin of the first molar, or photographic retractors obscuring the field of view.

Lip retractors provide a great contribution to the final outcome of intraoral photography. Two sizes are needed and the dental assistant should be trained for their utilization.

Larger retractors are used for photographs in frontal view in 95% of patients, yet smaller retractors should be used in lateral view to provide greater horizontal than vertical retraction. Before taking the

photograph, the retractor should be pulled as distally as possible to achieve an angle as perpendicular as possible to the molars and premolars.

This will allow reproduction of the buccal segment of the sagittal discrepancy and also ensures observation of the distal aspect of first molars on the photograph. In order to enhance the possibility of achieving good-quality and well-focused photographs, two or three shots should be achieved for each view and then the best image is selected.

LIGHTING

Lighting is one of the most important aspects for the achievement of high-quality photographs. Two basic flash systems are available for photography, namely the point flash and ring flash. In intraoral photography, the ring flash is usually the system of choice, allowing uniform illumination, while the point flash has high intensity and provides pictures with excessive lighting, in which photographic details as texture and light and shade contrast are lost. These photographs invariably exhibit excess light, alter the natural color of teeth and soft tissues, producing low-quality photographs as a result of overexposed image.

Most digital cameras have the flash connected laterally or above the objective (point flash), which produces an uneven distribution of light in the intraoral photography, creating unwanted shadows, which may be noticed as a shadow in the buccal corridor of the patient.

The literature has reported several adjustments to eliminate these disadvantages. The light intensity emitted may be regulated by trial and error, adjusting layers of masking tape,coffee filter paper or tracing paper over the flash to get the necessary attenuation of light intensity, or alternatively by reducing the flash intensity on the camera settings. The correct
for the achievement of more lighting allows the observation of nuances and details of the teeth and periodontal tissue.

Some authors proposed turning on the dental unit light and turning off the flash, stating that the observation of teeth would be enhanced, yet this became unnecessary in cameras that allow adjustment of light intensity. Also, with a view to control the amount of light·that will sensitize the camera CCD, some cameras allow adjustment of the exposure compensation, which varies from -2 to +2 in the

average. Ideally, the intensity should be regulated as low as possible, compatible with the distance used in lntraoral photographs. The equipment instructions should also be read to facilitate the adjustments in the equipment. Thus, some trials may be performed or less light according to the desired goal.

McKeown et al (14) suggested that, when achieving intraoral lateral photographs with cameras with a laterally connected flash, the camera may be rotated in horizontal direction to allow illumination of the area that would be shaded by the cheeks or retractors. Moving the camera further back from the patient may also allow light diffusion and better lighting of the area, yet a larger field would then be photographed. In that case, the image should be trimmed and rotated at 180° .

High-quality photographs in occlusal view are difficult to obtain with point flashes due to the proximity between patient and camera, which produces shadows. Besides the great distortion of the captured image, there is unwanted condensation of water vapor on the camera lenses because of patient breathing, causing loss of image quality. McKeown et al (14) suggested focusing as

distant from the mouth as possible, providing more light and reducing the shadows. In this situation, the area of interest represents only 20% of the area captured by the camera. Therefore, the picture must be trimmed saving only the area of interest, either lateral or occlusal. For that purpose, the camera resolution should be as large as possible to produce a good image after trimming, since 80% of the photograph will be discarded.

Finally in most cases, the camera should be set in the "A" aperture priority mode, in which the desired aperture is selected and the equipment adjusts the shutter speed automatically. Thus, the amount of light is reduced and suitable for the short distance required in intraoral photographs, besides providing greater depth of field.

Another possible option is setting the appropriate light intensity and the time required to achieve the image, which are represented by the exposure time and aperture. The aperture refers to the amount of light passing through the diaphragm to the CCD at a given moment, while the exposure time indicates the period during which that light is received. With different combinations of aperture and exposure time, a greater aperture may expose the CCD for less time and vice versa. Thus, the professional may

select the photograph with better definition and balance between high and low light intensity, increasing and decreasing the depth of field.

MAGNIFICATION VIEWS

If only particular parts of the oral mucosa or teeth are of interest, it is best to compose the picture concentrating on the desired areas. As a general rule, excess magnification is detrimental to image quality. This is because most macro lenses are incapable of resolving beyond a 1:1 magnification, and while it is possible to magnify objects to greater than life size using various attachments such as extension tubes and bellows, the result is a deterioration of image quality. If a magnification greater than 1:1 is required it is better to enlarge the image, again within limits, using photo-editing software. This is one of the reasons to start with a high quality image that is capable of enlargement without loss of detail.

The major factor to consider when taking magnification views is that the depth of field is substantially reduced, sometimes as small as 2 mm. This means that fewer teeth or parts of teeth are sharply focused, not forgetting that the depth of field is in front as well as behind the point of focus. Therefore, to ensure maximum depth of field it is advantageous to focus on a midpoint. While framing of a picture is not critical since the image can be cropped afterwards, incorrect focusing is difficult to rectify in photo-editing software. A certain degree of sharpening can be applied, but if an image is captured out of focus it will remain and appear out of focus no matter the amount of manipulation. A tripod is invaluable for precise focusing and accurate framing. With a 1:1 magnification and assuming normal tooth alignment, the ideal point of focus is the distal aspect of the maxillary central incisors for maximum depth of field, which can also be verified by using the depth of field preview button. Finally, if no indication is given on the macro lens regarding the degree of magnification, an easy method for ensuring a 1:1 magnification is when four maxillary incisors occupy the entire viewfinder of a 35 mm DSLR camera.

MAGNIFICATION IMAGE

Oral mucosa

Photographing the oral mucosa and gingivae is similar to photographing teeth but requires minor modifications in technique. Firstly, disease is painful and therefore extra care is necessary to avoid trauma when placing retractors and mirrors if the tissues are inflamed. Mirrors are essential if pathological lesions are located in the deep recesses of the oral cavity. However, if trismus is present mirrors are not recommended for safety reasons as well as those of limited access. For maximum comfort and depending on the site of the lesion, the patient can either be seated or placed in the supine position. If not contra-indicated, administration of topical or injectible local anaesthesia helps alleviate pain and expedite the photographic session. When composing the picture, ensure that a healthy area beyond or encircling the lesion is visible for comparison between healthy and diseased or pathologically altered tissue. Also, to assess the size of a lesion, placing a periodontal probe or millimetre scale adjacent to the pathology is helpful. The intensity of the photographic light needs to be increased to illuminate poorly lit posterior regions. Finally, colour is important when photographing soft tissues, as changes from the norm often indicate present or previous pathology. Therefore, calibrating with an 18% grey card is advisable for precise colour rendition.

Texture, dentine layer and enamel cracks

Pictures that reveal texture, dentine strata, enamel cracks and perikymata are invaluable for a ceramist for visualising and subsequently mimicking these characterisations in artificial prostheses. The standard lighting for intra-oral images, ie two bilateral flashes mounted on either side of the camera, is the ideal configuration for capturing texture and lustre by specular reflection off the enamel surface. However, specular reflection masks the underlying dentine colour and characterisations as well as subtleties such as enamel cracks. To visualise the latter, a silver or white card is used to cover one of the bilateral lights, acting as a reflector to bounce muted light from the opposite flash onto the teeth without specular reflection. This set-up reveals the underlying dentine strata or intra-enamel nuances. For this type of image, continuous light sources (LED or dental operatory lights) are advantageous because the reflector can be angled until the desired structures, for example dentine layer or perikymata, are visible in the viewfinder before taking the picture. which reveals enamel cracks.

Failure to clearly visualise and capture cracks or other characterisations can result in artificial prostheses that do not mimic adjacent natural teeth. In the crown on the right central incisor is devoid of an enamel crack, which is clearly discernible on the natural left central incisor.

Translucency – incisal and interproximal

Enamel translucency is usually located at the incisal edges, cusps and interproximal regions of a tooth. The ability to map the extent, degree and shape of translucencies and mamelons is invaluable for communication between the clinician and ceramist when fabricating artificial restorations. The technique is as follows. A black card, appropriately cut to size, is placed behind the teeth to obscure the oral cavity and a 1:1 magnification is chosen to concentrate on the desired teeth. Since black is an

optical contrast to the white teeth, the camera's automatic metering may compensate by overexposing the image by ½ or 1 f-stop. This will diminish the visibility of translucency and it may be necessary to override the metering by underexposing to obtain correct exposure. As for recording texture and lustre, a continuous lighting source is helpful to visualise translucent areas by angling the light until the translucent areas or mamelon distribution are visible in the viewfinder.

Shade analysis

Absolute tooth shade comparisons are impossible with photography alone and must be considered in combination with ocular or instrumental analysis. However, relative shade analysis is feasible with photography and is a useful guide for the dental ceramist for assessing the progress and extent of bleaching relative to a shade guide.

Photographs for shade are taken using a standard bilateral flash lighting set-up. As for the oral mucosa, calibration with a grey card is essential. The teeth should be moist and not unduly desiccated, especially if using a rubber dam, which causes inaccurate shade assessment. While moisture control is still necessary, saliva should be encouraged to flow over the teeth, simulating a natural oral environment. The patient is asked to hold the entire shade guide for a cursory analysis, or to hold individual tabs adjacent to the concerned teeth. Shade analysis with shade guides is useful for assessing the extent of bleaching.For a more precise shade comparison, a shade tab can be placed adjacent to a tooth that requires a crown. Ideally, shade analysis should be performed pre-operatively, after tooth preparation and at the try-in stage, especially if the treatment objective is to whiten or brighten the shade of the definitive restorations.

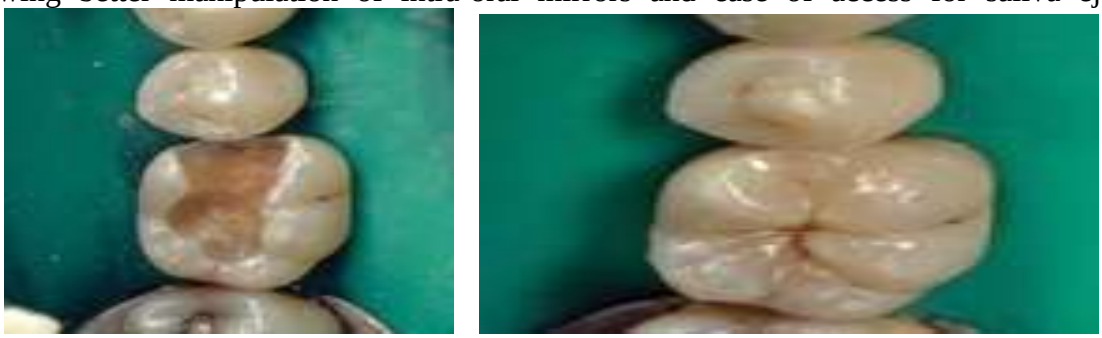
TWO WEEKS AFTER BLEACHING

CROWN PREPARATION

If the shade of a natural tooth does not match those in a standard shade guide it may be necessary to fabricate a custom shade tab. As with conventional shade tabs, if the shade matching is proving difficult photographs should be taken with illumination of different colour temperatures. This helps to avoid metamerism and facilities the matching procedure.

Posterior teeth

Photographing posterior teeth is challenging because of limited access and poor illumination, especially with restricted mouth opening or excess salivation. The set-up is identical to that for photographing quadrant occlusal images, described above. Therefore, a supine position is preferred, allowing better manipulation of intra-oral mirrors and ease of access for saliva ejectors. For



photographing a few teeth or a quadrant, unilateral cheek retractors and narrow occlusal mirrors are the ideal choice. A rubber dam is an excellent method of isolation, preventing condensation on the mirrors as well as safeguarding against ingestion or inhalation of dental instruments. These types of dental images are ideal for using ring flash illumination, which is intense, uniform and allows ease of manipulation in limited access areas. As previously mentioned, a slight overexposure may be necessary to compensate for light being reflected off the mirror surface to illuminate the teeth.

DIGITAL PHOTOGRAPHY IN DENTISTRY

Digital imaging in current dental practice is commonplace. This can include radiographs, impression taking and intraoral and extraoral photography. The use of photography in dentistry has evolved from 35mm single lens reflex cameras to digital image capture devices including intraoral cameras, point and shoot cameras and digital single lens reflex cameras (DSLR).

High-quality digital photographs are helpful in several dental specialties and their use may be highly beneficial. The need to capture patient images Is fundamental for several reasons, especially for legal purposes, since the number of dentists involved in court cases has been increasing and is not expected to decrease. When photographic records are available, the professional has better conditions to prove the oral conditions of patient, besides serving as expert evidence for reimbursement from health and dental insurance.

Post-treatment photography is also important for a critical evaluation of treatment outcomes, encouraging the professionals to improve their own performance. Image magnification allows the observation of details that may had remained unnoticed, helping the professionals to detect their errors and decide how to solve them. They may also be used to demonstrate the correct procedure, thus being a valuable tool in the constant quest for excellence.

This technology has presented great evolution in the recent years, leading to the utilization of digital imaging in Prosthodontics. The knowledge on digital photography aided the use of resources that enhanced the diagnostics, communication between professionals, laboratory technicians and patients, scientific illustrations, applications for didactic, counseling, research and publication purposes. Trevisan et al4 and Machado6 further mentioned the possibility of immediate visualization of the result

of photographs, no costs with films and processing, and systematic management of images in the clinic as the main advantages of digital photography.

However, some disadvantages may be pointed out, as the need of knowledge on informatics (for camera settings and file transfer), higher cost compared to conventional equipments, the legal value of digital files and the obsolescence of equipments with the advances in technology.

According to Clinical digital dental photography by Dr. Amit Patel, UK :

In today's environment of paitent's high expectations and increased litigation, especially with regard to cosmetic dentistry, good record-keeping is essential. Clinical photography is a very important tool in general practice in documenting treatment, especially in aesthetic and cosmetic cases.

Clinical photography and academic presentation have undergone a transformation over the past ten years. In the past, clinical slide photography and carousel slide lecture presentations were the gold standard in both dentistry and the medical fields. Over the past decade, the availability of digital photography, digital imaging systems and digital presentation software programs has revolutionized teaching and lecturing.

Before the advent of digital photography, it was expensive to purchase dedicated 35 mm dental photographic equipment and accessories, and it was more likely to be dentists who were also amateur photographers who bought such equipment. Since the development of digital cameras, the costs have been brought down quite considerably. This has made it more accessible for most dentists in their everyday practice. The main advantages of digital versus film photography are instant image acquisition, reduced costs of film processing and a relatively easy learning curve.

It is very difficult to outrace technology, as it is evolving daily at a rapid rate and one will always be behind. So don't plan on using your current digital equipment for the rest of your life; it is always outdated within a couple of years. Over time as our own skills and knowledge improve with digital photography, we will want to improve on our old images; therefore, reinvesting in technology is part of the challenge in the pursuit of excellence. One of the biggest advantages of digital photography is that the images can be viewed instantly and can be edited in many ways, such as improving brightness and contrast, cropping changing hue and saturation, adding text symbols, using software.

BASIC USES OF PHOTOGRAPHY IN DENTISTRY

Photography has a wide role of significance in teaching, research and clinical recording.

I. Clinical photography has become an important part of standard dental practice. Clinicians in both general practice and specialty areas have found the pictorial representation of a patient's condition to be of a valuable part of the patient's record.

II. When evidence-based dentistry is gaining roots worldwide, dental photography finds an important place in providing the evidence.

III. In addition to conventional patient records and radiographs, dental photography offers the dental professional another possibility of visual reconstruction of the various stages of treatment. Photographs are an essential part of clinical records for number of reasons:

Unreliable memories: Within a matter of months, patients and practitioners tend to forget how severe the original condition was. Having photos available at every visit reminds both the dentist and the patient of the original situation, against which all improvements can be judged.

Treatment evaluations: A quick scan of sequential slides with patients during treatment will save lengthy explanations of intended treatment plan.

Teaching needs: Slides are probably the most important teaching aids in dentistry. If cases are to be presented in lectures, papers and posters, a high standard photograph are required. d) Medico legal

Cases: It is critical to have clinical photographs that indicate any preexisting pathology or trauma to the teeth. Proper records will help avoid any post-treatment disputes.

DOCUMENTATION

The basic aim of dental photography is documentation of dental treatment which includes photographs demonstrating the process and stages of therapeutic treatment .Images should be made prior to each non- invasive and invasive diagnostic procedure, which results not only in a bunch of interesting dental files but it also shows those forensic elements as well, which are of crucial importance in judicial-medical, investigation and proof finding procedures.

In many situations, discrepancies between the dentist and patient may also be overcome in this way. In addition, images should be always made after the treatment, the purpose of which is not only to legally protect the dentist but the patient as well. Dental photography is also useful in the course of treatment and control check-ups in order to monitor pathological changes on osseous and soft oral tissues. The results of investigations, furthermore, may be documented with the help of images in order to define preliminary diagnoses.

COMMUNICATION

The appearance of hard and soft tissue may be quickly and easily photographed, thus facilitating the communication among dentist, physician and laboratory.The images also provide dental technicians with important information on the structure and colour of teeth, thereby making it possible to them to individually match aesthetically and functionally artificial crowns as much as possible with natural teeth. Even when the choice of colour has not been made by the dentist, the photograph can be a means of direct communication with dental technician, with the aim of making the colours of artificial crown and natural tooth on the photograph as more even as possible.The preoperative photograph sent along

with the sample of the tissue to the pathologist may render important information and in this way also help in defining the proper diagnosis.

Images also play an important role in consultations regarding the patient. They not only make it possible for the dentist to accomplish informative communication with the patient, but offer the patient numerous possibilities to talk about his/her impressions and wishes about the success of the therapy applied.

SELF CHECKING

In the years to come, quality control will become increasingly important to the dentists. In this context, the photograph will be increasingly significant. Even without institutionalized control of quality, the photograph will make it possible for the dentist to self check his or her own result. Anyone who has photographed the stages of dental treatment, subsequently enlarging and designing the results, is capable of verifying it understood. Marketing in the positive sense may allow the patient to immediately compare the beginning and outcome of the treatment. Two images, printed next to each other, are generally sufficient for this and can be given to the patient. Very little text is needed. Patients are often prone to show them to friends and people they know. There is probably no better, small but efficient, marketing tool from this. Finally images also contribute to maintaining and supporting profession of dentist, which becomes increasingly important for career advancement.

TELEDENTISTRY

It was established in 1994 as a military project of the American army (U.S. Army's Total Dental Access Project), with the aim to improve patient protection, offer dental education and realize the communication of dentist dental technician laboratory. Via teledentistry, dental professionals may mutually be consulted at remote locations. The military project has made it clear that teledentistry reduces total costs, widens protection to remote and rural regions, and provides as complete information for needs of analysis as possible. Teledental system enables dentists to share the information about the patient, x-ray images, graphic presentation of periodontal and hard tooth tissue, applied therapies, notes, photographs and other information that can be transported via multiple providers.There are two basic techniques used in teledentistry. One is the real-time video conference

and the other one, more common, is store - and - forward. Both techniques include professional digitizing and electronic transmitting of video information, drawings, diagrams, photographs, radiograph shots etc.

PRE- AND POST-OPERATIVE COMPARISONS

One of the most compelling reasons for taking intra-oral photographs is to provide a “before and after” comparison, or to demonstrate the stages in a surgical or restorative procedure. To make such comparisons effective and easy to follow, it is important that the viewer can move from one image to the next in the sequence without having to re-orientate themselves. This generally means that all images in the series should be taken from the same angle and with the same exterior limitations. A useful technique for emphasizing the foreground in these anterior shots is to hold an opaque piece of matte (i.e. non-reflective) plastic or oxidized alumina behind the teeth, thereby removing the confusion of the background. As with almost all professional photography, it is up to the photographer to dictate both the composition and angle of the image required in order to achieve satisfactory results. Taking a little more time to stage manage each photograph and taking a number of shots of each stage if necessary is preferable to being rushed and ending up with images that are of no use for the purpose intended.

VARIOUS ANGULATIONS USED IN THE INTRAORAL IMAGES FRONTAL VIEW

Lift the soft tissue upwards and outwards from the buccal surface of the teeth using a lip retractor. Focusing on the lateral incisor helps ensure an adequate depth of field that will have all teeth with an acceptable focus range. Keep the occlusal plane horizontal, lined up with the top or bottom edge of the viewfinder. We should remember that with digital images alignment errors can often be corrected

Although the subject can be asked to hold their own lip retractor while photos are taken, an assistant who understands the needs of clinical photography can be a great asset in positioning the retractors optimally and in achieving the best results for publication or education.

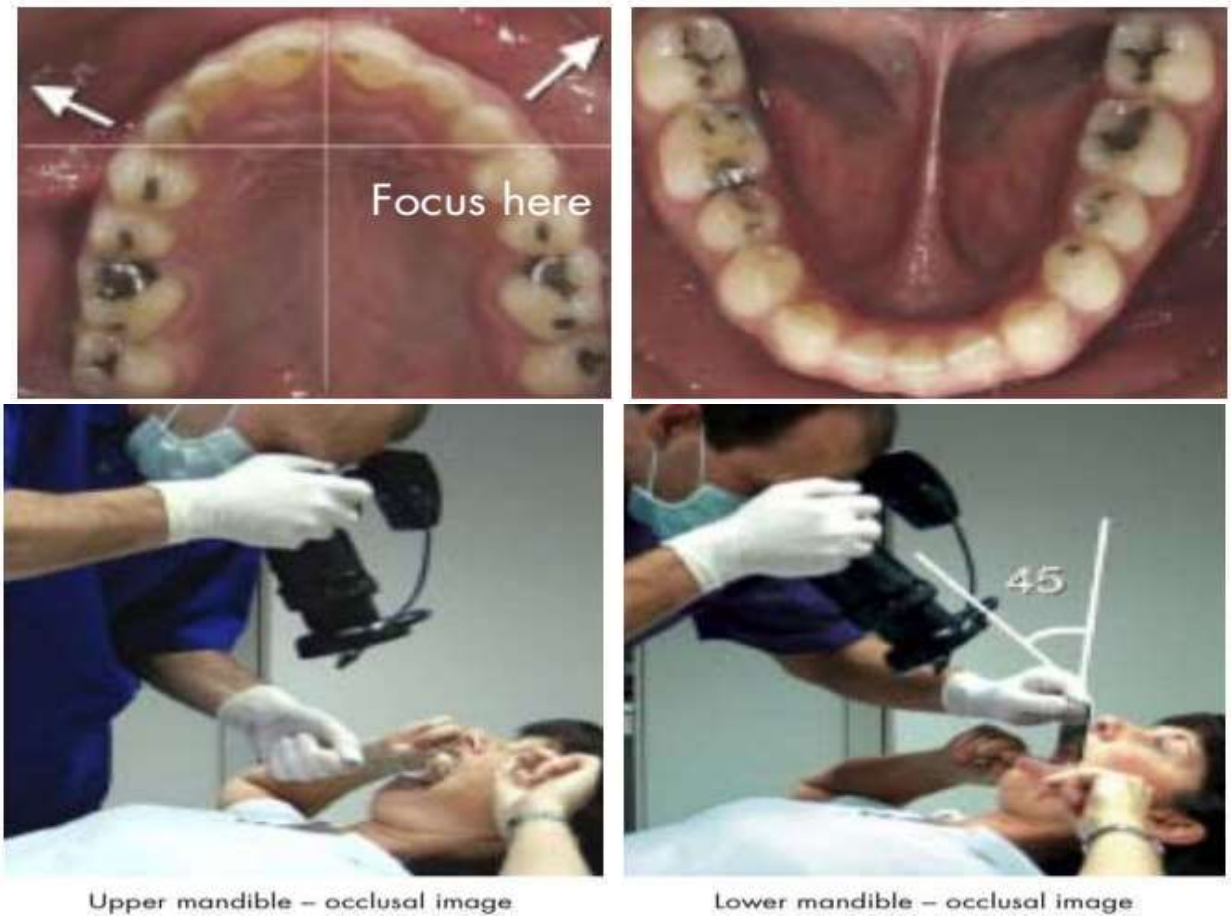
Viewed from the front, the assistant should be asked to pull the retractors (i.e. retractor A) not only outwards, but also forwards towards the camera. This ensures that the buccal surfaces of the posterior teeth are not obstructed by the soft tissue of lips and cheeks.

Take one shot of the intercuspal position and complement this with a second shot with the patient in a resting position showing "free space."

Remember to use suction and syringe to dry the teeth and remove pooled saliva before each shot.

afterwards. Take one shot of the intercuspal position and complement this with a second shot with the patient in a resting position showing “free space.

OCCLUSAL VIEW



The occlusal view requires the use of a mouth mirror. Use lip retractors to lift the soft tissue away from buccal tooth surfaces and focus on one premolar. For optimal results with the occlusal view, the lips should be retracted before positioning the mirror. Ordinary lip retractors will put too much strain on the oral tissue to allow correct insertion and positioning of the mirror. The best solution is either to use two mouth mirrors, held by an assistant, or to use two specially adapted lip retractors, cut down and rounded for safety. Establishing a 45 degree angle between the mirror and the camera for occlusal shots is recommended although this may not always be achievable. Positioning the mirror far enough back in the mouth to capture the upper second and third molars can elicit the gag response, so be prepared to use the same techniques you might use when taking radiographs or impressions. If this is

a problem, the mirror can be positioned to highlight the region of interest and rest on the occlusal area of, for instance, the first molar. When photographing the lower mandible, the patient should be encouraged to relax the tongue and if possible, to keep it behind the mirror, pressing upwards toward the palate.

LATERAL VIEWS

Lateral image taken using only a lip retractor. This often works well as a standard method as it is quick and easy. Other variations are possible, such as with a more anterior direction when keeping an esthetic record of the front (with or without a retractor).

Lateral images taken with a mirror may sometimes produce better views, but are more difficult for both the patient and the photographer. Note how the flash produces different lighting effects on the two cropped images above. The mirror image needs to be rotated horizontally (as in the image below it) in order to get an accurate view.

Lateral images can be taken either with or without a mirror. When taking images without a mirror, it is better to use a lip retractor with a narrow (acute) angle between the upper and lower sections (i.e. lip retractor A). This puts less tension on the lip musculature and helps ensure that the lip can be drawn backwards as far towards the ear as possible. It will show buccal surface of the teeth clearly as far back as the second or third molars.

For the best esthetic result, watch for the lower lip escaping back over the cervical area of the lower incisors, marked with arrows in the first image on the left. By asking the patient to relax and at the same time releasing the pressure on the lip retractors slightly, it is usually possible to prevent this from happening. When using a mirror for lateral photos (i.e. mirror no 2), ask the patient to try to relax once the mirror has been inserted. This creates space for the check to be lifted outwards and permits a better angle between mirror and camera. A lingual positioning of the mirror can trigger the gag reflex. Asking the subject to keep his/her tongue relaxed and in the middle of the mouth will create more space for the mirror in the sulcus than if the subject, trying to be helpful, moves his/her tongue from one side to

the other and in doing so raises the floor of the mouth. Lateral image taken using only a lip retractor. This often works well as a standard method as it is quick and easy. Other variations are possible, such as with a more anterior direction when keeping an esthetic record of the front (with or without a retractor). Lateral images taken with a mirror may sometimes produce better views, but are more difficult for both the patient and the photographer. Note how the flash produces different lighting effects. The mirror image needs to be rotated horizontally in order to get an accurate view.

INTRAORAL VIEWS

An excellent clinical photograph requires a clean and accurate subject area which is visually free of influences such as saliva, poor use of mouth mirrors, retractors or backgrounds. The camera flash is to be properly positioned to provide good contrast and shadow direction. Also, the patient's position is to be adjusted according to the different views and the operators ease in making the view.

For most straight anterior views, the patient should be seated in a semi upright position with a slight tilt backwards. In a contoured chair, the patient must be turned to the side so the operator does not lean to the side over the chair and the patient. The chair height should be adjusted so the operator is comfortable while taking the picture.

The dental operatory light should not be shone directly onto the teeth as the colour balance shift can be seen on the teeth and tissues. Light is needed only to give enough focus. When the dental operatory light is bright on the side of the arch that should have contrast, it will dim the contrast produced by the flash.

For full mouth views, the focus should be just ahead of half the anterior-posterior distance. This is considered to be the cuspid midline to first bicuspid midline. The depth of field at this point of focus will produce anterior-posterior sharpness.

Objects such as retractors, mirror edges, fingers and also the patient' s lips should be excluded from the frame when not needed in the scene. The camera lens is set for an accurate f-opening (f/22) to focus on the six anterior teeth. For general views, two plastic lip retractors should be used. The retractor on

the same side of the mouth as the flash should be extended more than the other side to prevent a shadow on the posterior teeth.

FULL FACE IMAGES

Full-face images should be taken against some type of background. A blue background is very popular, but the results can be that the facial skin tone takes on a yellowish hue. A grey or black background is more neutral. Positioning the subject (the patient) against a background and taking a shot with a flash will give what is called a projected shadow.

Projected shadows can be eliminated by using a darker background. A black matt blind was hung as a backdrop. The ring flash on a modern camera can be removed so that the camera can be held in one hand and the flash in the other. By angling the flash so that it casts its light diagonally from the front of the subject and by taking an image with a lower aperture (< 18), it is easy to achieve results such as these. The red eyes effect will be minimized as well.

Ask the patient, for the purpose of variation, to turn sideways or to turn his/her head in order to give the shot more depth. If we would like facial images to be of a more professional standard, better quality lighting is required, such as for slave flash photography. In such a case, you should seek the advice of a professional photographer to make more individual upgrades and adjustments. We have to make sure that extra-oral shots are taken before the intra-oral shots to avoid the risk of redness and marking from lip retractors.

GETTING THE SHOTS

Before attempting to capture images, it is critical that both camera and flash if applicable have charged batteries and that an appropriate memory card is inserted into the camera. Cheek retractors and dental mirrors should be clean and ready for individual patient use. In some cases, practitioners may choose to have a hot water bath available for heating the mirrors to prevent fogging. Also it is very helpful to have an assistant available to help with holding retractors blowing air on a mirror to prevent fogging, or other tasks requiring an additional pair of hands.

SHOT NO. 1: FULL FACE – SMILING

The full-face shot should be taken directly in front of the patient, against a solid-color, nondistracting background (eg, white, gray, or black). when possible the operator and patient should be at the same height so that the resulting picture is not taken from below or above the patient's eye level. 5.7 The AACD recommends a horizontal orientation (ie, landcape) of the camera; however, many practitioners may choose to orient the camera vertically (ie, portrait) to more easily capture the patient's head without excessive background showing. 1 Try to center the patient's eyes as the horizontal midline of the photo; the facial midline should optimally be centered vertically. The point of focus is the patient's eyes.

SHOT NO. 3: FULL-SMILE

For this shot a point and shoot camera should be switched to macro mode; DSLR macrolenses should be used at approximately 1:2 magnification (Figures 6a and 6b). Attempt to take the photo from directly in front of the patient, avoiding a downward or upward angle of view. The patient should exhibit a natural smile, with framing of the photo extending from the right to left corner of the mouth. Point of focus for this shot is on the central or lateral incisors. The horizontal midline should be the incisal plane; the vertical midline should be the anatomic midline. The AACD recommends operators not tilt the camera to compensate for a canted incisal plane.

SHOT NO. 4: ANTERIOR (FRONTAL) VIEW --- RETRACTED

To achieve the retracted anterior (frontal) view shot, the patient should ideally be seated in the dental chair with the operator standing in front of the patient. Cheek retractors must be used with the lips retracted outward, away from the teeth. Whenever possible, minimize the appearance of the cheek retractors in the image. Clear plastic retractors are typically used because they are non-distracting and may be seen in the photograph, although they are more breakable with repeated use and sterilization; metal retractors may be more distracting but will last longer. A common error during retraction is pulling the lips outward and backward; this results in the buccal soft tissue resting against the teeth and preventing adequate visualization of the buccal corridors. Use the largest set of retractors that the patient can comfortably tolerate to avoid the centre of the upper and lower lip from showing in the photograph. The horizontal midline should be the occlusal plane and the vertical midline should be the anatomic midline. If possible, air-dry the teeth to minimize the appearance of saliva and to better capture the gingival appearance. The teeth should be together in maximum intercuspation, although a complimentary image with the teeth slightly apart may help in recording the appearance of incisal edges.

SHOTS NOS. 5 AND 6: RIGHT AND LEFT BUCCAL VIEWS

The right and left buccal views are accomplished using the same patient and operator position and same camera settings as the frontal view. They can either be achieved using a direct view with retractors or a reflected view with a buccal mirror.

For the direct method, place both cheek retractors and shift the retraction to the side being photographed. For example, if the right side is to be captured, the right retractor should be pulled out and away from the teeth, while the left retractor is left slack and not pulled but simply holding the lips apart. Standard adult cheek retractors may be used; however, it is helpful to use buccal retractors to more easily capture all the teeth in the image. The difference between standard and buccal retractors is the shape: standard retractors are U-shaped while buccal retractors are V-shaped. The teeth should be in maximum intercuspation; the horizontal midline should be the occlusal plane. The vertical midline should be the canine, but may be variable based on the angle of view and number of teeth captured. Ideally the canine and molar relationship should be visualized; however, with proper retraction it is usually possible to capture the entire buccal segment from second molar to incisors. Practitioners may choose to take an additional photo of the teeth slightly apart to view incisal edge position.

The buccal view taken with a mirror is a more technically difficult shot compared to the retracted buccal view. In this instance a single cheek retractor is used for the contralateral side and a buccal morrors is used to both retract the tissue and visualize the teeth on the side being photographed. Again to prevent mirror for it is sometimes useful to warm the mirror in a water bath or simply ask the assistant to gently blow air on the mirror. It is also useful to have the patient breathe in and hold his or her breath one the morror is inserted to further obviate fogging. Whenever possible eliminate excess moisture from the mirror before capturing the image. It is recommended that the assistant hold the cheek retractor and the operator hold the mirror. After the cheek retractor is inserted ask your patient to open so that the mirror can be inserted. Once the mirror is outside the teeth the patient should bring the teeth together. Advance the mirror so it is resting on buccal tissue behind the most distal tooth. At this point, the mirror should be pulled outward so the end is not resting on the teeth and ratated to visualize the arch. The point of focus is the premolars and the occlusal plane should be the horizontal midline. It is sometimes useful to take and additional photo with the teeth slightly apart.

Common errors for the reflected buccal view include: allowing the end of the mirror to rest on the teeth possible resulting in a double image showing unreflected teeth; not using a cheek retractor on the opposite side, preventing full visualization of the anterior teeth; inadequate framing; and for on the mirror.

SHOT NO. 7: MAXILLARY OCCLUSAL VIEW

For many practitioners the maxillary and mandibular occlusal shot present the most difficulty. this shot is always taken with both retractors and an occlusal mirror. Camera setting are identical to the anterior retracted shot although patient and operator positioning are different and ultimately critical to success. The patient should be reclined to approximately 45 degrees and asked to raise his or her chin. The

operator should be in front of the patient. Cheek retractors should be placed so that the lips can be pulled upward and outward; in some cases the medial corners of the cheek retractors will touch at the middle of the upper lip. If properly used the cheek retractors will keep the buccal soft tissue and lips off of the teeth allowing for proper visualization of not only the posterior teeth but the anterior teeth as well. Standard cheek retractors or “fork” retractors may be used.

The mirror should be inserted so that the edge extends behind the most posterior tooth. It may sometimes rest on the tuberosity as a means of stabilization. Rotate the mirrordownward so that the back side is touching the lower incison teeth. In doing so the operator can help the patient “open wide” but also attain the 45 degrees angle needed to properly capture the image. Fogging of the mirror can again be a challenge with preventive strategies including warming the mirror gentle bursts of air or asking the patient to breathe in and hold his or her breath.

The image captured should ideally include all maxillary teeth and allow visualization of incisal edges and embrasures.The vertical midline should be the anatomic midline of the patient, and the point of focus should be the premolars. In sone cases the operator must allow the camera to focus on the premolars (eg, hold the camera shutter button half-way, locking the focus) and then recompose the image to achieve better framing. If the center of the palate is used as the point of focus the teeth may appear out of focus because of limited depth of field.

SHOT NO. 8: MANDIBULAR OCCLUSAL VIEW

The mandibular occlusal shot is accomplished with the same camera settings, and similar positioning of the patient and operator as the maxillary occlusal. The patient should be reclined at a minimum of 45 degrees and should raise the chin as far as possible (neck extended maximally). Standard retractors

(or a fork retractor) should always be used to keep soft tissue and lips off of the teeth. If standard cheek retractors are used they should be positioned to pull the lips downward and outward. Insert the mirror so that the end rests on soft tissue behind the most posterior teeth making sure that it is not touching the teeth. Rotate the mirror upward so that the back of the mirror is resting against the maxillary incisor teeth; the image should be taken at approximately 45 degrees to the mirror.

Too often the patient's tongue may prevent visualizing all of the mandibular teeth. It is sometimes helpful to ask the patient to "lower your tongue", having the patient practice doing so in a facial mirror. Other times it may be possible for the patient to move the tongue to the posterior or the mirror could be used to hold the tongue out of the way.

The image should be framed so that the vertical midline is the anatomic midline of the patient. Like the maxillary occlusal shot, ideally all mandibular teeth are visible and the anterior incisal edges and embrasures are discernable. The point of focus for the mandibular occlusal shot are the premolars. Re composition may be necessary after focusing as described for the maxillary shot.

BASICS OF PHOTOGRAPHY IN ORO FACIAL SCIENCE AND ITS APPLICATIONS IN PROSTHODONTICS.

Basics of photography should be kept in mind for precise and quality documentation. There are wide ranges of applications of photography in Prosthodontics.

Photography proves to be a useful tool in complete denture cases. With the help of pre- extraction photographs it helps clinicians select teeth based on the various parameters such as size, shape, form and colour of the teeth used in the denture. Any observed malocclusion, crowding or diastema can be recreated in the final denture based on preoperative photographs.

For cases involving fixed partial dentures, photographs can help clinicians as well as lab personnel in characterization of the definitive prosthesis. Photographs can help us assess the shade of the teeth and of the gingiva; they can also help in providing texture to the teeth as they are built in ceramic.

Smile designing should always include an evaluation of the facial as well as dental compositions.A multitude of factors have to be considered such as location and alignment of teeth and the position of the midline, the degree of tooth to be displayed etc. Photography helps us assess these factors.

With the help of photographs we can establish facial or asymmetry in cases requiring maxillofacial prosthesis. Having preoperative photographs can help us gauge the structures on the contralateral side of the face and fabricate an esthetic and accurate prosthesis. In conditions where the patient is missing structures from both the sides of the face, earlier photographs can help clinicians design the prosthesis as well as shade matching.

For full mouth rehabilitation, photographs can provide guidance to fabricating provisional restorations, adjusting the increase in vertical height and observing the function and esthetics of the patients bite. Planning dental implant therapy for patients can be greatly enhanced due to radiographs. Photographs can be taken prior to implant

treatment to assess the clinical aspect of the surgical site, and also of the radiographs to evaluate the bone level. These photographs can be compiled with subsequent photographs of the case for record keeping and to weigh the success of treatment.

Earlier clinicians had to wait for the developed film to arrive to know if the photograph was taken well, but with modern advances in digital cameras that problem is eliminated. Dentists can easily take a photograph and view its accuracy, they can save, store and transfer files with ease. Clinicians can now view the pictures immediately and can retake the photo in case it does not meet the required needs. SLR cameras have since taken the world of photography by storm and provided clarity that can aid the clinician in achieving excellence. A variety of cameras are available in the market today, however the wrong decision in choosing the right camera could not only produce bad photographs but could also prove to be expensive.

Digital cameras today have increased resolution, improved anti-dust technology, and added versatile flash accessories for macro imaging.

Photographs provide an honest outlook and help each clinician become self - critical and aware on how to improve. Constant self - evaluation is simplified by photography and along with careful documentation it can contribute to achieving excellence in technical aspects. It is not until you have experience with using a camera that you can assess the clinical worth of the photograph. At least two or more views must be made in relation to posterior points which are difficult to access. Care must be taken to eliminate all foreign bodies and saliva from the site of concern.

SELECTION OF EQUIPMENT FOR PROSTHODONTICS

A good camera may not necessarily be an ideal dental clinical camera unit. In quality most camera units are about the same, but the best dental clinical camera is one that will produce the best results in the least time, one which is most versatile at the least cost.

OPERATOR POSITIONING FOR INTRAORAL VIEWS

Adjust the camera to the patient's position to minimize movement of the camera. Operators arms are to be kept close to the body or the elbow is rested on steady support. The camera is moved back away from the centrals until they are out of focus, then moved forward and focussed on the cuspid or first bicuspid.

The flash for all intra oral views should be on one side of the lens. 9 or 10 o' clock or 2 or 3 o' clock views should be used but seldom the 12 o'clock view except for a direct view under the tongue.

INTRAORAL LIGHTING AND CONTRAST

The flash should be positioned on the correct side of the lens to produce some shadow. This provides the subject with some form and texture. The flash is generally not used in the 12 o'clock position as it produces shadows from the upper gingiva or the oral cavity. If the flash is mounted facing one arch of the patient, the opposite will show more contrast into the proximal spaces with the mesial portions being more illuminated than the distal portions on each tooth.

RETRACTORS

It is advisable to use two retractors at a time, unless the area of importance is being covered by the retractor itself. Using two retractors facilitates better illumination. If the patients mouth is very small and the lips tight, a single retractor can be used for right or left buccal views, then a small retractor can be used on the other side just enough to keep the lips apart to allow light for illumination. The smaller retractor can be replaced using a tongue blade, mouth mirror or two gloved fingers. Cleft lips almost always require modified retractors for intraoral photography. A very small retractor maybe necessary due to the lip being tight with very little elasticity in these cases.

Often the retractors are placed on the lip, and the patient or assistant is asked to retract by pulling the handles back towards the ears. This should be avoided as the buccal mucosa is pressed back onto the buccal surfaces of the teeth if not held out or pulled slightly forward. This does not provide good illumination for posterior teeth and is also uncomfortable for the patient as the retractors are pressed against the gingiva.

Retractors or the lips should not be included in the camera view if they can be eliminated. To view the maxillary arch with a mirror, the patients head is tilted upwards slightly so that the camera may view the arch at about 45° angle in the mirror. For direct viewing of the maxillary arch, the patients head is bent back so that it can be viewed in the camera on a flat plane. This position may be uncomfortable for the patient but it allows good photography from a lower camera position.For viewing the mandibular arch, the head should be upright with the lower lip retracted downwards for a direct view. Focus should be midway in the arch.

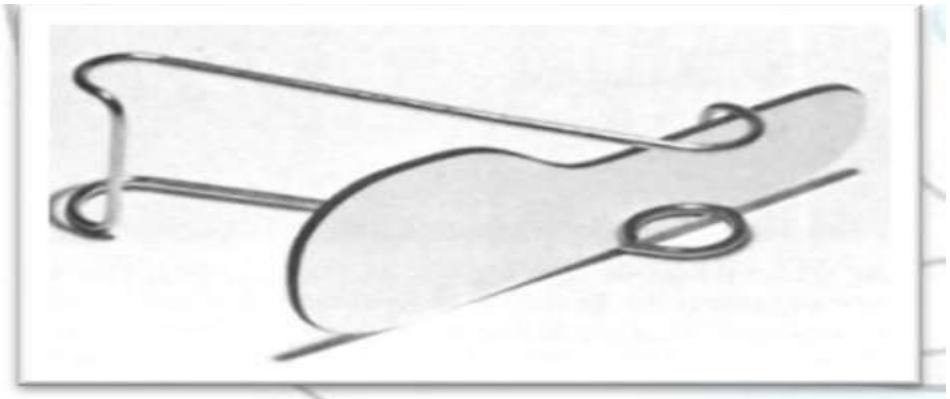


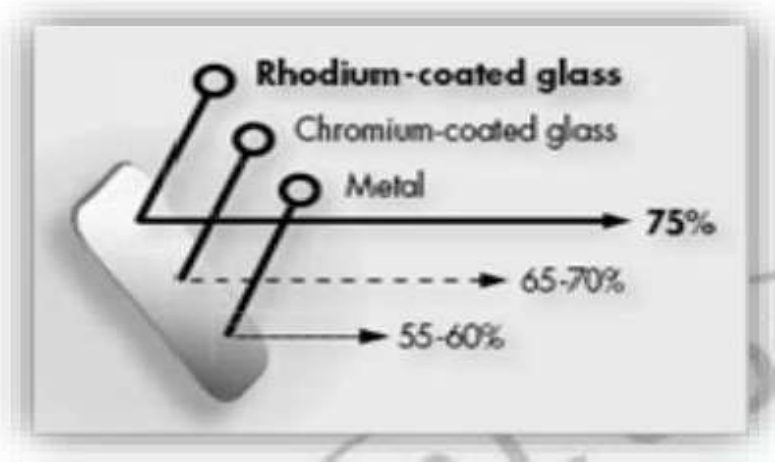
Figure 10: Columbia Wire lip retractor

MIRRORS

Mirrors that are rhodium plated on one or both sides are preferred. The same mirror can be used for the maxillary and the mandibular arches. The mirror should be about l to 1 1/8 inches wide and long enough to help visualize until the third molar. The mirror should always be placed distally to the area to be viewed and should be held at 45°to the buccal surfaces of the teeth. The only image that should be viewed is that of the teeth from half of the cuspid up to the last tooth in the arch.

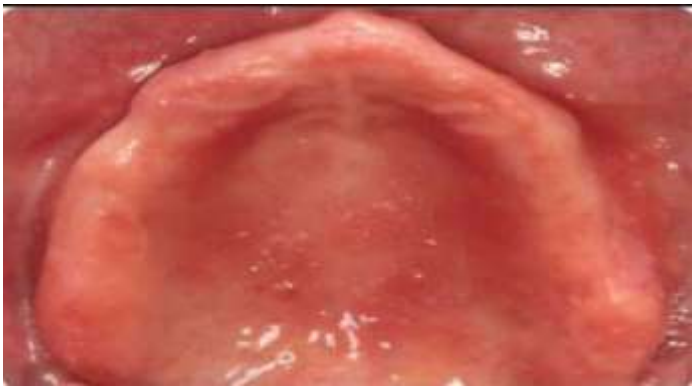
Care should be taken to centre the teeth well in the image. If the mirror is rotated and not parallel, the view will show more of the cusps or more of the gingiva.

Reflectance value of Rhodium vs. Chromium-Coated and Metal Mirrors	
TYPE OF MIRROR	VALUE OF REFLECTANCE
Rhodium-coated glass	75%
Chromium-coated glass	65 - 70%
Metal	55 - 60%



PLACEMENTOF MIRRORS MAXILLARY ARCH

For the maxillary arch the patient is asked to tilt their head back slightly. Two plastic retractors are placed and can be held by the patient while the dental assistant can warm the mirror to prevent fogging.



The assistant is asked to hold the anterior edges of the mirror between the thumb and the first or second finger. The distal cusps of the last tooth is where the posterior portion of the mirror is made to rest while being centred in the arch and held at 45° angle. To visualize the lingual surface of the anterior teeth, the mirror can be held as previously described but should be placed one tooth distally to the one wanted in the view.

MANDIBULAR ARCH

The same procedure is advocated in the mandible except that the head must be tilted back far enough to allow the arch to be almost parallel to the floor when the mouth is opened wide.

FACIAL VIEWS

For facial views, the camera is held vertically, the flash must be positioned at the top of the lens at the 12 o'clock position. If the person's right profile is facing the camera, the flash must be on the right side. The flash above the lens may cause a shadow to form from the nose and the chin. For a frontal view, the head measures up to 8 inches from on ear tip to the other on average. From nose tip to the back of the head the measurement is about 9 inches. Keeping this in mind it is necessary to eliminate about I½ - 2 inches of the back of the head to keep both frontal and profile views of the same proportion.

The patient should stand 10 - 12 inches from a white or light coloured matter surface background. In case the hair length is shorter than the ears there will be a soft shadow below each ear in the image. To

eliminate this it may be necessary to use a second flash in the background for which the patient will be required to stand 2 - 3 feet away from the background. The second flash should be angled up to the wall to illuminate the back of the head.

When the background light is not strong enough, a longer shutter exposure is necessary despite flash being used. The longer shutter exposure may burn out the background shadow but due to a slower speed may cause a blur if the patient moves after the flash has gone off.

To make frontal or profile views, the dentist should aim the centre of the lens 1-1½ inches above the pupil of the eye. Looking either up or down to a great degree may cause distortion of the patient's features. Photographs taken in a dental chair usually yield poor results as there is no background and the floor, wall or chair headrest maybe be visualized. Black or dark backgrounds should be avoided as dark hair will blend into the background and leave only the face visible.

To take a profile view, the patient's face is rotated about 3°- 5° back towards the camera lens. This can also be achieved by shifting the camera to the side so that the lens is pointed to the comer of the eye rather than at the ear.

BACKGROUND AND LIGHTING FOR OBJECTS

Practitioners need to photograph small objects such as impressions, casts, and larger objects such as articulators. Instead of using whatever piece of cloth, paper or tabletop that is handy care must be taken to choose the right background based on the texture of the background and the colour. Generally is a paper is used, it is curved to form a floor and then gently raised to a curve to form the backdrop. The gentle curve eliminates the line of horizon.

For direct anterior views of casts, the material curves down the front of the table for 2 - 3 inches after which it is taped flat to the top of the table with the gentle curve to form the back wall. The camera lens is lined up along the cusps of the teeth, while the surfaces of the background blend together for a smooth clean background.

Black backgrounds may be used for white casts or others; in such conditions usually a smooth finish paper is preferred. Black backgrounds should be jet black only and not black - grey.

When taking photographs of burs or other instruments, paper without texture is preferred. For full mouth casts, where a coloured background is indicated, crepe paper can be stretched to get rid of the wrinkles and is taped down.

Cloth generally does not make for a good background as it has too much texture. The background should be smooth and free of wrinkles, because they steal focus from the object when enlarged on a bigger screen.

PHOTOGRAPHS OF METAL OBJECTS OR INSTRUMENTS

Prior to taking a picture of the metal object, the practitioner should decide if the porosity or texture of it is important or the smooth gloss of its metal surface is of interest. Both these properties cannot be highlighted in the same view. For less contrast on metal, the objects can be sprayed with a matte or dulling spray which can be washed off any object when needed. This spray might not be suited for smaller instruments such as burs or instrument points as it lays a satin finish on the metal, however it can be used on larger objects.

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PUBLISHING YOUR IMAGES

The following guidelines will be useful when submitting your photographs for publication.

Before submitting photographs, contact the publisher to check their exact requirements, the financial and copyright terms on which they accept images and, if appropriate, the arrangements for returning your material after publication.

Obtaining a written statement from the publisher which clarifies these matters before you submit your work can save a lot of time and trouble should a dispute arise. Requirements also differ in terms of the type and quality of material which publishers will accept.

DIGITAL IMAGES

To ensure the highest possible quality of the original digital image, the camera must be set up for high resolution (which will reduce the number of images you can capture in memory).We should remember that an image that looks fine on your PC screen may not be of high enough quality for print reproduction. If you are manipulating original digital images on your computer (e.g. cropping, rotating, amending colour balance), make sure that the image quality is maintained when you re-save the amended file and that you do not overwrite the original files. Certain types of files compress or otherwise degrade the data to save space, but in doing so sacrifice quality. Before submitting, check with the publisher what types of files they will accept, what size files they will allow and what type of image compression they will be happy with. Also check whether they prefer to receive your files by email or CD/DVD.

TRANSPARENCIES

The rapid evolution of digital photography reduces the importance of transparencies. When submitting transparencies, ensure that they are in glassless mounts and are well protected. Ensure that your name and address are marked clearly on the mount using a small sticky label, and “spot” the slide to show which way the image should be viewed (especially important with some dental subjects shot using a mirror). To “spot” a slide, hold it in front of you the right way round and right side up and apply a small round sticker or equivalent felt pen mark to the bottom left corner of the slide mount.

PRINTS

Improvements in print technology have meant that an increasing number of publishers accept prints for publication. Quality of reproduction is not as good as when starting with a transparency, but could be acceptable for some purposes. Remember that not all film processing laboratories work to the same high standards, so have the film processed by a reputable laboratory. Photography magazines routinely run laboratory comparisons and the difference can be staggering.

A NOTE ON COPYRIGHT

The fact that you have treated and photographed a patient does not give you the right to use those photographs. Your patient may be grateful, impressed and very pleased with the work you have done for them, but you should respect his/her rights. To do so, make it a habit to get a "model release" signed by each subject, even if you do not think at the time that those particular images will be published or shown in public. There are many variations on the Model Release document, and an Internet search will reveal many, which you can adapt to your own requirements, language and local laws.

STANDARDIZING IMAGES

It has never been easier to take standardized photographs and use high-quality controlled clinical images. Focal distance can be standardize by securing a piece of dental floss or chain to the bottom of the camera and holding it near an appropriate area (chin) of your patient. This ensures that you will be at the same distance from the patient for all views.

For macro photography, a macro lens and ring flash for a DSLR can be used for capturing close-up images of the subject. Ring lights (usually a ring of LEDs fixed to the lens) can also be obtained for most point-and-shoot cameras. It is not always essential to have all these accessories, as you do not need to get close to the subject. These cameras automatically compensate for various lighting conditions and some can compensate for macro distances.

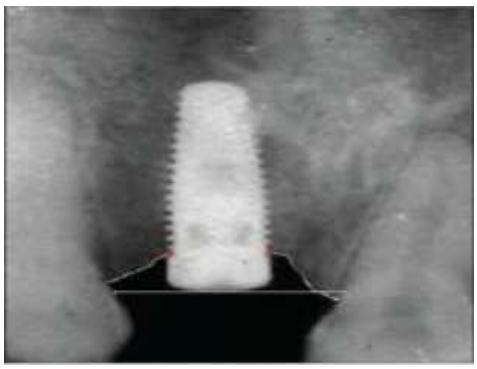
Getting too close will overexpose some areas and block the flash in other areas, causing shadows. The best technique is to keep away from the subject and use the optical zoom to get close to the area. By doing this, you are far away enough for the flash to disperse over a larger area. With digital editing, you can crop any extraneous anatomy. If the image is taken at a high resolution, your image will be of sufficient magnification after cropping the unwanted structures (macro-like).

STANDARD ADULT MAGNIFICATION RATIOS	VIEW RATIO
Full length	1:50
Head & neck	1:10
Face	1: 8
Both hands	1: 10
Single hand	1: 5
Single eye	1: 2

RADIOGRAPHS

Taking images of plain film radiographs can be difficult. The film is placed on an X-ray viewer box and the image is then taken. In most cases, there will be a greyish green cast to the image. This is due to the fluorescent light in the X-ray viewer that produces flicker at the mains frequency. Essentially, when the image is taken, the fluorescent light may be flickering on or off, thereby affecting the colour of the image.

There are many complicated ways of overcoming the colour cast, but we have found two methods that appear to achieve the desired results more easily. The image can be manipulated to produce a black and white image (Fig. 14b) using bought software such as Adobe photoshop (www.adobe.com) or using open-source software such as GIMP (www.gimp.org). The second technique- and the easiest-is to set the digital camera to capture images in black and white.



PRESENTATION SOFTWARE

For presentations use Open Office. It is virtually the same as Microsoft Office; the only difference is that you can save the documents in any format available, such as those used by Microsoft Word and Google Docs. Open Office offers a program called impress that is equivalent to Power Point. We use a black or a while background for my slides, as this makes the images more prominent on the slides . These presentations are used both for patients as an education tool and for lecturing purposes. Its useful to take a photograph of the nearest shade tabs to the adjacent tooth so that all information available can be sent to the laboratory technician . The image is sent as either a JPEG or an Open Office impress file to the laboratory. The technician will be able to use the image to create a restoration with the correct shade and characterization. We also use the images taken pre and post-operatively of any restorative and implant work and supply the images to the dental technician, as rarely do technicians see their own handy work in situ.

Another open-source programmer (GIMP) to manipulate the images, that is to crop out any unwanted distractions, such as the retractors . Using this software, it is possible to re-orientate the image if not level with the horizontal plane using the rotation tool. The image is simply saved and imported into the presentation program.

REVIEW OF LITERATURE

Bernstein ML. in 1983 said the dental charting and word of the forensic dentist on identification have been readily accepted and rarely challenged in court .In the era when technology has made quality photography accessible to all dentists ,these techniques permit improvement of a procedure, adding photographic record to a written document in postmortem dental charts promotes accuracy and reproducibility of detail and is desirable and logical for a technique whose value is predicted on its scientific behavior.

Christensen Gordon J. in 2005 said the dental clinical photography of the past, when making a clinical photograph required significant expertise and effort and the results were unknown for days to weeks after making the image. Fortunately, those days are past. Digital technology has revolutionized clinical dental photography. Today's pictures, instead of requiring days' or weeks' time to be developed, are available in seconds and can be displayed on computer screens or large projection screens within minutes. Images can be rotated, enhanced, lightened, darkened, cropped or altered in almost any way a photographer would wish.

Ward DH. In 2007 said digital dental photography has been crucial to the advancement of cosmetic dental procedures .It is an effective and necessary tool in the esthetic dentists' armamentarium. Practice will allow the dentist to achieve treatment results and allow every case to be improved .Dentists wishing to advance their techniques and to complete accreditation protocols should master these techniques.

Morse et al in 2010 said Although not mandatory, the importance of photography as a clinical, administrative and marketing tool suggests that its use should be widespread in the UK. Developments in digital photographic technology have facilitated the integration of photography into clinical dentistry as many practitioners have access to a computer. These facilitate practice administration and reduce dependency on paper records. Computerization, coupled with software, enables the manipulation and storage of digital images and transfer of data over the Internet.

Manjunath SG. Et al in 2011 Intraoral photography is a part of contemporary dental practice. Intraoral conditions which in the course of dental treatment are subject to change can be recorded in detail by means of photographs. These provide an improved documentation and the option of monitoring particular situations over longer periods of time. With the right skills and photographic methods, the

clinician enhances communication with the patient regarding treatment planning. This article emphasizes types of camera and the accessories for intraoral photography which enables the practitioner to make standardized photographic documentation of cases.

Maclaren EA, Schoenbaum T. in 2011 said Digital photography is an exceptional tool for communication, diagnosis and documentation .So much of what is possible today with dental treatment hinges strongly upon dentists' ability to fully capture the necessary diagnostic information and properly educate their patients with proper training techniques ,equipment and implementation ,dental photography can significantly enhance the level of treatment provided.

Malay Kumar et al in 2014 said Dental Photography is mainly used for documentation and patient education. With development of technology digital photography eliminates the delay between image-capture and review compared to the film based photography in the past. This review article is based on an exploratory study conducted on the medical literature to provide clinicians an overview of the function and basic components of a professional digital single lens reflex (DSLR) camera system, the criteria for evaluating and selecting a digital camera system, clinical applications for dental photography along with the guidelines for obtaining a quality dental images.

Anna Kataoka, MS, MBA in 2016 said The application of digital photography has permeated every aspect of modern dentistry. In fact, it would be difficult to imagine today's dental practice without the use of photography. It is simple and fast, and its uses include case documentation; treatment planning; and patient, peer and lab intercommunication, collaboration, and education.The main objective of dental photography is documentation of dental treatment, through images demonstrating the patient's record, the treatment plan, and progress of the results.

Clinical photography offers an instant look at the patient's case which can be effortlessly reviewed, monitored, and compared with the patient's other records. Other applications of dental photography include:

• **Patient education and communication:** Visual aids help educate patients on diagnosis and proposed treatment, ultimately resulting in better understanding of a proposed treatment plan, higher case acceptance, and improved practice productivity.

• **Peer-to-peer collaboration and referrals:** Images introduce an entirely new dimension when referring patients to other specialists. Clinical photographs, in particular, play a pivotal role in consultations regarding new patients, facilitating effective communication with both the patient and the referred specialist.

• **Laboratory communication:** Although a stone model accurately renders the details of a tooth's shape and position, it provides no details on a tooth's gingival character, shade, color, or translucency. A shade guide may help characterize the color, but it does not have the ability to portray the complexity of the tooth structure as comprehensively as an image. Photographs, on the other hand, effectively convey visual information about hue, chroma and value of a restoration, leaving little room for misinterpretation of the desired outcome.

• **Patient record management and insurance verification:** Dental charting, radiographs, and the proper description of a patient's clinical condition are required by insurance providers before benefits can be disbursed. Although useful in recording the state of the mouth, radiographs and charting do not provide
information about the tissue. Digital photographs of a patient's condition can support a recommended treatment plan and expedite authorization of an insurance claim.

• **Legal documentation:** A malpractice lawsuit is every dentist's nightmare. In certain cases, clinicians may find themselves involved in consulting on, or even rectifying a negligent treatment. Proper photo documentation may support the case of a mistreated patient or, conversely defend a falsely accused colleague.

CONCLUSION

Dentistry has benefited from the trends and advances in digital photography, and a well designed protocol of dental photography may be a great contribution for the Prosthodontic practice. Digital records may be used for several purposes, including patient records, treatment evaluation, patient counseling, didactic and medico-legal uses, as well as to present the quality of procedures for marketing purposes. A good for dental photography protocol may greatly enhance the dental practice. The aim of this article is to describe scientific and technical information in detail to provide a guide for dentists who wish to use photography more effectively. This article also addresses some relevant questions for the selection and applicable settings of semiprofessional and compact digital camera systems to enhance the achievement of good-quality and well-focused photographs.

1. Approximately one-third of the surveyed dentists in our country use dental photography for the purpose of daily practice.
2. Most often, dentists (2/3 of respondents) use compact digital camera for dental photography.
3. More than half of dentists say that the reason not to use dental photography in everyday practice is expensive investment in equipment and one-third of respondents indicated that further training is needed.
4. Most commonly dentists use photography to register the health benefits, secondly, for the purposes of medical records and thirdly to improve communication with the dental laboratory.
5. The percentage of colleagues who use dental photography is greater among men, among doctors under the age of 35 years and with experience under 5 years, dentists who practice in a group practice, and using a dental assistant.

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