A Short Guide to
Clinical Digital Photography in Orthodontics

Second Edition

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Revised & Updated

Shadi S. Samawi

BDS, MMedSci, MOrthRCS

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References, Resources & certain adapted Images:

See "References" Section at the end of this e-book.

About the Author..

Shadi S. Samawi...

.. Received his Bachelor in Dental Surgery (BDS) from the University of Jordan in Amman in 1999. Following one-year Residency training at the Royal Medical Services of the Jordanian Armed Forces and two years in private practice, he left to the United Kingdom in 2001 to obtain his two-year Master's degree in Clinical Orthodontics (MMedSci) from the University of Sheffield in 2003, and has been a registered specialist since then.

Later worked full-time as an *Honorary Clinical Fellow in Orthodontics* at the Charles Clifford Dental Hospital in Sheffield for an additional year and obtained the Membership in Orthodontics from the Royal College of Surgeons of Edinburgh (MOrthRCSED) in the United Kingdom, and has since been in private practice in Amman, Jordan.

He has lectured – and continues to lecture - in several meetings & venues including the Jordanian Dental Congress , JOS meetings as well as local schools, and is a member (Fellow) of a number of orthodontic societies such as the **Jordanian Orthodontic Society (JOS)**, the **Arab Orthodontic Society (AOS)** and the **World Federation of Orthodontists (WFO)** .

Currently, he is in charge of the Jordanian Orthodontic Society's Internet & Multimedia committee, and administers the society's official website. He had also been appointed as Head of the Secretarial Committee of the Bureau of Conferences at the Jordan Dental Association between 2009-2011, which was in charge of the 22nd Jordanian & 39th Arab Dental Congress, and the 1st Jordanian Cosmetic Dentistry Congress held in Amman in October 2010 & May 2011 respectively.

He has been on the Board of Directors (Executive Committee) of the **British Universities Alumni Association (BUAA)** since 2008 and has been re-elected for the 2010-2012 term.

Some of his other major interests include Photography, Computers, Graphic and Web Design and he is responsible for the development and administration of several websites including those of the AOS, JOS, and BUAA, as well as his own website (www.sdoc.jo).

"Do not seek praise. Seek criticism."

Chinese Proverb

If you have any questions, comments or suggestions
to help improve this ebook in future editions,
please email me your constructive criticism
to info@sdoc.jo

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1. Introduction

Why Take Orthodontic Photographic Records?

Basic Orthodontic Records include three main types of records:

1. **Study models**; properly-trimmed, stone-cast moulds of the dentition.
2. **Radiographs**; normally a Panorax (OPG) and a Lateral Cephalometric view.
3. **Clinical photographs**.

Each of these types of records provides certain diagnostic information to the orthodontist to aid him/her in diagnosing and determining the best possible treatment plan for each particular case. The emphasis has long been on taking the first two (study models and X-rays), while the third (clinical photographs) was often seen as a luxury; an unnecessary waste of the clinician's time, by many orthodontists!

The Benefits of taking Clinical Photographs

Times have certainly changed. Now, with more and more emphasis from the orthodontic community on the achievement of balanced facial harmony and smile esthetics for our patients - in addition to the traditional orthodontic goals of a well-aligned and functional dentition - the need for proper clinical photographic records of the orthodontic patient has become even more essential for proper treatment-planning and follow-up.

Clinical photographs allow the orthodontist to carefully study the existing patient's soft-tissue patterns during the treatment planning stage. We can assess lip morphology and tonicity, the smile arc and smile esthetics from various angles. We can also assess the degree of incisal show upon smiling. Thus, they allow us to study the patient in a so called “social” setting, and all without the patient ever being present. Such information greatly aids the orthodontist in formulating the best possible treatment plan for each patient, and monitoring them in subsequent follow-ups.

Obviously, there has always been the need for photographic records for purposes of research and publication, and for lecturing and teaching presentations. Also, the growing importance of the need for such records for medico-legal reasons cannot be over-emphasized.

Why Go DIGITAL?

Going for a digital camera is THE obvious choice in this digital age. One of the major reasons is the ease of use of such cameras, along with the ability to repeat / delete unsuitable images on the spot. There is no need to wait till the film is developed to check your photos. Any problems can be easily rectified immediately. Another important advantage is the “Running Cost” issue. Digital camera setups are cost-effective; no more buying film, no more developing costs and hassles, and no more worries about where to store all the slides and “physical” photographs of your patients. All you need is a one-time investment in a suitable digital camera setup, a generous memory card, and a reasonable-size computer and hard disk setup.

The last advantage to mention is the ability to enhance, or “post-process” your images. Even if some images are still not suitably aligned, rotated, or the color, brightness or saturation etc. is not up to standard, it is very easy to adjust those using a suitable image-editing software on your computer, before saving the images in the patients’ file.

2. Basic Photography Terms

Image Resolution

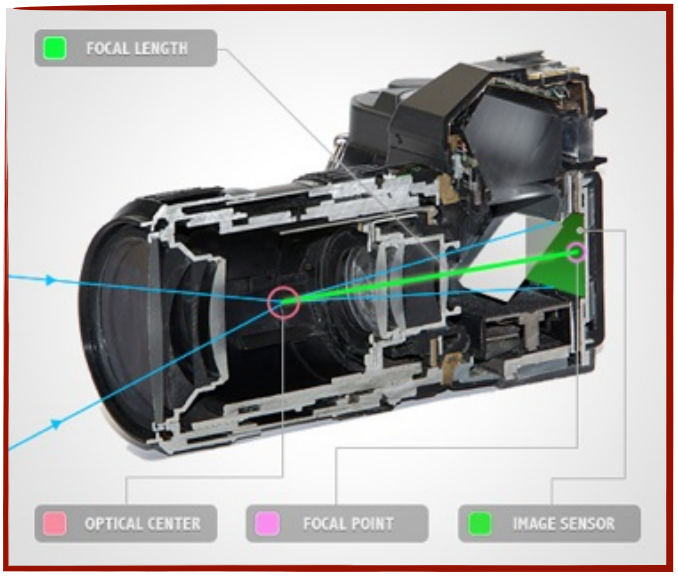
Resolution describes how much detail an image can hold. An image's resolution is determined by the image's pixel count and the bit depth of each pixel. A pixel is the smallest discernible element in an image. Each pixel displays one color. A pixel's color and brightness range is determined by its bit depth. Pixels are grouped together to create the illusion of an image. As the number of pixels increases, the image's detail becomes sharper.

A camera's resolution is calculated by the number of megapixels (millions of pixels) its digital image sensor is capable of capturing. A display's resolution is expressed in pixels per inch (ppi) or as a maximum dimension, such as 1920 x 1280 pixels. A printer's maximum resolution is expressed in dots per inch (dpi)—the number of dots it can place within a square inch of paper. The number of megapixels a camera is capable of capturing can be used to roughly determine the largest high-quality print that the camera is ultimately capable of producing.

PRINTING RESOLUTION GUIDE		*Adapted From: www.exposureguide.com*	
MEGAPIXELS	IMAGE RESOLUTION	PRINTED AT 200 PPI	PRINTED AT 300 PPI
2 MP	1600 X 1200	8.0 X 6.0 IN.	5.3 X 4.0 IN.
3 MP	2048 X 1536	10.2 X 7.7 IN.	6.8 X 5.1 IN.
4 MP	2400 X 1800	12.3 X 8.2 IN.	8.2 X 5.4 IN.
6 MP	3008 X 2000	15.0 X 10.0 IN.	10.0 X 6.7 IN.
8 MP	3264 X 2448	16.3 X 12.2 IN.	10.9 X 8.2 IN.
12 MP	4290 X 3264	21.4 X 14.0 IN.	14.3 X 9.3 IN.

In theory, the minimum camera resolution suitable for orthodontic purposes would be around **3-4 Megapixels**. Although a higher resolution would be an added advantage, it ultimately results in larger file sizes and thus requires larger capacity hard drives for storage. *The choice is yours!*

Focal Length

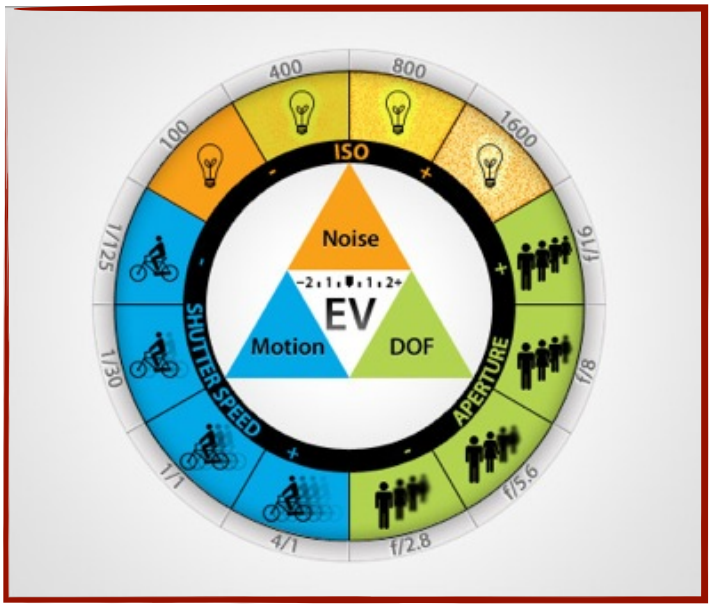


An important attribute of a lens, besides its quality, is its focal length. Focal length is technically defined as the distance from the part of the optical path where the light rays converge to the point where the light rays passing through the lens are focused onto the image plane—or the digital image sensor. This distance is usually measured in millimeters. From a practical point of view, focal length can be thought of as the amount of magnification of the lens. The longer the focal length, the more the lens magnifies the scene. In addition to magnification, the focal length determines the perspective and compression of the scene.

Exposure: What Controls it?

The Exposure Triangle ::

Aperture, Shutter Speed & ISO



When these three elements are combined, they represent a given exposure value (EV) for a given setting.

Any change in any one of the three elements will have a measurable and specific impact on how the remaining two elements react to expose the film frame or image sensor and how the image ultimately looks.

1. Aperture

A lens's aperture is the opening in the diaphragm that determines the amount of focused light passing through the lens. At a small f-stop, say f/2, a tremendous amount of light passes through, even at a fraction of a second; but at f/22, when the diaphragm is perhaps at its smallest, only a tiny amount of light is let in (even at longer shutter speeds).

2. Shutter Speed

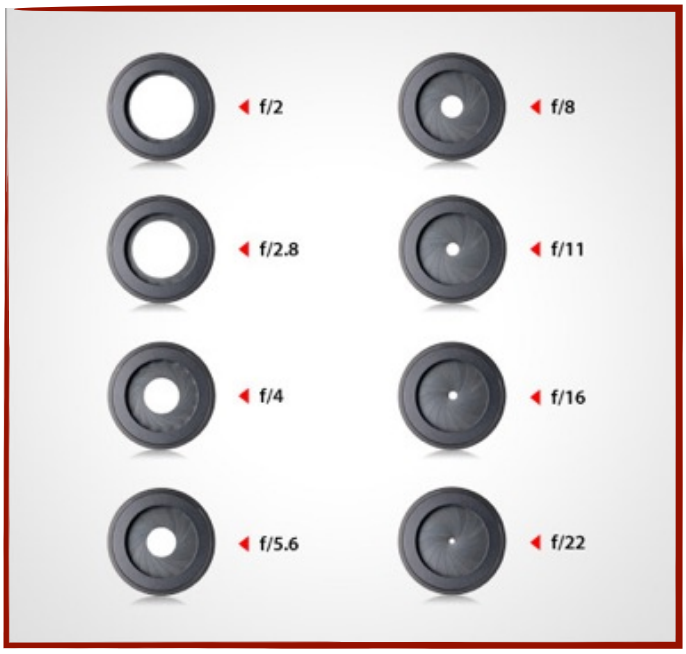
Shutter speed refers to the amount of time the shutter is open or the digital image sensor is activated. The exposure of the image is determined by the combination of shutter speed and the opening of the aperture. Shutter speeds are displayed as fractions of a second, such as 1/8 or 1/250. Shutter speed increments are similar to aperture settings, as each incremental setting either halves or doubles the time of the previous one. For example, 1/60 of a second is half as much exposure time as 1/30 of a second, but about twice as much as 1/125 of a second.

3. ISO

ISO stands for International Standards Organization. The ISO rating, which ranges in value from 25 to 6400 (or beyond), indicates the specific light sensitivity. The lower the ISO rating, the less sensitive the image sensor is and therefore the smoother the image, because there is less digital noise in the image. The higher the ISO rating (more sensitive) the stronger the image sensor has to work to establish an effective image, which thereby produces more digital noise (those multi-colored speckles in the shadows and in the mid-tones). The digital camera engineers have designed the image sensor to perform best at the lowest ISO (just like with film). On most digital cameras this is ISO 100, although some high end DSLRs have a mode that brings the ISO down to 50 or even 25.

“F” Number & Depth of Field

The F number basically refers to the aperture opening size on the lens. The smaller the F number, the larger the aperture opening and the “shallower” the depth of field of the image is, i.e: less and less parts are in focus. The larger the number is, the smaller the aperture and more depth of field exists i.e: the photo is “sharper” throughout (See image below).



3. Clinical Requirements

A. The Digital Camera

There are three types of digital cameras available; the “Point & Shoot” digital camera, the fixed-lens Zoom camera and the DSLR (Digital Single Lens Reflex) cameras. The DSLRs are what professional photographers currently use, as they allow maximum flexibility and customization for the highest possible quality of digital images. There are many cameras from all spectrums that are suitable for dental/ orthodontic record-taking purposes, however, this section will focus on DSLRs, as they are the best cameras suited for our purposes due to their high quality images and versatility.

Digital Single Lens Reflex Cameras (DSLRs)

ADVANTAGES	DISADVANTAGES
+ Full manual control	— Maintenance
+ Excellent image quality	— Heavy and bulky
+ Superior build quality	— Weak built-in flash
+ HD Movie recording options	— Sometimes expensive
+ Extremely large ISO range	— Limited control over video
+ High Res. LCD screen with live view	— Bigger images = Bigger files

Based on the previous points, DSLR Cameras are highly recommended for taking orthodontic photographic records. The high level of professional customization and wide range of possible settings allow for the best professional-looking, high-quality photos possible.

Fixed-lens Zoom Cameras

ADVANTAGES	DISADVANTAGES
+ 10–20x optical zoom	– Bulkier than compacts
+ Packed full of features	– Limited expandibility
+ Relatively good picture quality	– Weak built-in flash
+ Movie recording options	– Low-resolution LCD screen
+ Optical Image stabilization	– Shutter lag (0.5 sec)
+ Live view	– Poor high-ISO noise reduction

Point & Shoot Compact Cameras

ADVANTAGES	DISADVANTAGES
+ Convenient and easy to use	– Limited manual control
+ Compact, light and portable	– Sometimes expensive
+ Relatively good picture quality	– Weak built-in flash
+ Movie recording options	– Short battery life
+ Optical Image stabilization	– Smaller ISO range
+ Live view	– Shutter lag

B. The Lens

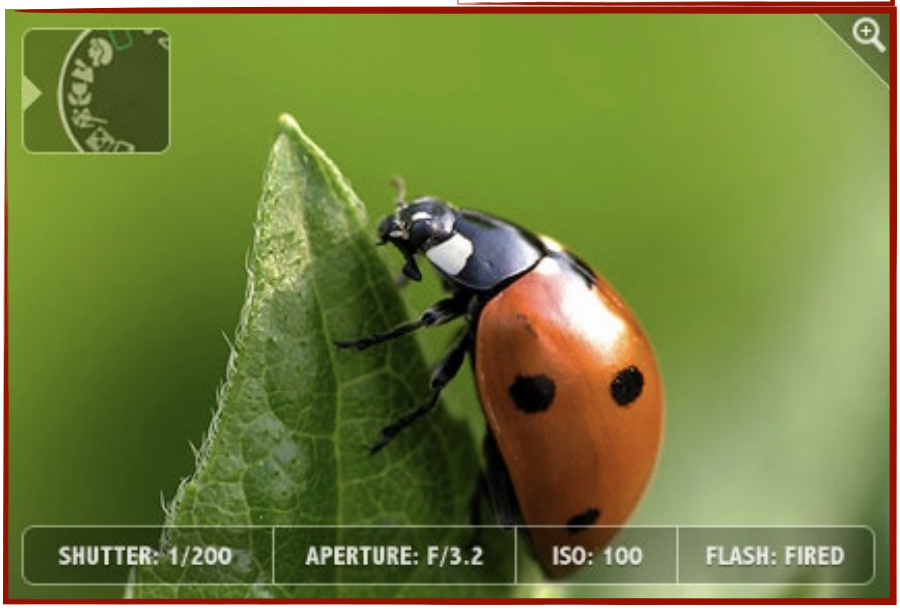
Macro Lens vs Macro Function

What is “Macro” ?

Macro photography refers to *close-up* photography; the classical definition that the image projected on the "film plane" (i.e film or a digital sensor) is the same size as the subject. Most Point-&-Shoot digital cameras have a built-in *Macro function* that is actually very good for dental photography purposes. However, a dedicated *Macro lens* attached to a DSLR camera provides even better close-up photos usually with higher definition and better focus, and is by far the superior choice.

Macro Lens

Macro Function



C. The Flash

Ring Flash vs Point Flash

The Point Flash may sometimes produce fairly good light distribution when used for clinical photographs. However, dark distracting shadows, which may also obstruct important details do occur frequently. These are often irreparable using image editing software, and will detract from the final quality of the image, and possibly the information gained from it. In contrast, the Ring Flash eliminates such shadows by allowing a more even distribution of light during extra and intra-oral photographs (See figure), and thus the quality of the image is enhanced due to overall better illumination.

Therefore, it is *highly recommended* to use a Ring Flash for orthodontic photography.

Point Flash

Ring Flash

D. Retractors

The recommended cheek retractors to be used for best results in clinical photography are the **double-ended retractors** shown (See image).

There are two sets of double-ended retractors; one set with a Regular and Small size either end **(Small set)**. These are mainly used for intra-oral occlusal shots (mirror shots). The other set has a Narrow end and a Wide end on the other **(Large set)**. These are used for intra-oral frontal and buccal shots.

Although other types of retractors are available on the market, it is accepted by most that this selection presents the most ideal set to be used for clinical photography, as they greatly facilitate taking almost any kind of intra-oral photographs with clarity and with the largest possible field of vision. Smaller one-piece orthodontic bonding retractors are generally NOT a good choice for orthodontic purposes, especially for buccal and occlusal shots, as their retraction potential is very limited, and it can often prove to be a “painful experience” for the patient.

It is a wise long-term investment to buy good quality retractors to ensure durability and reliability, with recurrent disinfection procedures.

Recommended Retractors

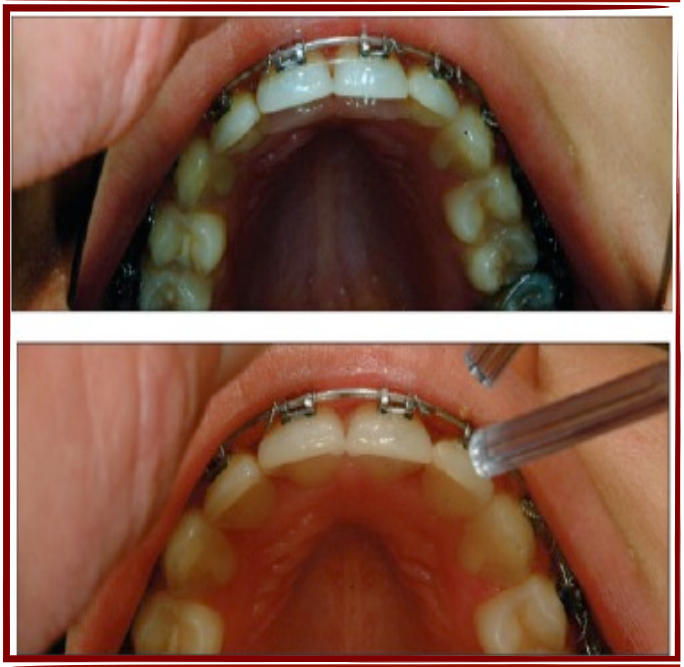
E. Dental Photography Mirrors

Many types of mirrors have been used for clinical photography over time, ranging from front-silvered mirrors to highly-polished Stainless Steel mirrors. **Front-coated silvered mirrors** seem to offer the best image quality and light distribution over other types of mirrors. As you can see from the accompanying figure, with front-silvered mirrors, no "ghost" image, or "double-layering" occurs. In contrast, when using glass or rear-coated silvered mirrors, "ghosting" can severely affect the quality of the image, resulting in haziness or a "Double-Image". Also, light reflection is not on par with the front-silvered mirrors, leading to a "dimmed", darkened image as an end-result. Therefore *front-coated silvered mirrors are highly recommended* over other types.

In addition, it is preferred to use **"long-handle" mirrors** (see Image) as they allow better control and handling by the clinician during the occlusal shots. You can find different sizes for use with different patients depending on age and mouth-opening size, but generally, the **"Medium"** sized mirrors would be fit for use with most patients.

Mirrors with no handles may be used successfully but are trickier to handle, especially when "juggling" an expensive digital camera in the other hand!

Rear-coated Silver Mirror :: Ghosting occurs



Front-coated Silver Mirror :: No Ghosting

Long-handle Mirrors

Digital Camera Set-up Recommendations

The following are a number of recommended cameras, lenses and flashes - in no specific order - that are suitable for clinical photography and combine ease of use, availability and a reasonable price tag! Higher-end DSLRs - although having more advanced features - are more expensive and not really necessary for orthodontic purposes. Camera brands other than Canon & Nikon with comparable specifications also are a good choice if you prefer.

(You may click the underlined links below to visit the equipment's Amazon page for further details.)

DSLR Cameras:

- *Canon EOS (XTi)*
- *Canon EOS (XSi)*
- *Canon EOS (T1i)*
- *Canon EOS (T2i)*
- *Canon EOS (T3)*
- *Canon EOS (T3i)*
- *Canon EOS (60D)*

- *Nikon D40*
- *Nikon D60*
- *Nikon D90*
- *Nikon D3000*

Lenses:

- Canon EF 100mm f/2.8 Macro USM Lens for Canon SLR Cameras
- Canon EF 100mm f/2.8L IS USM 1-to-1 Macro Lens for Canon Digital SLR Cameras
- Nikon 105mm f/2.8G ED-IF AF-S VR Micro-Nikkor Lens for Nikon Digital SLR Cameras

Flashes:

- Canon MR-14EX Macro Ring Lite for Canon Digital SLR Cameras
- Macro Ring Flash LED Light - Works with Canon/Sony/Nikon/Sigma lenses
- Phoenix Smart Flash RF46N Macro Ring Flash for Nikon Digital SLR Cameras

You can also visit http://www.thedigitaldentist.co.uk for a lot more detailed and useful info about digital camera set-ups for clinical photography.

How Many Photographs Do We Need?

Different clinicians take different numbers of clinical photographs, depending on who you talk to! There is no "standard" set that is universally-approved as a rule of thumb. However, it can generally be accepted - based on many authorities' opinions in this field - that a complete *"Clinical Photographic Set"* for any orthodontic patient at any stage of treatment, that would enable the clinician to obtain maximum benefit and information, should include *a minimum of nine photographs; four extra-oral, and five intraoral photographs.*

Needless to say, a clinician may also choose to take views other than the ones mentioned above, as needed to document the entire case in further detail.

Extra-oral clinical photographs are the easiest photographs to take. They only require proper positioning of the patient and clinician, in addition of course to the digital camera setup itself. **Intra-oral** photos require - in addition to the camera setup - the proper cheek retractors, dental photography mirrors, as well as a well-trained assistant if possible. Clinical steps for properly taking each photograph is explained further.

Extra-Oral Photographs

Extra-oral photos consist of the following four shots:

1. **Face-Frontal (lips relaxed).**
2. **Face-Frontal (Smiling).**
3. **Profile (Right side preferably - Lips relaxed).**
4. **(45 °) Profile (also known as 3/4 Profile - Smiling).**

These four shots provide the clinician with maximum possible information about the patient's facial and soft tissue features, proportions, and Smile esthetics.

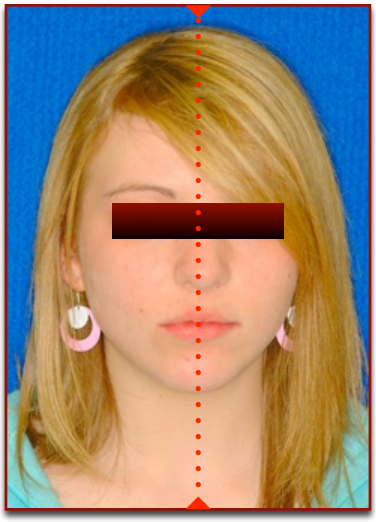
1. Face - Frontal (Lips Relaxed)

The first extra-oral photo to be usually taken, this photo is probably the easiest. However, there are still some important guidelines that need to be taken into account when taking this shot.

First, the **Framing** of the shot should encompass the whole of the patient's face and neck with a reasonable margin of space all around. This is ensured by holding the camera lens in a *vertical* position, and by standing a reasonable distance away from the patient when taking the shot (4-5 feet). The following general guidelines should also be noted:

A. The patient should stand with their head in the **Natural Head Position**, with eyes looking straight into the camera lens.
B. The patient should hold their teeth and jaw in a relaxed **(Rest)** position, with the lips in contact (if possible) and in a relaxed position.
C. Make sure the patient's head is not tilted or their face rotated to either side; the shot should be taken at **90° to the facial mid-line** from the front.
D. Ensuring the patient's **inter-pupillary line is leveled** is also very important.

Proper Framing



Mid-facial line centered

Pupil line leveled

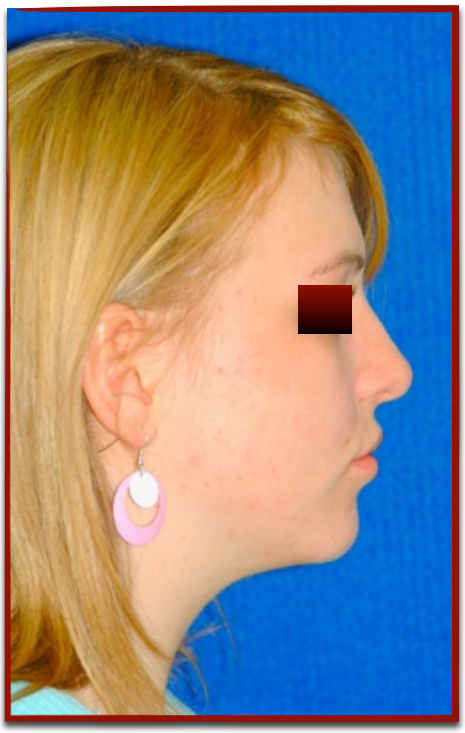
It is recommended that the patient stands in front of a plain, dark or white-colored wall or background when taking all extra-oral shots. This is to ensure maximum clarity of facial features and outlines without the presence of distracting objects in the background.

2. Face - Frontal (Smiling)

The same guidelines as for the (Face - Frontal)shot apply here, with the simple but important exception that the patient should be *smiling* in a natural way, with the teeth *visible.*

This photo greatly aids in visualizing the patient's Smile esthetics and soft tissue proportions during smiling.

3. Profile (Right Side - Lips Relaxed



The Profile photo has a high diagnostic value to the orthodontist. After taking the frontal face photos, the patient is asked to bodily turn to their left, thus having their right profile side facing the clinician. The head should be in the Natural Head Position, with their eyes fixed horizontally (preferably at a specific point at eye-level, or at the reflection of their own pupils in a mirror). The wrong head posture can result in confusion regarding the patient's actual skeletal pattern.

Ideally, the whole of the right side of the face should be clearly visible with no obstructions such as hair, hats or scarfs. For the most useful, professional-looking photo possible, the use of the Ring-Flash is essential. As explained earlier, the Ring-Flash will eliminate any shadowing of the border of the patient's profile onto the background, which can compromise the quality of the photo considerably.

4. (45°) Profile or ($^{3/4}$ Profile) - Smiling

This shot conveys the patient as if in "social interaction", and can give valuable information about the smile esthetics' changes pre- and post-treatment. From the Profile photo position, the patient is asked to turn their heads slightly to their right (about 3/4 of the way - hence the name), while keeping their body still in the previous "Profile Shot" position i.e. Facing forward. They are then instructed to look into the camera, and then smile. It is essential that the patient's teeth show clearly when smiling, otherwise the photograph would be of minimum benefit.

Quick Notes on Extra-oral Photographs..

• The background used in taking the photos should be either a solid-white background (or a back-lit light-box), or a solid-dark color such as Dark Blue. Taking extra-oral photos with the patient sitting on the dental chair or with multiple distracting objects in the background should be avoided.

• The clinician's positioning for these photos would be standing a few feet away from the patient, and at the same eye level if possible. Younger and shorter patients can stand on a special stand to get them to reach a suitable height if needed.

• For all extra-oral photos, the recommended minimum Aperture value (F value) range is between F8 - F11. You can still use the highest possible F value on your lens e.g F32, if you wish, since the presence of the flash will ensure adequate illumination and exposure of the scene.

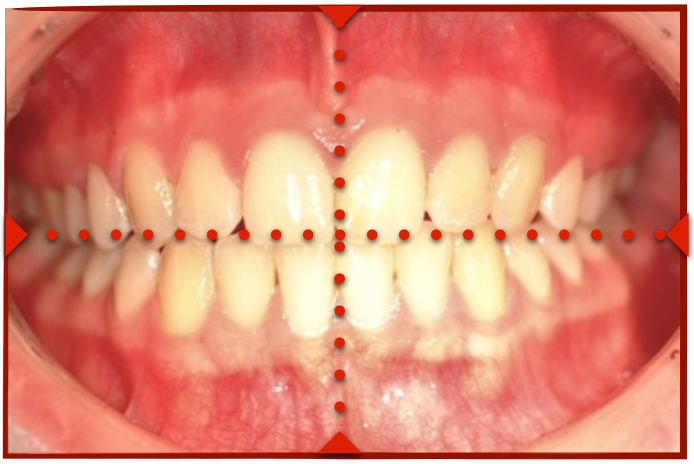
Intra-Oral Photographs

Intra-oral photographs require more attention to detail to produce good results. For these shots, the use of the special cheek retractors and dental mirrors will be required, in addition to help from a dental assistant.

There are five essential intra-oral photographs:

1. **Frontal - in occlusion**
2. **Right Buccal - in occlusion**
3. **Left Buccal - in occlusion**
4. **Upper Occlusal *(using mirrors)***
5. **Lower Occlusal *(using mirrors)***

1. Frontal - in Occlusion



The first photo to be usually taken of the set. With the patient sitting comfortably in the dental chair and raised to *elbow-level* of the clinician, the assistant stands *behind* the patient and uses the first *larger set of retractors from the wide ends* to retract the patient's lips ***sideways and away*** *from the teeth and gingivae*, & slightly towards the clinician. This is important to allow maximum visualization of all teeth and alveolar ridges, and also to minimize discomfort for the patient from retractor edges impinging on the gingivae. The photo should be taken 90° to the facial mid-line & central incisors.

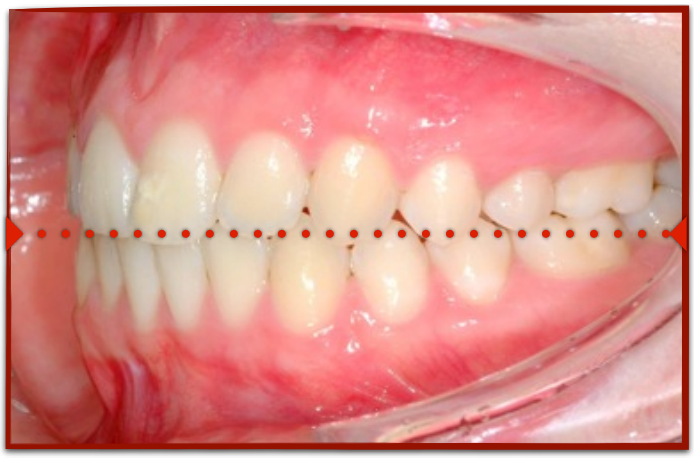
The dental mid-lines are not as reliable for this purpose as they can be shifted to one side or the other depending on the malocclusion present. The full extension of the sulci is paramount for full visualization and clarity, and the *high F value setting* e.g. F32 is required to attain *maximum depth of field* of the shot with even the last visible molars fully in focus. The Ring-Flash will greatly aid in producing a quality photograph by ensuring the best possible illumination with no shadows, especially in the deeper parts of the oral cavity and buccal vestibules.

2. Right Buccal - in Occlusion

Usually the second shot in the series. The assistant flips the right retractor to the narrower side, while the left retractor remains in place as for the previous frontal shot. The patient is asked to turn their head slightly to their left so their right side will be facing the clinician.

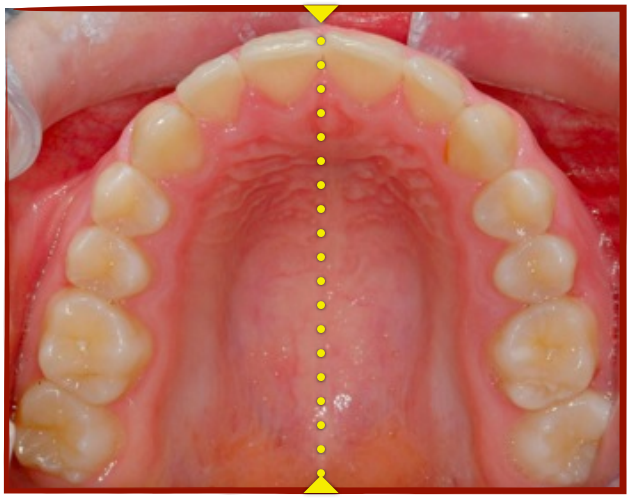
Here, the clinician holds the right retractor and stretches it to the extent that the last present molar is visible if possible, while the assistant maintains hold of the left retractor, without undue stretching. Again, the shot is taken 90° to the canine-premolar area for best visualization of the buccal segment relationship, as this is very important in orthodontic assessment. A useful tip would be for the clinician to fully stretch the right retractor *just before* taking the shot to minimize any discomfort for the patient, and achieve maximum visibility of the last present molar, if possible.

3. Left Buccal - in Occlusion



The third shot in the series, it is very similar to the Right Buccal shot. The assistant now switches the retractors with the narrow end on the photo side (patient's left) and the wide end on the other (patient's right). Again, the shot is taken at 90° to the canine-premolar area, and to ensure this, the clinician should move their body slightly to the right while holding the retractor on the photo side, while the patient turns their head slightly to their right.

4. Upper Occlusal - Mirror



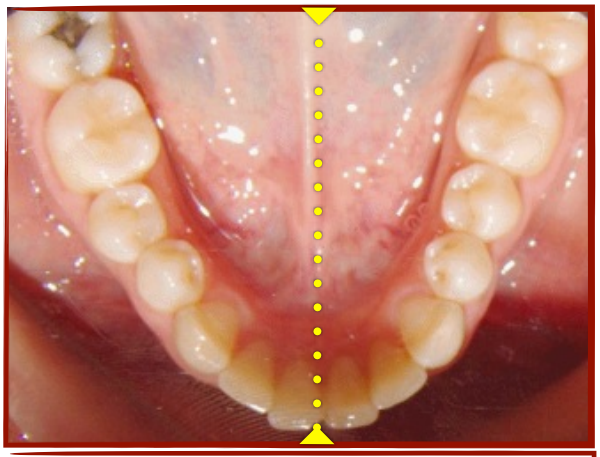
Here, the dental mirrors come into play. The assistant now switches to the *smaller* retractor set and with the patient's mouth held open, the retractors are inserted in a "V" shape to retract the upper lips *sideways and away* from the teeth. The clinician inserts the mirror with its wider end inwards to capture maximum width of the arch posteriorly, and pulls it slightly downwards so that the whole upper arch is visible to the last present molar. The patient is instructed to lower their head slightly so that the shot can be taken 90° to the plane of the mirror for best visibility. Use the mid-palatal raphe as a guide to get the shot leveled. Minimum retractor show in the image is recommended, and no fingers should be visible at any time.

Position Of Retractors For Upper Occlusal Shot

Upper Occlusal Shot

5. Lower Occlusal - Mirror

The final shot in the series. The assistant would now lower the smaller retractors into a *Reverse "V"* shape to retract the lower lips sideways and away form the teeth. The clinician would now lift the mirror upwards so he/she may visualize the reflection of the lower arch, while the patient is be asked to "lift their chin up" slightly. Ideally, the shot should be taken 90° to the plane of the mirror, with the last molar present visible.



"Ideal" Shot :
Tongue Rolled Back, Midline Centered.

"Less-than-Ideal" Shot :
Tongue Visible But Not Obstructing View.

An important issue here would be the tongue position of the patient while taking the photo. It is best to ask the patient to "roll back" their tongue *behind the mirror* so that it won't interfere with the visibility of any teeth, particularly in the posterior area.

The following images reveal in a more visual way some important aspects of Clinician/Assistant positioning, as well as retraction technique during photographic record-taking.

Position Of Retractors For Lower Occlusal Shot

Lower Occlusal Shot

Helpful Hints & Tips for Successful Photographs

- The direction of pull of the retractors is always sideways and slightly forward, away from the gingival tissues. This maximizes the field of view and minimizes patient discomfort.
- Wetting the retractors just before insertion eases the process of positioning them properly with minimum patient discomfort.

- When taking occlusal "Mirror" shots, slightly warming the mirror in warm water prior to insertion helps prevent "Fogging" of the mirrors which would prevent a clear image.
- In certain cases, profuse salivary flow and "frothing" can affect the quality of the image being taken, thus a saliva ejector can be used to eliminate saliva prior to taking each photograph.
- During occlusal "mirror" shots, instruct the patient to "open wide" *just prior* to pressing the camera button. This helps in obtaining the maximum mouth opening at the right moment, and minimizes the patient's fatigue during the procedure.
- It is recommended that all photographic records be taken *before* impression-taking, to eliminate the possibility of impression material being stuck between the teeth or the face during photographic record-taking.

5. Image Editing

Once all photographs have been taken, the next step involves downloading them to a computer for some (hopefully!) minor editing and image correction in preparation for saving and storing them on the hard drive, either in specific folders created by the user, or inside a dedicated database within a proprietary orthodontic imaging software.

Downloading Images to Your Computer

Images from your digital camera can be downloaded to your computer through either a *USB* connection, or the faster *Firewire* port present on some high-end PCs. Once the images are downloaded to a folder, it is good practice to ***immediately back-up*** that folder (with proper name and date) to another hard drive or removable media i.e. CD or DVD.

An immediate back-up ensures you have a complete back-up of all the original, unprocessed images in case something goes wrong during image processing!

Image-editing Software

Once that is done, you are ready to start editing your images using a suitable image-editing software. The best known software for image-editing is - without a doubt - *Adobe Photoshop. Corel's Paint Shop Pro* is another full-featured option.

However, for most orthodontic purposes, only basic editing functions are required to enhance most images before saving them, and thus a fancy (and often expensive) software is not really required. In fact, there are a number of free software programs on the internet that can be used easily and effectively for our purposes.

Some of the recommended programs include - but are not limited to - the following:

- **Microsoft's Preview** (bundled with Windows). It has all the basic functions for rotating, flipping, cropping, and enhancing the color and brightness of digital images.
- **Picasa (Windows & Mac)**: Not only does it have all the basic image editing functions in an easy-to-use setup, Picasa also provides an excellent cataloging feature for all your patients' images, and best of all, it's free!
- **Fast-stone Image Viewer (Windows)**: Another free piece of software that has most of the necessary functions as well as containing a simple and efficient library manager for organizing your photos into albums.
- **GIMP (Windows & Mac)**: it is also a free, open-source software with amazing capabilities, almost like a free version of Adobe's Photoshop!
- On *Apple's Mac* computers, the built-in **"Preview"** can also manage all the basic editing functions required. The bundled **"iPhoto"** can also do the same, and can make managing patients albums an easy and fun task. "**Pixelmator**" is a more advanced editing software that can also be considered a slimmed-down version of Adobe's Photoshop for Mac.

Basic Editing

Regardless of the software you choose to use, there are only a few number of editing procedures to follow to obtain the best possible end-result in most cases.

The main procedures include:

1. **Flipping (Mirroring) and De-rotation**, either vertically or horizontally.
2. **Cropping**; removing unnecessary image "information".
3. **Color, brightness and contrast** enhancement.
4. Selective "**Scratch Removal**".
5. **Saving image files**.

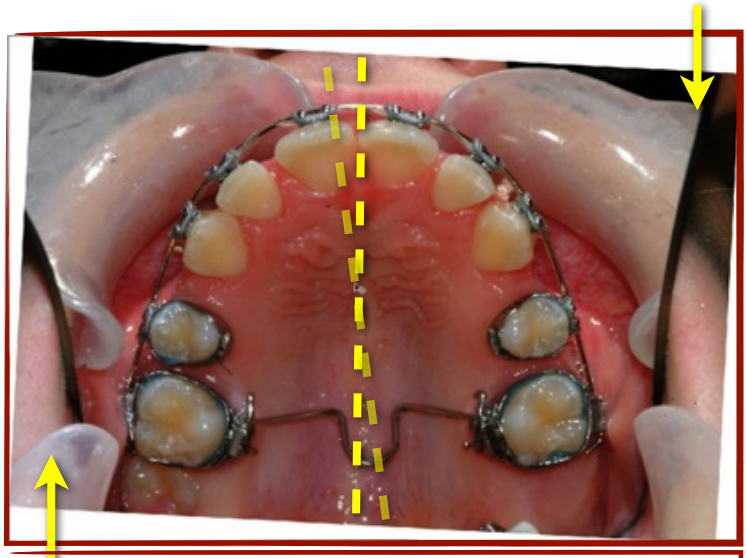
1. Flipping (Mirroring) and De-rotation

This should be the first step in editing the images. The purpose is to re-orient the image properly vertically and horizontally, and relative to the occlusal plane or mid-lines of the jaws. Frontal and buccal intra-oral shots should be level with the occlusal plane of the teeth. Upper and lower occlusal shots should have a leveled mid-sagital plane e.g. The mid-palatal raphe should be in the midline of the image.

These planes should be leveled ideally when taking the photos, but a small amount of correction usually remains needed. Upper and lower occlusal shots (Mirror) shots usually require vertical, then horizontal flipping to correct their orientation, followed by a degree of de-rotation to level the midline of the palate if needed (See below).

1. Before Vertical Flipping

2. After Vertical Flipping

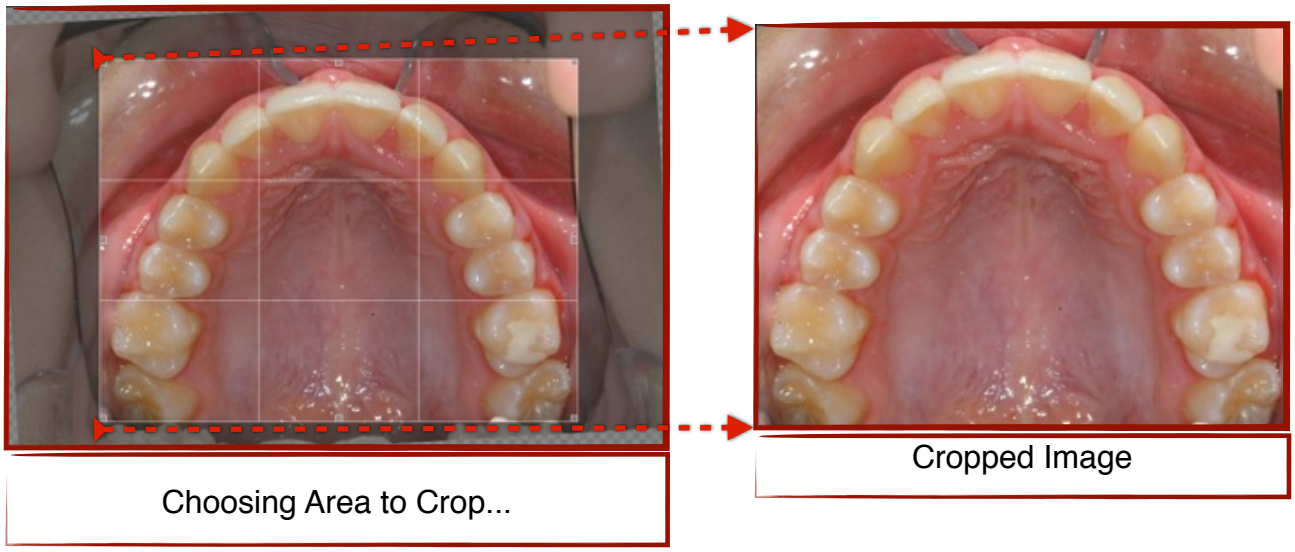


3. Image De-Rotation & Leveling

2. Cropping

The second step in processing the images. Its purpose is to remove all and any unnecessary parts of the image that are not required for a good image quality. This includes most of the cheek retractors, lips and fingers if present within the original image.

Cropping is easily achieved by selecting the “crop” tool within the image-editing software toolbar, and selecting the area that you require to keep. The software automatically “discards’ all other image information outside of the selected area (See example below).



Choosing Area to Crop...

Cropped Image

3. Color, Brightness, “Gamma” Control & and Contrast

Occasionally, images may require slight adjustments in their brightness/contrast values to make them more defined and in conformity with the rest of the images of the photo set. For even quicker adjustments, the “Exposure” and “Shadows/ Highlights” controls may be used, depending on the image-editing software being used.

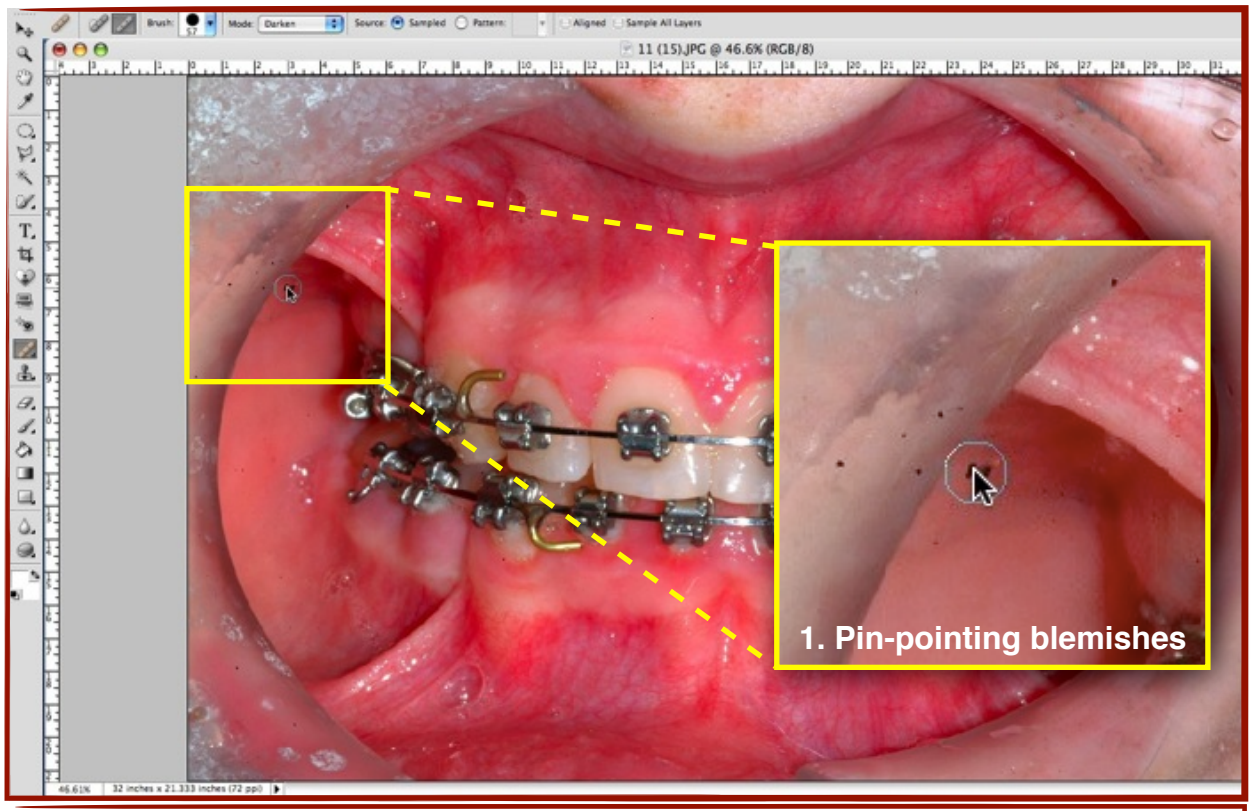
These controls can help minimize or even eliminate some dark shadows and the “dull” appearance of images.

The “Gamma” control is also a good alternative for both the “Brightness/contrast” controls combined. There are no specific adjustment recommendations here as the adjustments to be made are very subjective and variable depending on how the original image has been captured, and the operator’s preference and/or requirements.

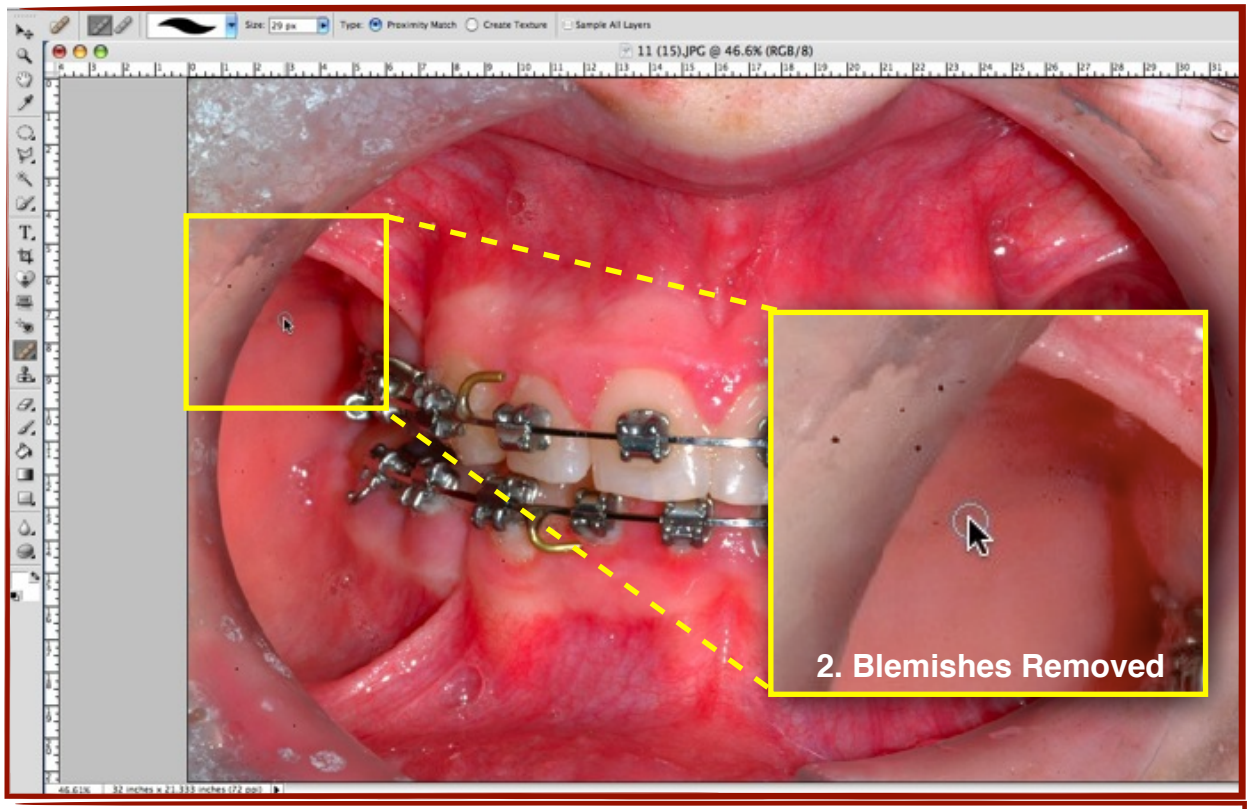
4. “Scratch” Removal

Sometimes dust particles become attached to the camera CCD sensor, or minor scratches occur on the mirrors used for occlusal shots.

These will appear on the final image as a “scratch” or dark blemishes scattered around the image and detract from the final quality of the the image. These can optionally be “removed” using the “scratch removal” tool that is found in some image editing software tools. This tool is sometimes called the “Healing” tool. The “Cloning” tool in certain software suites can also do a reasonable job of removing blemishes and dust shadows from images, as seen in the following figure on the next page...



Before using the “Scratch Removal” Tool.



After using the “Scratch Removal” Tool.

After the image enhancement part is accomplished, it is time to save the enhanced version, either in a dedicated folder for each patient and set of photos - labeled by date for example - or within a proprietary orthodontic imaging software database if available. There are many image formats to choose from, however, for practical purposes, we require only two main formats to effectively deal with storage and "working" images respectively, and so we shall briefly mention two formats;

1. Tagged Image File Format; commonly known as **TIFF** format.
2. Joint Photographic Experts Group Format, commonly known as **JPEG** format.

1. Tagged Image File Format (TIFF)

TIFF is a "loss-less" compression format i.e. No loss of quality occurs when saving files in this format (no data is removed to reduce the file's size). Therefore, this is the *preferred format for saving backup copies* of your original image files, before manipulation. This way, you will always have a high-quality copy of the original file in case anything goes wrong during the enhancement process, or in case of a computer crash!

The downside of this format is that it results in very large file sizes as no data is removed upon saving the file. Thus, large capacity hard drives are required to maintain storage of these backups, or alternatively, they can be regularly archived onto removable media such as CDs or DVDs, and filed according to patients' names or date of capture.

2. Joint Photographic Expert Group (JPEG)

This format may be considered as the "working" image format that can be used for performing the necessary image enhancements. It is a "lossy" compression format which means that every-time the image is saved, some image data loss occurs in order to maintain a reasonable file size, ultimately resulting in some degree of sacrifice in quality of the final image. Saving your final images in JPEG format is recommended as these images will be accessed frequently by the clinician, and may also used for presentation purposes.

PPI (Pixels Per Inch) & DPI (Dots Per Inch)

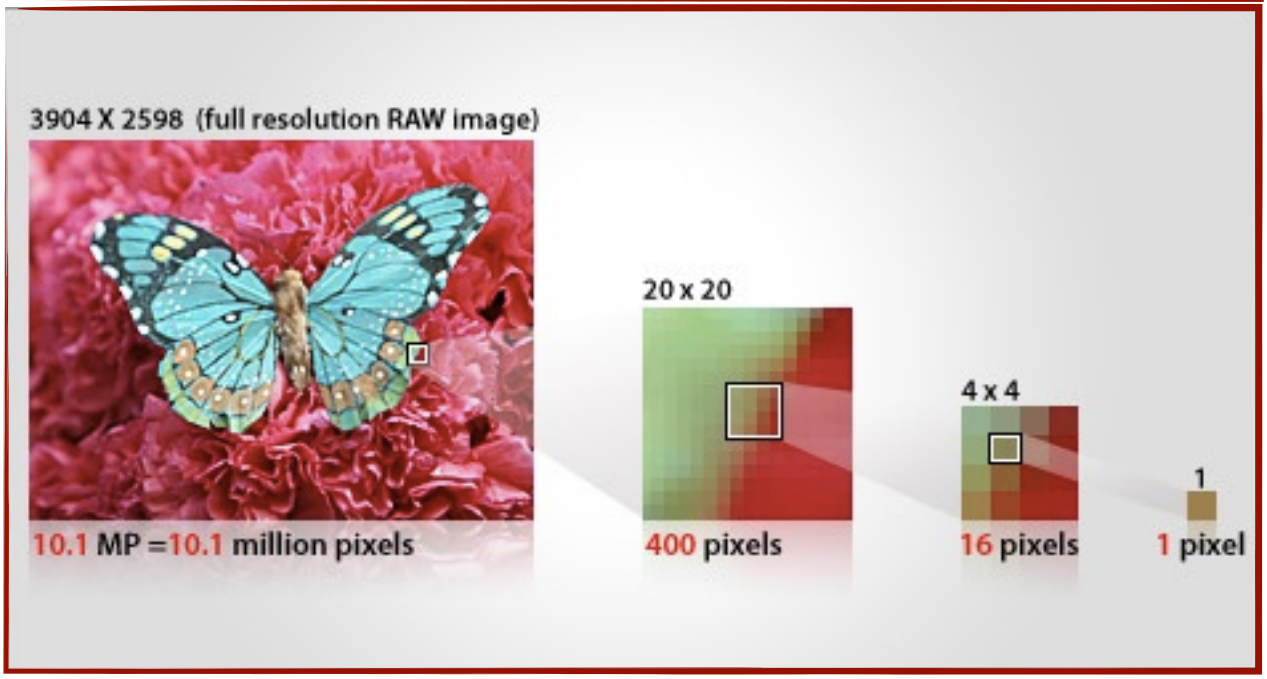
PPI (Monitor Resolution)

The total number of pixels that can be displayed on the screen at a time is called the resolution of the screen. This resolution is normally described in the pair of numbers, such as 2560 x 1440 for example. The actual number of pixels per inch depends on both the resolution and size of the monitor. An image with the same number of pixels varies on a monitor, depending on its size, as the same numbers of pixels are broadened over a larger screen. One pixel on a color display is actually a combination of three colors red, green, and blue. These small elements which form an image on the monitor are called *pixels*, thus monitor resolution is measured in *Pixels Per Inch or*

DPI (Printer Resolution)

The printer resolution measures your printer's ability to lay down an effective amount of color or black ink to accurately and smoothly reproduce your digital image. The resolution is measured in Dots (of ink) Per Inch or DPI. Your typical laser desktop printer has a resolution of 600 ppi, while inkjet printers can have a resolution of 2400 dpi or higher. This is why inkjets are used for photographic printing, because the high resolution easily allows for continuous-tone images with accurate reproduction of the colors, the shadow and highlight detail, and the overall image detail. You shouldn't think that you will improve the quality of your image if you use a higher dpi printer. That's only possible if the original image file has more pixels – from being photographed and saved at a higher resolution.

Screen Pixels



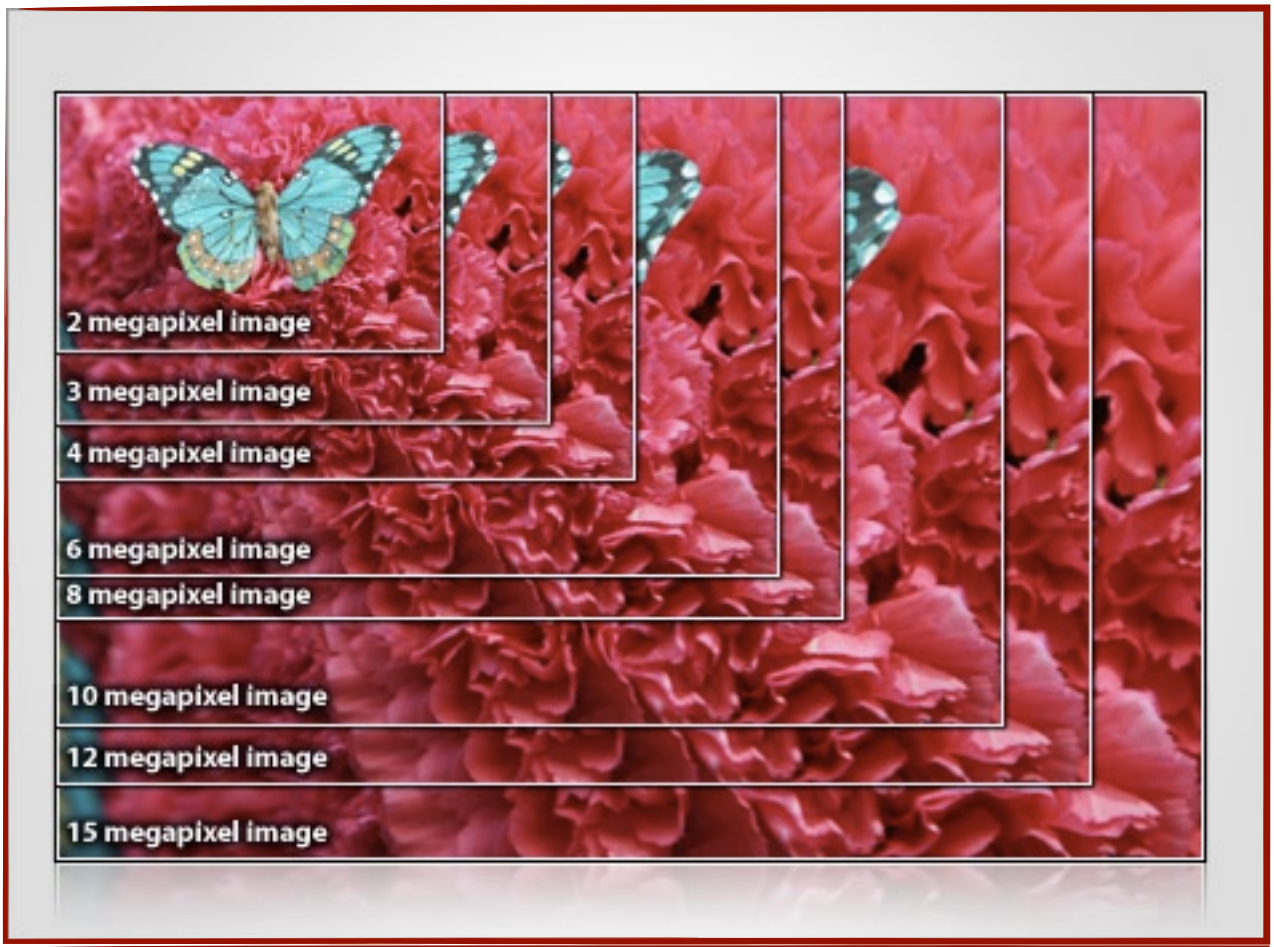
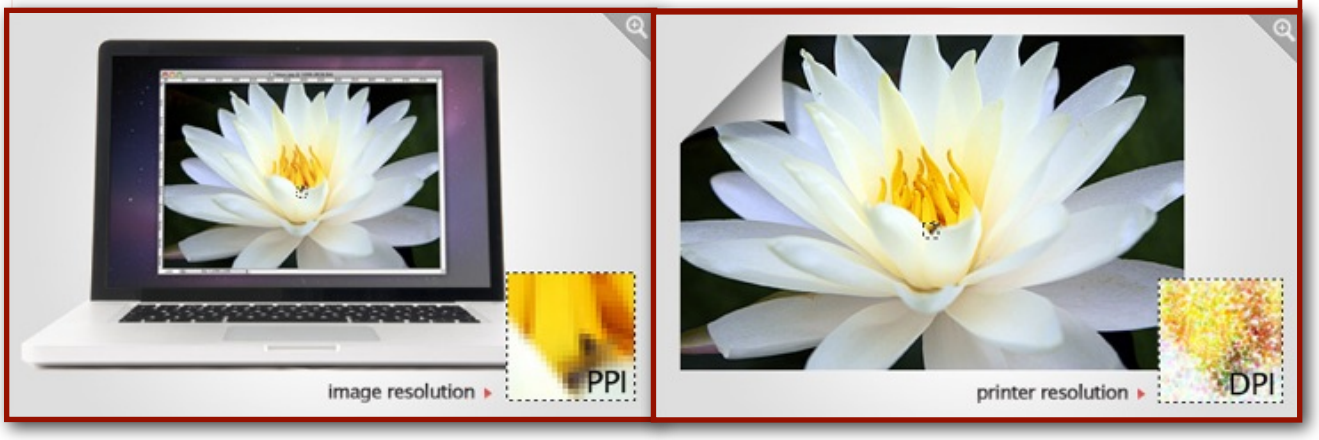


Image Resolution For Printing

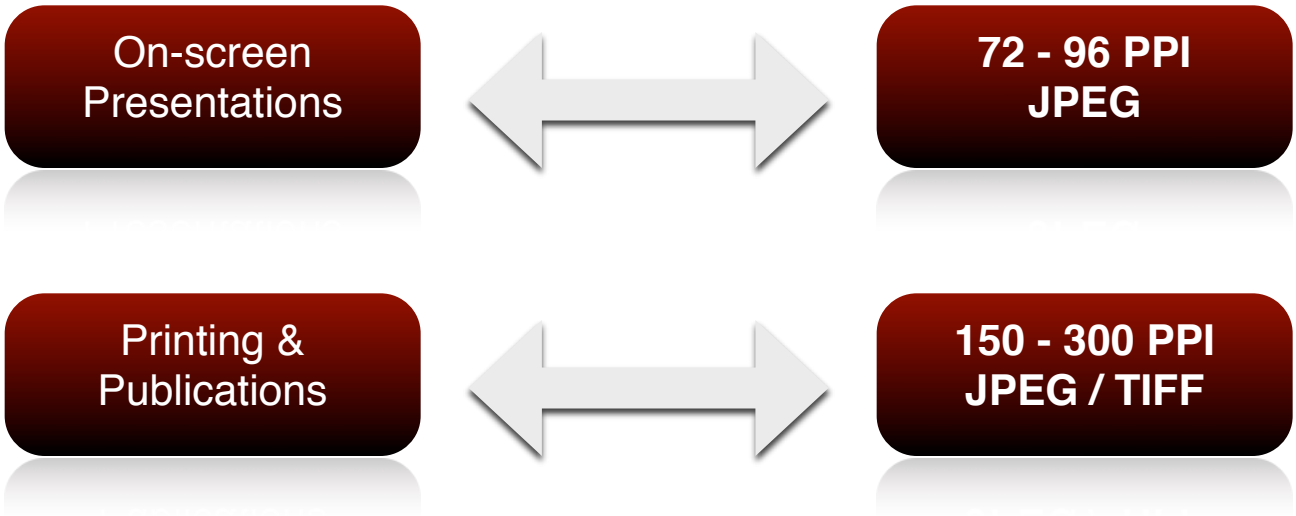
PPI (Pixels Per Inch) vs DPI (Dots per Inch)



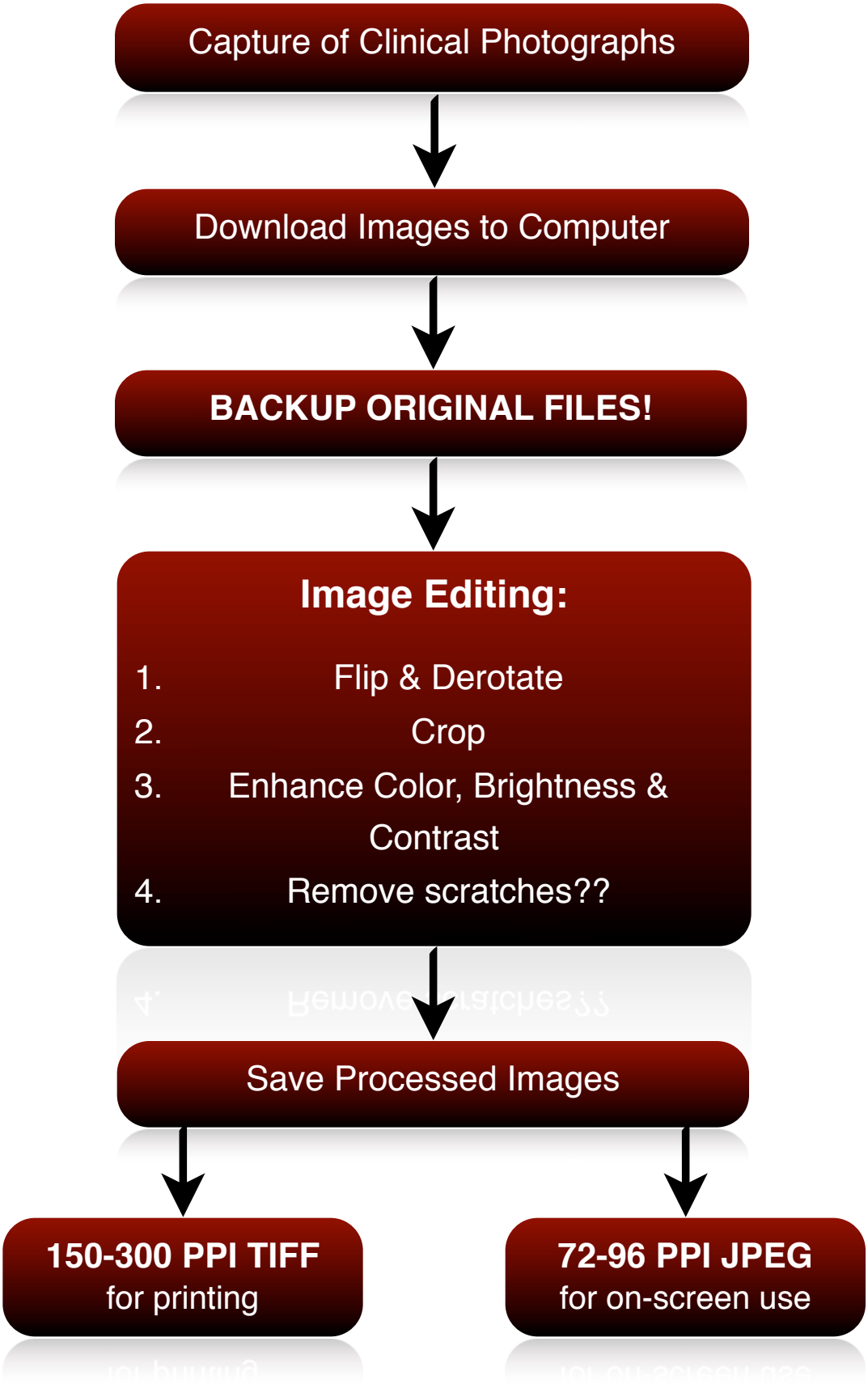
5. Saving Images for Publications and On-screen Presentations

For images that will be used in on-screen presentations or the web, it is not necessary to include very high-resolution images, as this will mean a larger file size and ultimately long loading times and slow performance overall. The recommended resolution for such images is in the range of **72-96 PPI in JPEG format.**

For printing and publication purposes, the resolution should be higher, in the range of **150-300 PPI in either JPEG or TIFF format**. This is to allow for higher quality printing with no "pixelation" of the images in print, especially when enlarged.



Flowchart of Image processing and Archiving

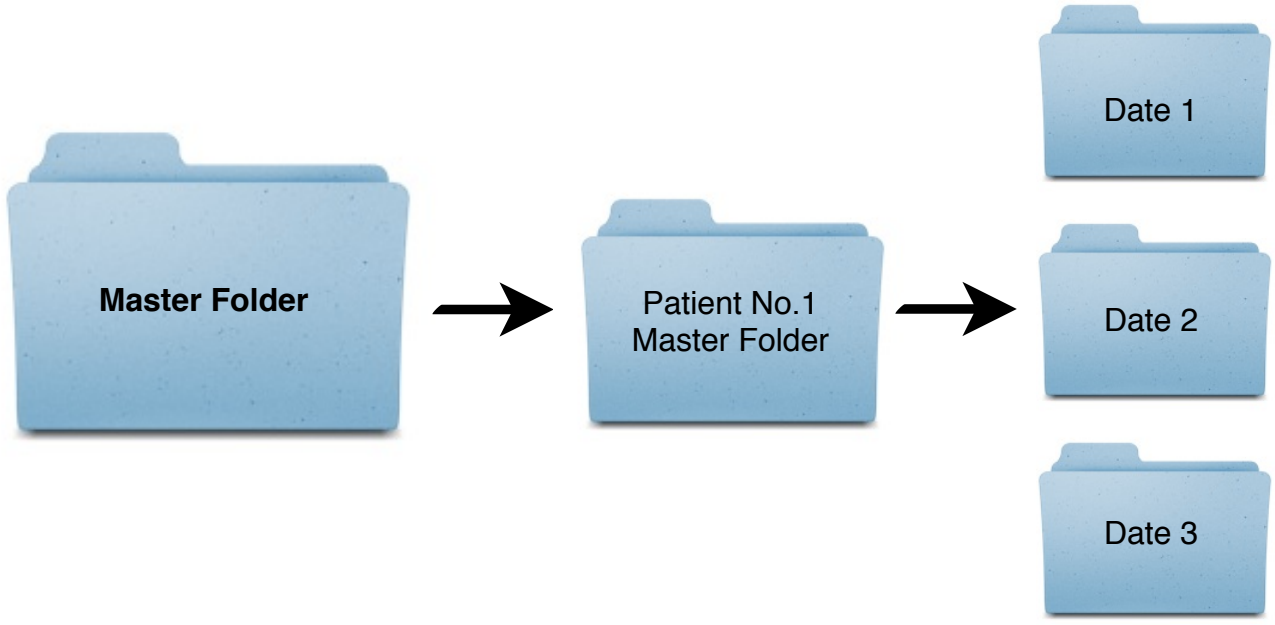


Filing Patients' Images

To ensure quick and easy access and retrieval of images when needed, filing your processed patients' images should be done in a clear systematic way. An easy system that you may consider using is to create **one Master Folder** containing all your individual patients image folders arranged by Name. Each patient's master Folder then contains separate folders - arranged by Date - that contain all images taken on that date (the Clinical Photographic Set described earlier). This filing method requires no additional software - it is done entirely manually by you through Windows Explorer or the Finder (Mac), but it will become more cumbersome as your patient and image database grows!

However, you also have the option of using a dedicated software that automatically imports all your patients images or folders - once you provide the initial setup. **Google's** [Picasa] is one such piece of free software that provides this functionality, in addition to having very good image editing capabilities. For the more advanced, **Adobe's** [Lightroom] is another brilliant piece of software - designed specifically for Photographers - and it has some of the most advanced Cataloging and Image Editing capabilities on the market today. However, it comes with a hefty price!

A Systematic, Manual Method for Filing Patients' Image Folders



6. References & Resources

Important Note:
Certain images used in this short guide have been adapted courtesy of some of the resources below.

Books

1. *Orthodontic Pearls: A Selection of Practical Tips and Clinical Expertise*; Eliakim Mizrahi. (2004) Taylor & Francis Group. (Chapter 4: Orthodontic Photography, by PJ Sandler, AM Murray)

Articles

1. H.F Mckeown, P.J Sandler, A.M Murray; *How to avoid common errors in clinical photography*. Journal of Orthodontics, Vol 32, 2005, p.43-54
2. J Sandler, A Murray; *Current Products and Practice: Clinical Photographs - The Gold Standard.* Journal of Orthodontics, Vol 29, 2002, p.158-167
3. J Mah, K Ritto; *The Cutting Edge.* Journal of Clinical Orthodontics, Vol 36, No. 11, 2002, p. 619-625
4. J Sandler, A Murray; *Digital Photography in Orthodontics. Journal of Orthodontics, Vol 28, 2001, p.197-201*
5. J Sandler, A Murray*; Recent Developments in Clinical Photography.* British Journal Of Orthodontics, Vol 26, 1999, p.269-272

Electronic Resources (ebooks)

1. Apple Inc. ; *Aperture: Digital Photography Fundamentals.* 2005.
2. Mastering Digital SLR Photography: The Serious Photographer's Guide to High Quality Digital SLR Photography. By David D. Busch | Thomson Publishing | 2005

Websites

http://www.exposureguide.com

http://www.digitalphotographyschool.com

http://www.thedigitaldentist-site.org.uk

http://www.amazon.com

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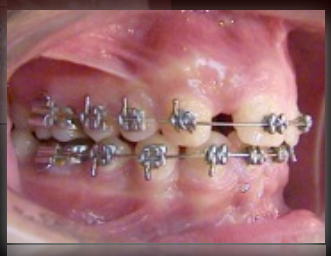

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