**Sheet no. : 6**

**Refer to slide no. :**

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**\*In the last lecture we talked about the receptors which will be hit by the photons after they pass through the body and make attenuation to create the final image. The first type which is the typical and most conditional way for capturing images is the film.**

**\*Now we will talk about the digital receptors :**

**-Using the old technique when taking radiographs had so many issues when it comes to: database management, processing, storage, fast, better interpretation (better image quality), using a lower dose, educating the patient (as it is always easier to point out details using a big screen, the good practices have an isolated consultation room which has a big LCD screen), and geometry issues (like cone cut, overlap, missing apices, angulation problems/ we will talk about them later), so they come up with a more advanced technique using digital receptors.**

**-Digital dentistry helped in the processing but didn’t play with geometry problems (they have a special technology we will talk about it later).**

**-Digital receptors can be used for intra & extra oral images.**

**\*So why digital receptors?**

**1- Fast image access, no chemicals, dose reduction.**

**2- Novelty (It is debatable): better professional images, dental marketing, “Keeping up with technology”.**

**3- As we said also database management& patient education (let him/her to participate in decision making process).**

**\*Why some people didn’t move to digital receptors?**

**1- Lack of information, fear of changes, uncertainty, people used to deal with films.**

**2- Perception that digital imaging is not as good as film (staff resistant): it is a big point.**

**3- Cost (new machines, network if you have a poly clinic), perceived steep learning curve.**

**4- Take the easy way, the film market has only two main big companies that produce good films and that’s it. The digital market is huge.**

**\*So:**

**-What is digital image?**

**-Types of receptors?**

**-How do they work?**

**\*Digital world is about zeroes and ones (0,1). Like the mosaic, a single piece means nothing but multiple pieces together give an image (this is the basic idea).**

**\*We see the image, the computer sees it as colors resulted from numbers.**

**\*So it’s all about put the numbers in an appropriate shades of grey to give us the final image.**

**\*The grey scale starts from the complete black all the way to the complete white.**

**- 0 means black**

**- 255 means white.**

**- So we have 256 different shades.**

**\* The pixel: the matrix element of a digital array which identifies a grey level at the point, can be processed and manipulated. “small building blocks of the digital image”.**

**\* So why do we prefer to have more number of pixels and more bits per pixel???**

**- We have something called bit depth: It means how many shades of grey are there within the image.**

**- The more the image can accommodate different shades of grey, the better the bit depth and this helps more with the contrast (this doesn’t mean that it has a higher contrast but we have much realistic image).**

**- If the image shows only black and white we will not see any color in between and it will have the highest contrast because there are no two colors far away from each other like the black and white.**

**- The number of grey shades= 2^(number of bits per pixels).**

**- Example: if we have three bits per pixel, there will be 8 grey levels (2^3=8). So I will see the difference between the enamel and the pulp in 8 grey levels which will make some structures not to be represented by the right color.**

**- If there are eight bits per pixel we will have 256 grey levels (2^8=256) so we will have more colors and the tissues will be represented by more accurate shade of grey.**

**- So the bit depth is the quality of a digital image that tells you how much shades of grey the image can accommodate. As it increases, more options to accommodate the right color, high image quality.**

**\* How can we get things digitalized???**

**1- The traditional way: you have a traditional film and then you scan it by a regular scanner. “They used it at the beginning to scan the previous films of each patient to put them in their files so they can come back to it in the future for the existing records”.**

**2- Solid state device (CCD, CMOS).**

**3- photostimulable phosphor (PSP).**

**\*\* Two and three are the main digital receptors.**

**- Solid state receptor is directly connected to the computer screen and computer case, so it’s like a part of the computer (like the USP device) through a wire or wireless.**

**- PSP is a plastic component (plate) with an active component, it has the same size of the traditional film. After it gets exposed we put it in a disk drum (instead of chemicals) and gets rid by a scanner and the scanner is the one that is connected to the computer.**

**\* The best thing in these two methods is that we don’t have processing and chemistry so it’s easier and cleaner.**

**\*\*\* Solid state receptors:**

**\* Multiple names:**

**- Digital radiography.**

**- Direct radiography “ Receptor is directly connected to the computer”.**

**\* Main types:**

**- CCD “charge coupled device”.**

**-CMOS “complementary metal oxide semiconductor”.**

**- Flat panel detectors “cone beam system”.**

**- Image intensifiers.**

**\* These types have the same idea but with different components and different ways of receiving the photon and converting it to image.**

**\* Immediate image access.**

**\* Very thick so it will annoy the patient.**

**\*\*\* PSP:**

**\* Indirect way to get the image: you have to load it in a processer then the image appears on the computer.**

**\* We expose the plate processer (light not chemicals) computer**

**\* 100% reusable.**

**\* The same size of the film.**

**\* Thin “more comfortable to the patient than the solid state”.**

**\* Flexible.**

**\* No wires.**

**\* Cheap.**

**\* Takes less gage than the solid state.**

**\*\*\*Note: If you are an endodontist the decision will be different.**

**\* PSP image plates are composed of:**

**1- Base. 2- Protective coating. 3- Active component.**

**- The active component is europium doped barium fluorohalid: BaFX:Eu2+**

 **- In the traditional film there is copper to make impurities in the crystals, here the europium makes the Impurities in the crystals. So it’s kind of similar thought process but the activator is different.**

**\* PSP process:**

**- The receptor (plate) gets hit by a photon, so the europium +2 becomes +3 by losing an electron, this electron gets more energy and goes to a higher energy level (called the F-center) this will make the latent image. The trapped electrons wait until they will be activated by giving them energy by the scanner (laser) to move from a higher energy state to a lower energy state (their original level). This descending will make them give energy, this energy will be measured by something called photomultiplier.**

**- These electrons and energy are electricity, this electricity will be converted by the computer to numbers and then display the image at the end. (It is not important to know how these electricity is converted to numbers and the numbers to colors).**

**\* If you have PSP system, you will take the image then laser scanning and display the image, then you remove the latent image and cover the receptor (plate) and reuse it again.**

**\* PSP cycle:**

**acquisition laser scanner view erase (in one system)**

 **Hygienic protection.**

**- Erasing: The digital receptors are so sensitive, so the latent image inside them has so much energy that the computer uses a small amount of the trapped electrons to display the image. So there are a lot of trapped electrons in the high energy state (F-center) will not descend. So if you use a receptor for a molar the same receptor without taking an image again can be scanned again and see the molar again.**

**- You can scan and re-scan it, because it still retains that signal for a longer time because it’s sensitive and traps more electrons than it is needed for one image.**

**- It is good because if you scan it and save it in a wrong place or there was something wrong in the network, instead of taking a second image for the patient you take the same receptor and re-scan it and display the same image again.**

**- But it’s bad because if you take an image for a molar of a patient then a second patient comes and you didn’t erase the molar image of the first one, there will be two images (two molars) above each other. So there are some processers take the image and erase it. After the image is displayed and you finish your work these processers will give a very strong light that will erase the image HOW??? The light is photons which have energy, so you flood the image with light and give it a very high energy to let all the trapped electrons to descend to their original level.**

**\*\*\* Some doctors use the viewing box to erase the images because it releases a very strong light.**

**- The same receptor can be used over and over so we don’t throw it away. The predicted lifetime for it is 1200-1500 exposure unless we distort it (by our fingers or by bending it) or we throw it away by mistake.**

**- There are different processer types, forms, used together or alone.**

**- The intra and extra oral PSP receptors are the same idea, the difference is the size (small, big).**

**\* Solid state device process:**

**- They are thicker and much more rigid (not flexible like PSP receptors).**

**- Solid state receptors come in all shapes and sizes (bigger sizes for the cephalometric images) and help in all different types of radiography.**

**- They are connected to a wire (can be wireless) which is connected to the computer.**

**- The solid state is a polymer contains silicon. The photon hits the crystals, an electron will be given energy and goes to a higher energy state and sets there. Here there is no laser to let the electron descend again, they are based on semi-conductors, they conduct the electricity so this energy will move from one pixel to another until it reaches the wire, then they pass through the wire to the computer. This is called “bucket brigade” (not sure from it).**

**- Solid state is the easiest method, you just put the patient name, take the image, save it in the patient profile, then you can make processing to the image (but it’s not a must, it’s up to you).**

**- Some of the wires are fixed, the others are not.**

**- Solid state is the best for extra oral images (much better than PSP).**

**- Most of the panoramic are solid state not PSP.**

**Traditional film**

**PSP**

**Solid state**

**Acquire
(take the image)**

**Acquire**

**Protect**

**Clean+ Unpack**

**Acquire**

**Re-use it again**

**Clean+ Unpack**

**Scan**

**Developer and fixer (manual in a dark room or machine)**

**Erase**

**Repack**

**\* Solid state receptors must be covered and protected because they can’t be sterilized because they are very sensitive to chemicals (sterilizers and disinfectants). They have a protective plastic containers.**

**\* We clean the receptors (film, plates,…..) because they come out from the patient mouth and they will be full of saliva, so we can cover them with disposable gloves (cut the fingers and put the film there) or we can have alcohol swap (not to sterilize them, but to be able to deal with them).**

**\* CCD and CMOS advantages:**

**1 Direct.**

**2- Faster for imaging small number of teeth and easier than PSP.**

**\*CCD and CMOS disadvantages:**

**1- Sensor dimensions.**

**2-Sensor positioning is harder than PSP because it’s thicker.**

**3- Expensive sensor.**

**4- Cable.**

**\* PSP advantages:**

**1- Film like.**

**2- Cheap plate.**

**3- Large exposure attitude.**

**\* PSP disadvantages:**

**1- Indirect.**

**2- Plate handling.**

 **\* The people who sell us the receptors try to select it out by the resolution (dots/inch=dots per inch “dpi”).**

**\* As the number increases, the pixel is smaller.**

**\* But the maximum resolution and the maximum contrast don’t depend on the image itself, they depend on the weakest and slowest thing of the system which is our eyes (our eyes can’t see so much as far as resolution and as far as contrast).**

**\* There are different devices take the images on different dpi, like 150, 300, 600 dpi, but this doesn’t mean that the highest number has the highest resolution, and the difference in the cost between them is at least double and the storage requirements are a bigger too. So we have to ask ourselves, does this affect detecting of certain anomalies like external resorption and root fracture?**

**\* Most of the intra oral bitewings are contrast related rather than resolution related.**

**\* Resorption and fracture are resolution related.**

**\* Caries are contrast related, because they are demineralization process so you want to see the difference between the demineralized enamel and the normal one (small changes in density). Perio is contrast related too.**

**\* Most of our tasks are contrast dependent not resolution dependent.**

**\* So you should balance things and think about these variables before you buy anything.**