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REVIEW

# Digital Camera – A Review Of Its Applications In Urology And Genitourinary Surgery

SINGH I.

## ABSTRACT

**Aims:** To choose the right digital imaging device and to report and review on the various applications of a digital camera in our urological setting. Advances and newer emerging tools in the field of digital imaging makes it mandatory for a urologist to acquaint oneself with the basics of digital imaging, so as to enable oneself to choose the appropriate system compatible with one's requirement and work setting. *Methods*: We have reviewed the basic technical literature on digital photography and the factors to be considered while choosing the right digital camera. We have described the usage and testing of three such camera devices (Sony Mavica FD73™, Sony Cybershot™ (DSC-T10) and the Nokia™ 6270 mobile phone in built camera device) in our hospital urological setting over the last three years.

**Results:** The right digital camera must have at least 2-4 mega-pixel resolution with a macro mode; CCD sensor, adequate compression, high memory and at least 4x optical zoom with white balance.

**Conclusion:** The digital camera is like a hand held mobile scanner that allows instant digital data acquisition. It is a portable, extremely versatile, reliable and efficient device to capture, store and reproduce digital images throughout the urological setting in any compatible format. It should be considered as a standard accessory by all practicing urologists and surgeons, so as to maintain a reliable documentation of all their records and investigations in a readily reproducible format.

**Key Words**
Digital imaging, digital camera, urological imaging

Dept of Surgery, Division of Urology
University College of Medical Sciences
(University of Delhi) & GTB Hospital,
Delhi-10095. (India)
**Corresponding Author:**
Dr Iqbal Singh, M.Ch (Urology, AIIMS),
DNB (Uro), MS, DNB (Surg), MNAMS,
Professor & Senior Consultant Urologist,
Dept of Surgery, UCMS &GTBH
F-14 South Extension Part-2, NDSE-2,
New Delhi-110049.(India).
Tel: (Resi)- 91-11-26257693,
(Fax)-91-11-22590495
E mail: iqbalsinghp@yahoo.co.uk

## Introduction

The increasing demand for a quick and reliable documentation of their professional and operative work has lead urologists to acquire several advanced imaging systems [1],[2]. All urologists need to be familiar with the basics of digital imaging, since it is expected to completely supplant conventional medical imaging in the next decade [2]. Already, most recording and documentation is being done via digital camcorders that have a convenient computer interface to edit, store and reproduce images and videos. We propose that a digital camera is

an efficient and economical way of acquiring and storing data in a digitized format that allows reproducibility and excellent compatibility with software programmes, computer and multimedia devices for presentations, internet based correspondence, teaching and educational purposes [3].

## Methods

The right digital device is the most important decision. The best way out, is to first familiarize oneself with the technical jargon that is often listed by most manufacturers and sellers to promote their device. These terms include pixels, resolution (megapixels), memory (storage capacity), compression format, aperture, zoom (optical versus digital), macro function, CCD sensor (storage film) and white balance, aperture and shutter speed. We have briefly reviewed the definitions of the salient terms pertaining to digital imaging.

## Digital Image

This is an image that is recorded in precise numbers (binary codes as 0 or 1) in a digitized code. It is usually saved as a 640x480 pixel resolution using the JPEG (Joint Photographic Expert Group) compression format by most digital devices.

### Pixels

These are the small units or blocks that comprise a digital image, which may or may not be individually visible, depending on the size of the image. The pixels of a digital camera do not always correspond with its printed version.; In other words, in the printed photo, the number of pixels tend to exceed the pixel resolution of the camera. This in effect means that the quality of a printed photo will always be inferior to the one visible on the camera monitor. For most urologists, for publication or documentation purposes, the standard print size of 4x6" would suffice (i.e., the digital camera should be of at least 2 megapixels). A higher megapixel only increases the file storage size without any real benefit on the standard sized prints of 4"x6".

### Resolution

This refers to the ability of the digital device to distinguish two very closely situated points (or pixels) as separate (measured in "megapixels", 1 mega-pixel =1,000,000 pixels). Thus, higher the resolution of a camera, larger will be the printouts. If a digitized image is enlarged, it generally results in a loss of picture quality, resulting in a poor quality print (pixels blocks become disturbingly visible). This can be avoided by following the simple rule that every one mega-pixel increase in resolution corresponds to an increase in print size by 4"x4" [Table/Fig 3]. For editing, cropping, enhancement and storing these images in electronic format, such as in a power point slide or multimedia presentation, the resolution will again matter, since editing often results in a loss of picture quality. The megapixels resolution being quoted for a particular camera should be the true (effective) one and not an interpolated resolution (artificially added resolution by the camera), since this is not the true resolution. Thus, the camera resolution specified should be the (effective) megapixel rating and it must not contain the word "interpolated". In our opinion and for most of our needs in our urological setting, we found that a 3 megapixels resolution camera offered us good value for money without compromising on picture quality.

**(Table/Fig 3) Table Showing The Minimal Resolution Required Of A Digital Camera For Making Quality Photo Prints**

| Print Size (Inches) | Minimum Resolution Needed | Megapixels |
|---|---|---|
| 4x6 | 1024 x 768 | < 1 |
| 5x7 | 1280 x 960 | 1 |
| 8x10 | 1600 x 1200 | 2 |
| Huge | 2048 x 1536 or more | > 3 |

## Auto-Focus (Af) Illuminator

Digital cameras use "contrast detection" when they focus on a subject. When light levels are low, the camera may not be able to decide on a focus distance and some cameras won't even take a picture, while others may default to some preset focus distance (usually infinity). Here, the AF illuminators come into play, they cast a

bright, focused beam of light onto the subject, and so the camera can see better and focus properly. An AF illuminator is desirable for the imaging required in the hospitals and operating suites.

## Memory

This is the size of the storage media. Most digital cameras use a memory stick//card to store its images. The "Sony Mavica™" directly records onto a 3½" floppy disk, allowing direct computer connectivity, while others necessitate the use of a plug in device via a USB (universal serial bus) port. The Sony Cybershot™ records both images as well as videos directly onto a built in memory disk or onto removable miniature flash disks of varying storage capabilities (1-2 Gigabytes), which can be easily transferred to a computer interface both via a blue tooth™ wireless protocol, as well as directly via the USB interface. Many manufacturers of digital video recording digital devices have also started to transition to DVD-R and DVD-RW-based cameras (at present priced in the range >700-1000 USD$) which cost double the cost of a 3-megapixel still digital camera. The latest hand held digital camcorder devices like those of Cannon™ can store the recorded images and videos directly on to an inbuilt hard disk with recording durations of up to 24 hours, thereby doing away with both the digital tapes as well as the digital disks (DVD). This has the advantage of obviating the need to first separately capture the video on a computer prior to its editing.

## Recording Format

This is the program used by the camera to record images. Most digital cameras record images in the standard "JPEG interchangeable file format"- a program that is readily recognized by most image displaying and editing programs such as the MS Power point™, Adobe Photo Deluxe™, Adobe Photoshop™, etc. Digital cameras tend to compress images to maximize their storage. A compressed image often looks slightly inferior, but most digital cameras have the option of switching off this compression mode. The compressed digital images come handy when these have to be e-mailed, since this needs $1/4^{th}$ the usual space and mailing time as compared to an uncompressed digital image. For publication purposes, journals insist for distortion free high quality art images (high-resolution art images in an uncompressed mode) which are saved as “TIFF” or “EPS” files.

## Macro Function

The macro mode the ability to capture high-resolution images from an extreme close up. This is needed to capture operative images in the operating suite or for close up shots of clinical specimens and subjects with interesting clinical findings, such as unusual genitourinary abnormalities. We prefer a macro mode camera to enable getting as close as 2-4 inches from the subject.

## CCD Sensor

This is the camera film! CCD stands for ‘charge coupled device’ (sensor device) used by most digital cameras to sense the image before it is recorded and stored in the camera’s storage media. CMOS (complementary metal oxide semiconductor) is another such much cheaper image sensing device; however, the quality of this image is far inferior to the one sensed by a CCD sensor. Thus, it is always better to prefer a camera with a CCD digital device.

## Zoom Function

The zoom function (optical or digital) generally refers to magnification of an image. The optical zoom uses the camera optical system to enlarge an image by bringing the object closer to the camera (true resolution zoom), since this does not result in any loss of picture clarity. The digital zoom (electronic brain) on the other hand, is an artificially blown up image gained by increasing the inter-pixel gap of an image, with the camera artificially filling in the empty pixels with a guessed colour pixel (interpolation), i.e., it makes a guess about how the picture should look while zoomed in, to enlarge an image. This often distorts the true image by causing it to become more “pixelated”. If the same digitally zoomed image is closely

compared with one that is optically zoomed, the outlined pixels tend to show image distortion which is visible only if one views close up print images. Thus, one must prefer a digital camera with a high optical zoom in place of digital zoom. For our purposes in a urological setting, we found the 4x optical zoom to be sufficient, as this enabled the capturing of sharply focused images of x-ray films.

## Exposure

A good exposure necessitates a balanced combination of the aperture and the shutter speed. Most of the cheaper digital cameras carry three or four shutter speeds, and this generally results in a loss of the picture quality. It is desirable that any digital still camera must provide a full range of shutter speeds from 1/1000 sec to 1 sec.

## White balance

A digital camera records images, depending on the amount of light its sensor device (CCD or CMOS) receives, it then generates an analog charge which is converted to digital pixels, and this allows a digital camera to generate the appropriate colour. For this reason, the images may not look true to colour. To prevent this, it is advisable to choose a digital camera with a white card that allows white balance calibration in a variety of different settings.

## Power

All digital camera devices drain the batteries heavily and so it is a good decision to go for the high performance rechargeable cells. Most of the digital cameras come packed with rechargeable NiCd-(nickel cadmium), NiMH-(nickel metal hydride) or Info-Lithium™ batteries. Info-lithium™ and NiMH batteries should be preferred over NiCd batteries, as the former do not have any memory, i.e. they need not be fully drained every time before recharging and are also cheaper in the long run. Alkaline batteries turn out be much more expensive in the long run and so it is wise to avoid them.

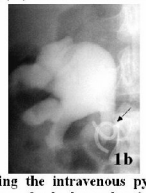
## Using The Digital Camera

We tested the portable digital Sony Mavica FD73™ camera in the hospital wards, operating suites and outpatient departments. The InfoLithium™ battery was pre charged for at least 2 hours prior to the first use. The camera resolution was set to the fine recording mode and a fresh preformatted 1.44MB Sony™ 3½" floppy disk was inserted into the camera. The camera was switched on and the full view was seen immediately via its 2.5" LCD screen. All images were recorded on to the floppy disk in the JPEG camera format. Operative and clinical images were colour recorded, while x-ray and scan films were recorded in the black and white mode to save disk space. The captured images were off-loaded onto an office desktop computer via its floppy disk drive onto its hard drive. These images were then viewed and edited using the Microsoft Photoeditor™ software for their polarity, size, contrast and brightness. They were then transferred to an ArcSoft™ photo album (bundled software provided along with the camera) to create a readily viewable digital photo library. Prints, when needed, were obtained using a HP DeskJet 5550™ printer. We also tested the Sony Cybershot™ (DSC-T10) which had a maximal 7.2 megapixel resolution with high sensitivity. All images recorded with this device were set to 2-3-megapixel resolutions. We also tested the Nokia™ 6270 mobile phone in- built 2-megapixel camera's ability to record images of x-rays and operative sites.

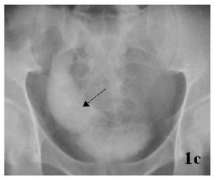
## Results

Choosing the right digital camera is one of the most important decisions to be made, keeping in mind the cost factor and the requirements of the urologist or the surgeon. Some of the good branded digital cameras that meet our requirements are those of Sony™, Cannon™, Olympus™, and Kodak™. In our urological and surgical setting, we found that a digital camera above 3-4 megapixels with 2x-4x optical zoom; with a macro mode CCD sensor, variable aperture speeds and at least 128 MB memory, was more than adequate for all our needs. This translates

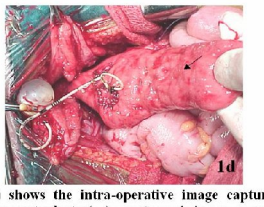

(Table/Fig 1a) shows the ultrasound sector scan image captured from thermal paper showing (→) an intravesical urterocele




(Table/Fig 1 b) showing the intravenous pyelogram image captured form an x-ray view box, of a hydronephrotic kidney showing the (→) broken stent




(Table/Fig 1c) shows (→) the obstructed megaureter



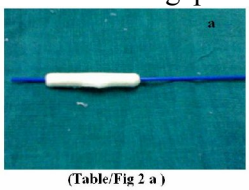

(Table/Fig 1d) shows the intra-operative image captured by optical zoom, of a gastrocystoplasty (→) anastomosis in progress (note the finer details are well seen


(Table/Fig 1 e) shows penile hypospadias with a webbed (→) penis, button holed prepuce

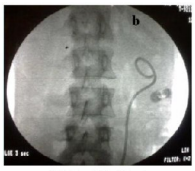

(Table/Fig 1f) shows a giant staghorn removed by anatrophic nephrolithotomy

to a cost of about 300-500 USD$. We extensively used the Sony Digital Mavica™ (MVC-FD73) with a built in flash for all our purposes and later the Sony DSC-T-10 Cybershot™ device. The former device records all the images on a standard 3½" 1.45 megabytes floppy computer disk, which can be easily viewed, transferred and stored on to a hard drive, while the latter recorded these directly on to its flash miniature disk. These stored images were further sorted into an Arc soft™ photo album digital library, allowing easy indexing, viewing, e-mailing, reproducibility and printing of high resolution good quality images for our academic and teaching purposes. The software (Arcsoft™) comes bundled with the digital camera and so no additional costs are involved in setting up such a digital photo library.

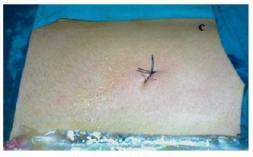
Some sample digital images recorded with the Sony Digital Mavica™ (MVC-FD73) are shown in [Table/Fig 1],[Table/Fig 2] depicts the images recorded with the Nokia™ 6270 mobile phone in built camera device. We found that the resolution of the photographs obtained from an inkjet printer were of a good quality, suitable for publication and poster display. On a single 3½", 1.44 MB computer floppy disk, we were able to record upto 30 black and white images or 20 high fine resolution full colour images. A 1 Gb flash memory disk on the other hand, can store up to 1000 still images with a 2-3 megapixel resolution.




(Table/Fig 2 a )




(Table/Fig 2 b )




(Table/Fig 2 c)


(Table/Fig 2 d)

(Table/Fig 2 a ), (Table/Fig 2 b ), (Table/Fig 2 c), (Table/Fig 2 d) Shows a series of digital images of a case of tubeless PCNL recorded with the Nokia™ 6270 mobile phone in built digital camera.

## Discussion

Various factors need to be taken into account by the urologist before choosing the appropriate digital camera [4]. Besides the cost [5], other factors that need to be considered are; (i) the effective M-pixel rating-should be at least 4, (ii) the optical zoom-should not be less than 2x in any case though 4x would be excellent, (iii) macro mode should be available and (v) there should be at least 128 MB memory.

The applications of a digital camera are tremendous. We captured images of X-ray films, analog photos, thermal prints of contrast studies, cathode ray tube (TV monitor) images by adjusting and synchronizing the shutter speed of the digital camera to 16 frames/sec and extreme close up shots of many operative procedures. With a lens-adaptor, one can easily hook up the digital camera to a still or operating microscope to acquire high quality digital photomicrographs, for teaching purposes [3]. Short duration digitized video clips can also be recorded for insertion into multimedia presentations.

For recording finer digital images in the operative urological suite, we used the uncompressed highest quality JPEG level camera setting. This may be needed for large print outs and poster display purposes (with a larger image there is more room to crop images, without affecting the quality).

Analog photographs have the drawback of being misplaced and getting faded over a period of time, reproducibility varies with each print and the negatives need to be carefully stored, since they also degenerate over a period of time [6],[7],[8],[9]. In contrast, digital images were easily available at all times, with secure backup copies being readily available on a backup drive (CD R or RW disk by using a CD writer), and thus the risk of loosing them was minimized. These could easily be e-mailed to another network computer for Internet based correspondence. Digital images are thus immune to quality degradation and are superior to their analog photos by way of colour, contrast, sharpness and depth [8],[9]. The chief advantage of digital images is that they can be further improved and favorably modified using image enhancing and filtering software [9]. Enhancement is accomplished by using a cluster of pixels (kernels); with the central pixel as a control, the surrounding pixels are subject to a computerized variation to digitally enhance the final image [9].

We found the Mavica™ camera to be cost effective (430 US$), portable, highly versatile, user friendly and an efficient device for the recording and documentation of all interesting urological clinical cases, specimens, x-rays and operative procedures. Digital imaging is already a well-established low cost method for accurate documentation of clinical findings in other specialties of medicine [5]. Digital camera should be added to the standard armamentarium of every urologist's armor. The mobile phone camera allows the acquisition of good-quality digital images of operative surgical procedures and radiographical studies with instantaneous data transfer and storage for records [10]. The newer technology of smart phones has considerably reduced costs, allowing instant capture and transmission of images via the multimedia messaging service (MMS) protocol, thereby facilitating teleconsultation and allowing the creation of an online Weblog for viewing medical images, thus increasing the efficiency of our surgical practice [11].

## Conclusions

The Sony digital Mavica FD 73™ camera, Sony Cybershot™ DSC-T10 and the Nokia™ 6270 mobile phone in built camera device were extensively used in our uro-surgical setting to capture high-resolution good quality easily reproducible images. We found that the still digital images recorded by the Nokia™ 6270 mobile phone in built camera device were of an excellent quality too, affording easy reproduction and good quality print outs. The other real advantages of using a

mobile phone camera recording device, is the ease of transferring images easily at the touch of a button using the in built blue tooth wireless technology or by using the multimedia MMS messaging service of the mobile phone service provider that can easily transmit images anywhere over the internet. Besides an excellent digital image library/archive being maintained by us, we found it very useful to review and refine our work, strategies and treating modalities. Easy tracking and storage of multiple images were also really simplified.

The overall convenience and low cost of the floppy disk media of our Mavica™ digital camera makes it a very versatile, efficient and cost effective portable camera. Above all, we found it to be an extremely cost effective and useful tool for teaching, academic and publishing purposes in a University teaching hospital setting such as ours. Though today, most recording is done with a camcorder and delivery to the computer is via a fine wire, and the floppy disc has been largely replaced by the CD (storage capacity of which is 400 fold greater than the floppy disc), DVD and hard disk, nevertheless, the Mavica™ type of digital still camera still retains it's place, mainly due to its affordability, versatility, mobility and instant reproducibility with all compatible medias. However, this has now been increasingly replaced by a mobile phone in-built camera device, now available on several mobile phones, that is convenient to use and transfer images over the internet, and that is readily available with many physicians even inside the OTs.

We recommend that digital imaging should be freely used by urologists who are desirous of maintaining a cost-effective, accurate and reliable documentation (digital archive) of their clinico-pathological and radiological findings.

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