



Maximizing Ultrasound Reading

Reading Dynamic Clips in Acquisition Order

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Ultrasound in a PACS Environment

As changes in the Radiology landscape are brought on by both healthcare reform and radiation dose minimization efforts, departments will likely experience an escalation in the volume of ultrasound studies performed with an even greater need for accurate diagnoses and optimized workflow.

With the use of Picture Archive Communication Systems (PACS) over the past two decades, the practice of radiology in healthcare facilities is more organized and efficient, however, the communications process between ultrasound and PACS remains suboptimal. If dynamic clips are obtained, it is difficult to find these buried in an exam when they do not play automatically. It is cumbersome to search for and click on each clip to play, yet they are part of the medical record for which the Radiologist is responsible. If clips are completely omitted, the mode of ultrasound reading is outdated with respect to what can be obtained with the modality, and important information to make the best diagnosis is missing.

In some cases, stills and clips are displayed separately at the review station, or not in acquisition order, and the reading physician is unable to follow the order of the exam or verify the completeness. In addition, frame rates may not be accurate when viewed on the PACS, and they may only run for three-to-five seconds long, thereby cutting short the full clip.

What can Radiology Departments do to make sure their ultrasound modalities communicate effectively with PACS? What solutions are out there for Sonographers to more effectively communicate with Radiologists, and for Radiologists to perform more confident, timely diagnoses for their patients?

Historical Look at Clips

Cine mode was initially introduced on equipment so that a Sonographer could back scroll through a video of a fast-moving structure to find the most accurate static image to store in the exam. However, these video clips were not able to be stored as part of the exam. With the introduction of dynamic clip storage into the Acuson KinetDx product in 2001, three or six second clips could be obtained and stored in the system for reading and permanent record. However, the lack of integration of this system with the main PACS system hampered widespread adoption. Further, the large PACS were not designed to handle automatic playing of these clips.

The Imorgon system solves both issues by using the dynamic clips as a holistic part of the study, automatically playing when viewing and it also resides on the main PACS with full integration to all other exams and modalities for each patient.

How to Approach to Clips

It is helpful to describe and categorize different types of dynamic ultrasound clips to aid Sonographers in providing Radiologists useful information as shown in Table 1. For example, in one type of clip, the probe may be held stationary and a short clip obtained showing a moving structure such as an embryonic heartbeat, 4-chamber heart view or fetal breathing and movements in a biophysical profile. Non-obstetrical examples would include normal movement such as neonatal spine normal nerve root movement, peristalsing bowel and pathology such as intimal flap movement in aortic dissection. A stationary view showing movement of “particulate” material is helpful in the case of a spermatocele, pseudoaneurysm, and acoustic streaming in an ovarian cystadenoma as compared with an endometrioma.

Table 1: Types of Dynamic clips

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|------------|--|---|--|--|
| Stationary | A moving structure: e.g. fetal heart, biophysical profile, dynamic cervix, ureterocele, vascular intimal flap | Elicited with a dynamic movement: e.g. inguinal hernia with Valsalva, neonatal hip | Particle movement: e.g. spermatocele, abscess | Document intervention: e.g. needle biopsy, tendon injection |
| Sweep | Through a complex 3-dimensional structure: e.g. neonatal brain, fetal cardiac outflow tracts, fetal brain, abdominal organs | For subtle echotexture abnormalities: e.g. adenomyosis, ovarian edema, heterogenous or geographic fatty liver | Rotating through a 3D volume: e.g. IUD arms | Twisting of vascular supply: e.g. testicular or ovarian torsion |

Using the vaginal probe to perform the “slide” test helps separate an ovarian from an extra-ovarian mass in the case of a tubal ectopic, and the clip serves as excellent proof of diagnosis to the reading Radiologist. Dynamic motion can be elicited by patient movement such as a dynamic hip ultrasound in the neonate, a groin or abdominal wall ultrasound showing movement of a hernia with Valsalva or a stone moving in the bladder with decubitus positioning. Dynamic studies of tendons, e.g. in the case of Thompson’s test of the Achilles tendon, peroneal tendon subluxation or snapping iliopsoas tendon are becoming more common. Ballotment of superficial soft tissue abnormalities can confirm the presence of fluid versus non-liquefied tissue. This can be useful in suppurative adenitis or abscesses.

As opposed to a stationary clip, a sweep clip is useful for scanning through a particular organ to verify normal findings, e.g. clips of the neonatal brain or abdominal organs such as liver or kidney. Subtle echotexture changes, e.g. in uterine adenomyosis, or subtle contour abnormalities such as a small renal mass or occult endometrial polyp can be diagnosed. Small mural nodules or echogenic foci scanning through an ovarian mass

may pick up more pathologic findings that a Sonographer could miss. A sweep through a twisted spermatic cord or ovarian pedicle also best demonstrates via a clip for confirmation of torsion. In the case of testicular torsion, once a twist is demonstrated, the Radiologist or Pediatric Emergency Physician can perform a de-torsion in the opposing direction to potentially temporize the vascular flow to the testis at risk before surgery.

With experience, the Sonographer will learn the best clip to obtain in each scenario. In the case of the fetal heart, use of stored clips in the routine exam has been recommended by several authors (1, 2). In addition to the stationary clip of the 4-chamber view, a sweep cephalad through the transverse view of the 4-chamber, the crossing vessel view of the outflow tracts and 3-vessel view of the mediastinum is suggested in our lab. We routinely clip either transvaginal or translabial cervical views to give the most accurate cervical length and also clip if there is dynamic funneling of the internal os. Timely clips are also helpful during sonohysterography, particularly if encountering any difficulty during the procedure. Clips will reliably show documentation of needle placement during biopsy or injection procedures. A newer venue for using the dynamic clip is 3-D transvaginal ultrasound. After obtaining the coronal reformation with 3-D software, an automatically rotating clip through the volume can be stored and viewed for thorough assessment of the endometrium, for example. This is useful when viewing an IUD malposition to include the tips of the IUD arms. Finally, it should be noted that cine clips are an integral part of contrast ultrasound enhanced ultrasound exams, which are done outside of the U.S. and at research institutions within the U.S.

Static images remain the mainstay of the ultrasound exam, however, some exams can be done more efficiently in some instances with the addition of strategic clips, as noted with sonohysterography and also in the case of neonatal cranial sonography where sweeps can accurately show the anatomy in less time. Nonetheless, in general, they are adjunctive and usually no more than 5-10 clips are needed in any study. They should not be a substitute for technical inadequacy, and it is still the Sonographer's requirement to thoroughly demonstrate normal and pathologic anatomy. The exams submitted for accreditation review should include static images to show technical proficiency, supplemented by clips.

Technique for obtaining the clips is important. As an example, when a sweep clip is obtained, it must be unidirectional so that the Radiologist can formulate the three-dimensional anatomy in his or her mind. The sweep motion should not be waggled back and forth, and it should be swept at an even, moderate rate of speed. Almost all routine dynamic studies can be obtained with a standard three-second storage, but there should be the option for a longer clip.

Clinical Benefits of Dynamic Clips

The addition of dynamic clips is likely to improve the Radiologist's diagnostic accuracy and confidence. The clips are most efficiently viewed when automatically played during viewing and in the order in which they are obtained during the exam. This places the Radiologist in the mind of the Sonographer as to the "train of thought" and process of the study.

Overlooked or incidental findings on a clip can be further investigated by the Radiologist by requesting additional views or, in some cases, an accurate clip may obviate the need for additional views. Exams with clips obtained when the subspecialist Radiologist is unavailable are more complete for later reading, so efficiency and accuracy is improved. The clips allow remeasurement of findings by the Radiologist, which may occasionally be needed for greater accuracy or comparison purposes to prior exams. For example, any nodules you are assessing on serial studies, such as thyroid nodules or uterine fibroids in post-menopausal women, should be assessed meticulously for stability or growth in order to determine appropriate management, and the clips can greatly help overcome technical differences between exams. We have seen another benefit of having a prior clip for review in the instance of an apparent new finding, but on review of the old study, the finding is retrospectively observed on the prior clip, indicating stability over time.

The use of the clips in a large integrated health system allows expert reading from remote sites with greater accuracy and extends the Radiologist's eyes over the IT network. With some exceptions, a system of Ultrasound PACS with "super techs" at the remote sites to perform back scans allows the Radiologist to diagnose even complex cases accurately. As a caveat, the Radiologist must be aware to view each clip fully to avoid "corner of the film" misses, but this is the case in any modality.

The dynamic clip is easy for the Sonographer to obtain and does not have as high a learning curve that 3D Ultrasound can have. 3D is preferred in a number of gyn applications, such as IUD imaging and uterine anomalies, however, if there is technical limitation due to uterine positioning or other factors, the sweep clip is often needed to supplement or provide a better primary visualization of the endometrium and uterine anatomy in a "multiplanar" fashion. In some applications where there is no specialized 3-D/4-D probe and the 3D software is not utilized, the properly obtained sweep clip serves as the "poor man's" 3-D, and although not a true volume acquisition, notwithstanding is very effective.

Finally, it should be noted that dynamic clips have become a mainstay of education through use in PowerPoint lectures at meetings and Internet presentations in various venues in the Ultrasound community. Easy selection and anonymization of images and clips from interesting cases can help Radiologists and Sonographers build clinical excellence through lectures and case reviews, both locally in their own labs and nationally. The ultimate goal of a specialized Ultrasound PACS system within a larger multi-modality PACS is adding value in each individual study and improved patient outcomes based on better ultrasound diagnoses.

Evidenced-based Data

There are few evidence-based articles scientifically validating the use of dynamic clips in ultrasound. However, two recently published series do show improvement in the visualization of normal fetal cardiac structures and the detection of fetal heart defects with the use of dynamic clips (3,4). Use of dynamic clips is occasionally mentioned in articles as part of the methodology or elsewhere. For example, in discussion of the "bright band sign" in diagnosing splenic infarction, Llewellyn and authors state the need for use of the clip to see the newly described finding of splenic textural alteration (5).

The guidelines for performing and interpreting diagnostic ultrasound from the American College of Radiology (ACR), in collaboration with the Society for Pediatric Radiology (SPR) and the Society of Radiologists in Ultrasound (SRU), include specific recommendations where cine clips may be used for documenting imaging of the fetal cardiac activity in the first trimester, the female pelvis, and neonatal spine (6). In addition, a March 2014 article (7) in *Ultrasound Quarterly* describes the national medical student curriculum for Ultrasound and details education for pathologic conditions for which use of still images (lecture format) and real-time images (including cine loops) are encouraged.

Emerson et al. (8) published an article regarding ultrasound imaging on PACS, whereby it was discovered that widespread implementation of PACS into radiology departments over the last two decades indicates recognition of the superiority of the digital image environment over traditional film. However, its survey revealed significantly lower Radiologist satisfaction with PACS support for ultrasound compared with extremely positive satisfaction for PACS support for CT. Going forward, future studies of departments with integrated dynamic clips and other aspects of an optimized workflow are needed to show if there will be a higher level of satisfaction in the Ultrasound reading environment. New features such as report auto population with sonographic measurements are beginning to be realized as further enhancements to efficiency.

Summary

Judicious use of dynamic clips can be employed in many applications in ultrasound and adds to the information available to the Radiologist to assist in making the most accurate readings. Having an intuitive, straightforward display of the images and clips allows the Sonographer to tell the diagnostic narrative in an efficient and effective way to the Ultrasound Radiologist. Addition of this simple technology to the Ultrasound exam brings a great benefit to patients. The Imorgon system, in use at our institution, continues to help optimize our Ultrasound reading, while being fully integrated within a large enterprise-wide PACS.

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