GE Healthcare

VIP

Multicenter Study

30% Less Scan Time

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Multi-center study: Volume Imaging Protocol (VIP) delivers improved productivity compared to routine diagnostic ultrasound scanning.

Abstract

While ultrasound-imaging technology has advanced significantly in the past decade, ultrasound workflow has remained relatively unchanged. The length of a routine ultrasound examination has not decreased due to unchanged techniques in scanning. Now, an innovative GE volume scanning method called Volume Imaging Protocol (VIP) demonstrates the ability to provide major ultrasound productivity gains.

VIP is an ultrasound scanning technique that utilizes quick sweeps with the transducer to acquire raw volume data sets, this enables 3D reconstruction and offline review, post exam. Preliminary clinical studies and early reports from clinicians using the VIP technique have indicated significant reductions in scanning time.

This multi-center study helps to corroborate and quantify the productivity impact by comparing VIP scanning times with those of traditional ultrasound imaging methods in more than 600 patient exams.

Results

This study demonstrated an average productivity gain of 29% and up to 55% improvement in productivity for the volume technique over traditional 2D scanning.

Study purpose

This multi-center study investigated the productivity of the VIP scanning technique compared to routine diagnostic ultrasound using traditional scanning methods.

Volume Ultrasound and the benefits of raw data

Diagnostic Volume Ultrasound scanning with VIP begins with survey scanning, then uses protocol driven quick sweep acquisitions that result in volume 3D data sets. These raw volume data sets allow offline reconstruction and imaging of the anatomy in any plane, giving unlimited access to multiple viewing angles. Due to the raw image data being available, patients do not have to wait while the clinician reviews the scan because rescans are rarely necessary. Raw data acquired on GE's LOGIQ® scanners is also available offline on the LOGIQworks™ workstation. Raw data gives the user the ability to optimize imaging parameters post exam, such as B-gain, color gain, time gain compensation (TGC), auto optimize and baseline angle corrections after the patient has left. Earlier studies and anecdotal reports have shown that Volume Ultrasound scanning is significantly faster than traditional 2D imaging, which requires multiple still-frame images of the areas of interest. In addition, published articles have documented that Volume Ultrasound enables anatomy to be displayed in planes that traditional 2D scanning cannot display, including the plane parallel to the skin surface (coronal plane). More information is available to the clinician in the 3D dataset because the entire volume can be examined. This is more robust information that goes beyond what is accessible with only static 2D images representing the area of interest.

Study background and significance

Ultrasound workflow has remained relatively unchanged over the last decade, while CT and MR imaging have seen marked productivity gains with the advent of faster scanners, better image quality, volume scanning and refined efficiencies such as dedicated 3D labs and 3D technologists. Brian Garra, M.D., director of ultrasound in the radiology department at Fletcher Allen Health Care, University of Vermont, Burlington states, "Ultrasound is being supplanted by CT, MR, and PET, which have seen major advances in speed and quality in the past decade." [1] While newer technologies have increased the imaging power of ultrasound, the length of a routine ultrasound examination has not decreased because ultrasound scan techniques have not been updated. Typically, every exam needs to be checked with the reading physician while the patient waits in the room. This adds to the length of the study. Furthermore, if the physician finds that there is insufficient information in the static 2D images to enable a confident diagnosis, the patient often needs to be rescanned, adding extra time to the exam. The scan room then remains occupied, increasing the patient backlog and creating schedule delays. The ultrasound room can be sometimes occupied up to 1.5 hours for one exam.

Along with the expected benefits of shorter exam times using Volume Ultrasound, the reduction in rescans and repeated exams means that sonologists', sonographers' and patients' time is not extended beyond the time required for the initial scan. Garra also stated that using ultrasound volume scans rather than static images would reduce or eliminate the need for sonologist rescanning without sacrificing diagnostic accuracy. He speculated that this technique would also decrease examination time because volumes are acquired much more quickly.[2]

In the Nelson et al study from 2001 on remotely acquired 3D ultrasound data, it was proposed that the ability to re-review and to optimize slice orientation and location after the patient is no longer present would represent a notable difference compared with 2D ultrasound and would offer the potential to ensure that optimal views are obtained. They proposed that such a capability may reduce the necessity of having patients return to the clinic for repeated studies.[3]

The study that is the focus of this paper was performed to evaluate and document the ability of VIP to improve workflow and increase productivity, and to further investigate the promised benefits of VIP.

Previous Volume Ultrasound productivity studies

Recent ultrasound productivity studies have examined the prospect of workflow changes in the ultrasound lab.

Study 1

In one such study, Dr. M.J. O'Neill, Director of the Radiology Department at Massachusetts General Hospital (MGH) in Boston, focused on driving ultrasound productivity improvement through volume sweeps and offline 3D manipulation of ultrasound data sets. According to Dr. O'Neill, "Improvements in ultrasound productivity and improved availability are key to the survival of this imaging modality." In 2002 at the Radiology Society of North America conference, O'Neill and MGH's Lead Research Sonographer, Patricia Mattos presented a new approach to ultrasound imaging that they had implemented using GE's LOGIQ ultrasound systems. Instead of capturing the very best static images and then labeling each image, sonographers were instructed to scan through the area of interest and then capture a steady volume sweep of ultrasound data along with a few select images. Volume sweeps would then be evaluated and manipulated on an offline 3D review station. 3D volumetric acquisition of the data was

also available to the interpreting radiologists for offline review. O'Neill and Mattos concluded that:

- Reading exams in the volume 3D mode increased radiologists' productivity and decreased radiologists' daily stress.
- Radiologists' desire to physically rescan patients was dramatically reduced in the 3D mode.
- Reading time was decreased for all exam types in the 3D mode.[4]

In 2005, Dr. O' Neill and Patty Mattos performed a similar study using the LOGIQ 9 ultrasound systems and the LOGIQworks workstation (GE Healthcare). Their findings confirmed the 2002 study results. Mattos presented their study findings at the Society of Diagnostic Medical Sonographers 2005 conference showing the benefits of Volume Ultrasound. Decrease in exam time using VIP compared to traditional scanning was shown across all four applications evaluated.

Renal 53%
Thyroid 43%
Scrotal 27%
Pelvic 22%

Sonographer stress and fatigue was surveyed and it was found that VIP decreased fatigue by 46% and stress by 42%. Radiologist stress and fatigue were both decreased by 65%. In addition, the radiologists' desire to rescan was reduced and fewer images were needed when using the VIP technique, while the radiologist diagnostic confidence was improved across all exams.[5] Other Volume Ultrasound studies produced findings consistent with the MGH reports.

Study 2

Take for consideration an early study, Nelson et al of 100 patients, "Feasibility of Performing a Virtual Patient Examination Using Three-dimensional Ultrasonographic Data Acquired at Remote Locations," published in The Journal of Ultrasound in Medicine (2001). In this study, researchers concluded that it was clinically feasible to acquire 3D ultrasound data at one site and to obtain accurate interpretation by offline review at another site within the context of providing high-quality clinical diagnostic studies. The exams included first- and second- trimester fetus, abdomen, and female pelvis. They also proposed that as 3D ultrasound expands its role in clinical medicine there will be increasing numbers of applications in which acquiring and reviewing patient data at separate locations or times from the initial clinical examination will be desirable. This would provide access to physician experts without the necessity of physically planting experts at all locations or necessitating transport of patients to the experts' locations.[6] In addition, they demonstrated imaging benefits from volume acquisitions particularly with the endovaginal probe. Their findings showed that imaging of the uterus in the C-plane is not possible by any other method, and provides important anatomic information regarding uterine morphology. Their research also found Volume Ultrasound provided better visualization of complex structures, not optimally seen in a single plane.[7,8]

Study 3

The Journal of Ultrasound in Medicine also published "How Sonography Tomography Will Change the Face of Obstetric Sonography," a pilot study of 50 consecutive patients using Volume Ultrasound scanning on 17 to 21-week fetuses using GE's Voluson® 730 ultrasound system. The study was undertaken by Beryl Benacerraf, M.D., clinical professor of radiology, Harvard Medical School and Harvard University researchers. Dr. Benacerraf found that volume scanning saved 12-13 minutes per patient, with total room time savings for the 50 patients of 10.3 to 10.8 hours compared to the normal 2D scan.[9]

Study 4

Lions Gate Hospital carried out a VIP vs. traditional 2D scanning study in Vancouver, British Columbia using GE's LOGIQ 9 and LOGIQworks systems. Dr. Simon Bicknell headed the project to evaluate room utilization, sonographer workflow and diagnostic confidence. The scope of the study included pelvic, small parts, renal and shoulder imaging. The results showed VIP provided a scan time reduction of 55% overall and improved sonographer satisfaction. They also performed a control study evaluating diagnostic confidence of the shoulder exam using VIP. The radiologist scanned the shoulder exams using the routine 2D technique after the sonographer completed the VIP study and confirmed the VIP and the 2D scans resulted in consistent findings 100 percent of the time.[10]

Summary

Multiple independent studies have shown that volume scanning and review procedures:

- Reduce scanning time.
- Provide more information than routine imaging, increasing diagnostic confidence.
- Reduce radiologists' and sonographers' stress.

GE Multicenter Study

Study procedures

The current study sought to provide more quantifiable data specifically on time savings of VIP versus conventional scanning techniques. The data was gathered at three sites:

- University of Rochester Medical Center, Rochester, NY (inpatient and outpatient facility)
- Inland Imaging, Spokane, WA (outpatient facility)
- Spectrum Health, Grand Rapids, MI (outpatient facility)

Institutional Review Board (IRB) approval was required from each clinical site. GE Healthcare Applications personnel trained sonographers at each site on how to perform VIP. The study enrolled patients for clinically indicated, physician-requested ultrasound exams. There were no restrictions based on age, gender or race. Informed consent was required. The ultrasound exams performed included:

- Renal
- Abdomen
- RUQ
- OB
- Breast
- GYN Transabdominal
- GYN Transvaginal
- Thyroid
- Scrotal

Data acquisition

Scanning protocol

Participating patients were scanned on the LOGIQ 9 ultrasound system (Breakthrough 2004). The patients were selected from among those coming to the ultrasound lab for clinically indicated studies. The LOGIQworks (Breakthrough 2004) offline workstation was used for 3D image reconstructions. VIP-trained sonographers performed the VIP studies; acquiring volumes using GE supplied protocols. Scan data was transferred via DICOM to the LOGIQworks workstation – virtually rescanned, reconstructed, and edited as needed. The entire exam was then sent to PACs for review. Traditional exams were performed by staff sonographers, based on their departments' established routine protocols. The reading physician dictated the studies from PACs.

Establishing study times

Duration for both the VIP and routine scan protocols was documented. The scan time began when the probe was placed on the patient to scan. The scan time ended when the probe was removed from the patient. The time needed for study reconstruction on the LOGIQworks workstation using the VIP scan protocol was also noted. If it was necessary for a radiologist to enter the exam room to observe either type of study, the rescan time was logged. Other data, such as pathology or comments, were also recorded on a data log sheet. All data sheets were faxed to GE Healthcare for statistical analysis and graphing.

Results

A total of 609 patients were scanned at the three sites. In all, 281 routine studies and 328 VIP studies were performed. The exams included in the study were renal, thyroid, GYN Transvaginal, scrotal, GYN Transabdominal, abdominal, breast, OB, and RUQ. In the compiled data for all exams, a statistically significant difference between 2D ultrasound and VIP was found.

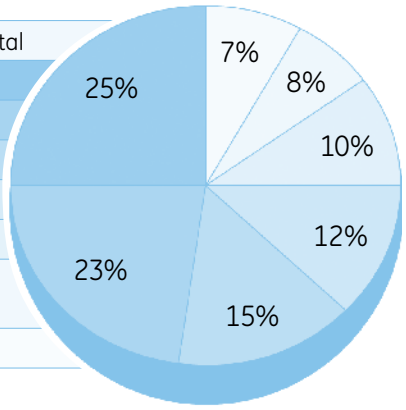
Overall, the VIP protocol was 29% (P = 0.00) more productive than traditional 2D scanning. The median scan time for traditional scanning was 14 minutes. The median scan time for VIP was 10 minutes. The separate sites showed relatively consistent overall productivity gains ranging from 25% to 33%.

Graphical analysis of results

Breakdown of exams

609 total exams

Type of exam	% of Total
Renal	25%
Thyroid	23%
GYNTV	15%
Abdominal	12%
GYNTA	10%
Miscellaneous (Breast, OB & RUQ)	8%
Scrotal	7%

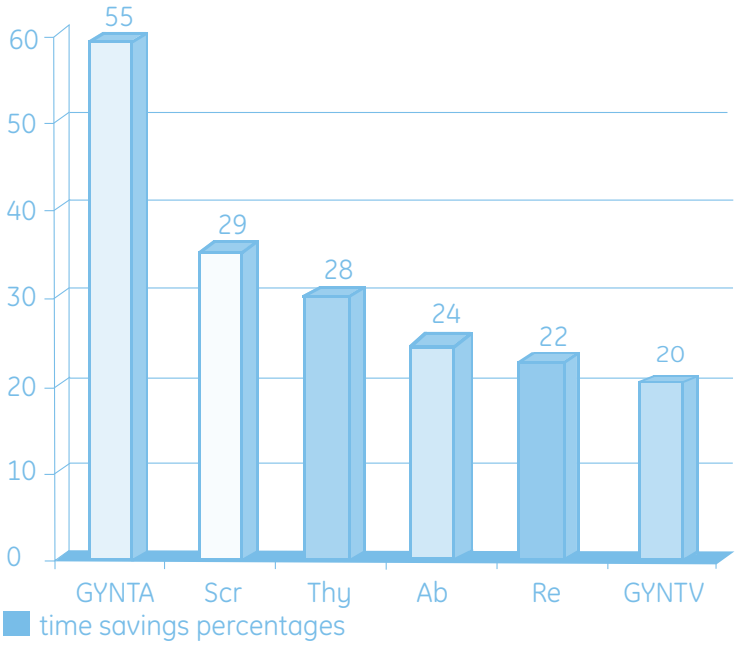


Productivity gains

The productivity gain with VIP for each of the exam categories is listed below. The highest productivity gains were in GYN Transabdominal, scrotal and thyroid scanning, at 55%, 29%, and 28%, respectively.

Productivity Gain By Exam Type

Type of Exam	Productivity Gain
All types	29%
GYNTA	55%
Scrotal	29%
Thyroid	28%
Abdominal	24%
Renal	22%
GYNTV	20%



Time savings ranged from 20% to 55% more productive when using VIP compared to traditional scanning.

Exam time consistency

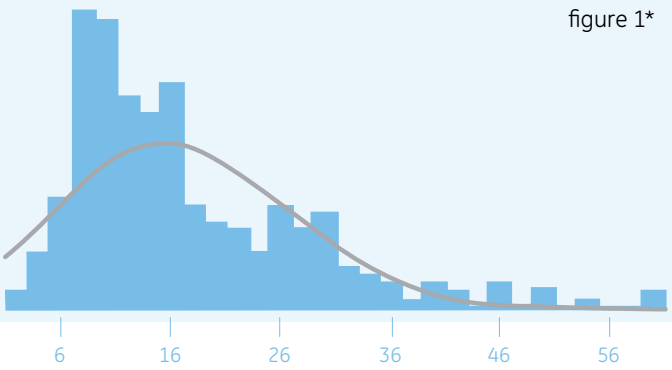
Routine

The data for routine scans was non-normal, showing a wide bell-shaped distribution of the exam times. The median scan time was 14 minutes, the mean scan time was 16.7 minutes and the third quartile was 22 minutes. The maximum was 60 minutes. (See figure 1)

VIP

Significantly lower variability in exam times was noted for VIP scanning. The VIP data was also non-normal, with a narrow bell-shaped distribution of exam times. The median scan time was 10 minutes, the mean scan time was 11.6 minutes and the third quartile was 15 minutes. The maximum was 45 minutes. (See figure 2)

Routine Descriptive Statistics



Variable: Elapsed Min

Group: Routine Anderson-Darling Normailty Test

A-Squared	9.570
P-Value	0.000
Mean	16.6584
StDev	10.4920
Variance	110.083
Skew ness	1.40638
Kurtosis	2.22686
N	281
Minimum	1.0000
1st Quartile	9.0000
Median	14.0000
3rd Quartile	22.0000
Maximum	60.0000

95% Confidence Interval for Mu

15.4263	17.8904

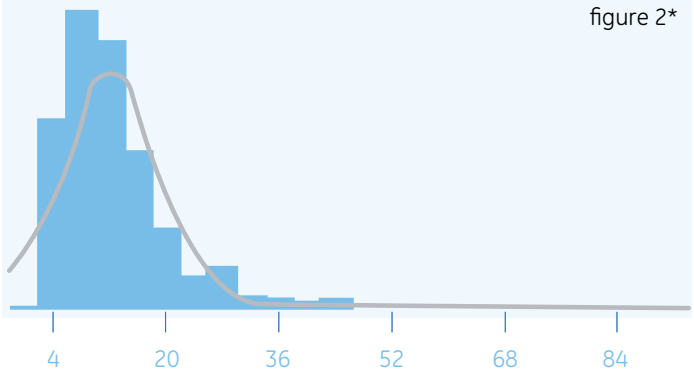
95% Confidence Interval for Sigma

9.6904	11.4395

95% Confidence Interval for Median

12.0000	15.0000

VIP Descriptive Statistics



Variable: Elapsed Min

Group: VIP Anderson-Darling Normailty Test

A-Squared	9.370
P-Value	0.000
Mean	11.6494
StDev	7.1122
Variance	50.5831
Skew ness	1.55573
Kurtosis	3.30926
N	328
Minimum	2.0000
1st Quartile	7.0000
Median	10.0000
3rd Quartile	15.0000
Maximum	45.0000

95% Confidence Interval for Mu

10.8768	12.4219

95% Confidence Interval for Sigma

6.6064	7.7025

95% Confidence Interval for Median

9.0000	11.0000

*MINITAB statistical software was used for the data analysis.

Discussion

Key issues in diagnostics with ultrasound, apart from image quality itself, include workflow productivity, patient satisfaction, and the health, career satisfaction and retention of qualified sonographers. Shorter and easier scanning procedures have potential for positive effects on all three. In this study, VIP scanning showed a 29% increase in productivity through shorter scan times. Translated to actual clinical practice, the timesavings could enable increased patient throughput, thus greater capacity and increased revenue from the same ultrasound scanner. In the workflow study conducted in 2002, staff at Massachusetts General Hospital documented an actual increase in ultrasound throughput from 150 exams per day to 200. Meanwhile, the department scheduling backlog decreased from 21 days to four.[11] In another report based on clinical experience, staff at Florida Hospital Celebration Health in Orlando found they could complete ultrasound scans in three to five minutes using VIP, versus 10 to 15 minutes with traditional methods. Stress on the staff was markedly reduced.[12]

Besides increasing throughput, shorter scan times could enable staff to spend more time thoroughly researching patients' histories and prior studies, interacting with the patients versus leaving them to wait in the scan room, or taking lunch and other work breaks that reduce their stress and make them more effective. More consistent scan times with VIP, documented in this study, should enable more reliable scheduling of ultrasound exam rooms, resulting in less patient waiting and more efficient facility utilization. Dr. Debra Rubens, associate chair of radiology and surgery at the University of Rochester Medical Center, who took part in this study, commented that the VIP workflow standardizes exams, while providing new information and a new way to look at things.

Implications for sonographer health and career longevity are significant, as repetitive motion trauma is a major cause of injury to sonographers and is a reason why many leave the profession. A Society of Diagnostic Medical Sonography study in 2000 reported that 81% of sonographers report work-related musculoskeletal injuries and that 20% leave the profession because of these injuries.[13]

Each clinical site in this study showed that VIP reduced actual scan time – the amount of time the sonographer had his or her hand on the transducer. Less time spent scanning, with attendant static pushing and holding of probe, could translate to a reduction in scanning fatigue and fewer repetitive stress injuries.

When considering the sonographer impact of volume imaging, Dr. Benacerraf reported that musculoskeletal injuries would likely decline with volume imaging because of decreased scan time and reduced manipulation of the probes. Sonographers with knowledge of fetal anatomy could also participate in reconstructing images offline, further reducing time spent manipulating probes and increasing the variability and challenge of their work life.[14]

As VIP is a new method of ultrasound workflow, the sites experienced a learning curve. Sonographers had to adjust to a new way of working, and physicians had to learn to read ultrasound studies as they would CT or MRI exams. As the sites performed more exams, the sonographers and physicians improved their proficiency at their respective tasks. This indicates that over time, proficiency in VIP scanning and in reading exams will continue to improve so that productivity gains increase over time.

Summary and conclusions

This multiple-site study showed a significant improvement in productivity using VIP scanning versus traditional 2D. Unanimously, every site realized productivity improvements across all of the exam categories tested in this study.

Four months after the study concluded, all participating sites report continued and/or accelerated use of VIP in their ultrasound department and continue to enjoy improved productivity consistent with that reached during the study.

In conclusion, we have demonstrated through this study, that sites that similarly incorporate VIP have the potential to realize similar improved productivity gains.

29% time savings overall

Time in minutes

Exam type	Exam time savings	Routine scan time	VIP scan time
GYNTA	55%	10	5
Scrotal	29%	21	15
Thyroid	28%	13	9
Abdominal	24%	25	19
Renal	22%	14	11
GYNTV	20%	10	8

Potential annual impact formula

(# of minutes) X (# of scans) X (days) X (rooms) = (time savings)

Example of time savings

If five minutes was saved per exam **x** 12 scans per day **x** 260 scans per year **x** 5 rooms **=** 78,000 extra minutes or 13,000 extra hours.

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