Video Radiology Reports: A Valuable Tool to Improve Patient-Centered Radiology

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BACKGROUND. Improved communication between radiologists and patients is a key component of patient-centered radiology.

OBJECTIVE. The purpose of this study was to create patient-centered video radiology reports using simple-to-understand language and annotated images and to assess the effect of these reports on patients' experience and understanding of their imaging results.

METHODS. During a 4-month study period, faculty radiologists created video radiology reports using a tool integrated within the diagnostic viewer that allows both image and voice capture. To aid patients' understanding of cross-sectional images, cinematically rendered images were automatically created and made immediately available to radiologists at the workstation, allowing their incorporation into video radiology reports. Video radiology reports were made available to patients via the institutional health portal along with the written radiology report and the examination images. Patient views of the video report were recorded, and descriptive analyses were performed on radiologist and examination characteristics as well as patient demographics. A survey was sent to patients to obtain feedback on their experience.

RESULTS. During the study period, 105 of 227 faculty radiologists created 3763 video radiology reports (mean number of reports per radiologist, 36 ± 27 [SD] reports). Mean time to create a video report was 238 ± 141 seconds. Patients viewed 864 unique video reports. The mean overall video radiology report experience rating based on 101 patient surveys was 4.7 of 5. The mean rating for how well the video report helped patients understand their findings was also 4.7 of 5. Of the patients who responded to the survey, 91% preferred having both written and video reports together over having written reports alone.

CONCLUSION. Patient-centered video radiology reports are a useful tool to help improve patient understanding of imaging results. The mechanism of creating the video reports and delivering them to patients can be integrated into existing informatics infrastructure.

CLINICAL IMPACT. Video radiology reports can play an important role in patient-centered radiology, increasing patient understanding of imaging results, and they may improve the visibility of radiologists to patients and highlight the radiologist's important role in patient care.

As radiology transitions from volume-based to value-based practice, a major focus is improving patient experiences [1]. Both the Radiological Society of North America (RSNA) and the American College of Radiology (ACR), through the Radiology Cares and Imaging 3.0 campaigns [2], have made patient-centered radiology and improved patient communication priorities. The primary method of communication between radiologists and patients is the radiology report. Studies have found that patients appreciate being able to easily access and read their radiology reports [3]. The development of online (digital) patient portals has been an important tool to initially allow patients to access their reports and, more recently, to view, download, and share their images. A 2016 study reported that 51% of patients with online patient portal access actually viewed their report online [4]. At New York University Grossman School of Medicine, a review of the data showed that 76% of patients have active online patient portal access; 58% of outpatient examination reports and 38% of outpatient examination images are viewed.

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Studies have shown that patients have difficulty in understanding the meaning of their imaging reports. A study by Gunn et al. [5] in 2017 found that the median score of radiology report comprehension by patients was 2.5 on a scale of 1–5. This is most likely because radiologists have traditionally viewed the referring physician as the audience of their reports rather than the patient. As a result, the radiology report is typically full of medical terminology and is written at the 10th to 13th grade level, far above the fourth to sixth grade level recommended for communications for patients [6, 7]. Major problems for patient comprehension include unclear or technical language and the length of the radiology report [5, 8].

A number of strategies have been proposed to improve the ability of patients to understand their imaging reports [7, 9–14]. A few pilot studies have shown the feasibility and efficacy of a short video report to highlight important findings for referring physicians [10, 11]. Creating short video reports specifically for patients offers several potential advantages in improving radiologist-to-patient communication. By seeing the radiologist show relevant findings and hearing the findings described, patients may be more likely to understand that radiologists, not referring physicians, are the physicians who actually interpret the examinations, thus increasing the visibility of radiologists to patients. The video report can be focused on one or a few key findings and be prepared using lay terms to allow increased patient comprehension, although the referring physician (and patient) would still have access to the more comprehensive and detailed traditional written report. To be practical, creation of the report would need to be seamlessly integrated into the radiologist's daily workflow at the workstation with only a minimal increase in time spent by the radiologist. The report would also need to be easily accessible by patients through an online portal on their mobile devices or computers.

The purpose of this study was to determine if it is possible to create patient-centered video radiology reports using simple-to-understand language and annotated images and to assess the effect of these reports on patients' experience and understanding of imaging results.

Methods

The study qualified as a quality improvement project and therefore did not require institutional review board approval. The pilot study ran from September 20, 2021, until January 22, 2022.

Technical Considerations for Creation of the Video Radiology Report

In collaboration with Visage Imaging, we built an integrated video reporting tool inside the diagnostic viewer. The tool allows simultaneous capture of visual content on one or multiple viewports, the radiologist's voice, and the mouse cursor. Using the same microphone, the radiologist creates the video report after dictating but before signing the written report. The radiologist chooses images they think are appropriate, places them in the viewports, and explains the findings on the images using simple-to-understand language. The user interface was designed according to the well-understood paradigm of classic recorders. It provides functions to start, pause, rewind, play back, and finalize the recording. To ensure good visibility on portable devices such as cell phones, the mouse cursor position is captured during interaction, and a large yellow arrow is rendered into the video. Figure 1 illustrates the user interface of the video radiology report creation tool.

Once the radiologist finalizes a video report, the audio and video streams are automatically encoded as an MPEG stream, embedded into a DICOM object, and inserted into the PACS server. The DICOM object can thus be routed and archived seamlessly in the existing radiology information technology infrastructure. Encoding can take a few seconds to a minute, depending on the length of the report and speed of the computers. The encoding

HIGHLIGHTS

Key Finding

- *Video radiology reports created specifically for patients using lay language and including annotated images improve patients' understanding of their imaging results. Report creation and delivery to patients can be integrated into existing informatics infrastructure.*

Importance

- *Video radiology reports have the potential to improve radiologists' communication with patients and to play an important role in patient-centered radiology.*

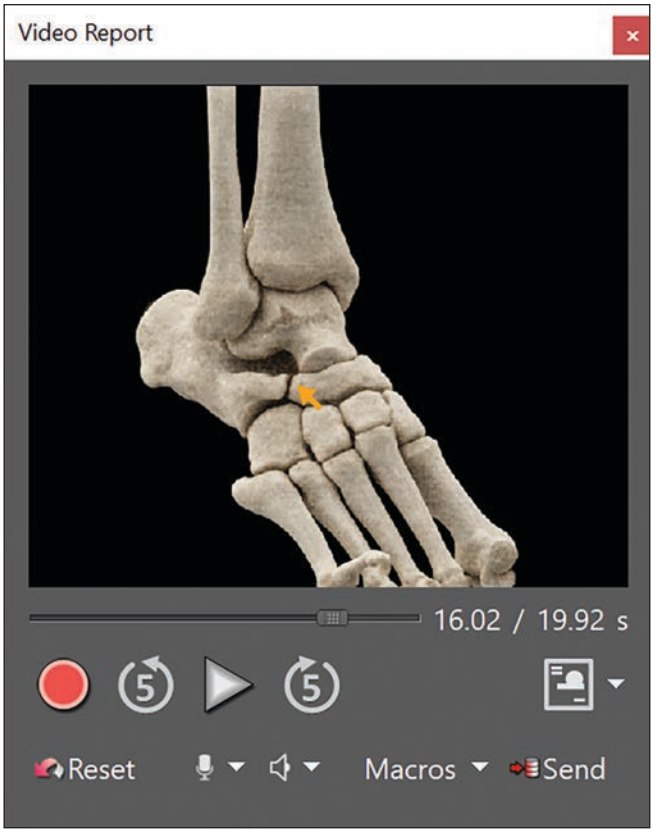

Fig. 1—Screen shot shows user interface for integrated video radiology report creation tool including easy-to-understand buttons to start, pause, and stop recording; rewind; and preview or review area with increased-visibility mouse cursor. Arrow denotes calcaneonavicular coalition on this cinematically rendered image.

happens as a separate compute thread in the background, so the radiologist can continue to work and advance to the next case. A health level 7 image notification message with a direct link to the video radiology report is generated and sent to the electronic medical record (Epic). This notification is used to create logic within the electronic medical record so the link to the video report is shown at an appropriate time and place in the medical record. Video S1 (available in the online supplement) shows an example of a video report created for an ultrasound (US) examination in a patient with hepatic steatosis.

Automated Cinematically Rendered Images

For video reports that were created for cross-sectional studies, the goal was to present images to patients that would be more easily understood than traditional 2D cross-sectional images. Cinematic rendering is a volume rendering technique that creates photorealistic rendering of volumetric datasets [15, 16]. Cinematic rendering has been shown to be useful in a number of clinical scenarios [17–21], but its integration into clinical practice has been limited by the expertise and time needed to create cinematically rendered images. In combination with scientists from our 3D imaging vendor (Siemens Healthineers), we developed a novel technique for automatically creating cinematically rendered images. Renderings are sent directly to the PACS and are immediately available to radiologists at their reading workstation. A brief summary of the technique follows.

To achieve the required fully automated process, thin-slice volumetric datasets were automatically routed from the CT scanners to a syngo.via server (Siemens Healthineers). Predefined render tasks were then applied to the datasets on the basis of specific DICOM attributes. These render tasks define which anatomic structures and organs will be rendered and provide specific information about how to visualize these structures in specific presets. The structures were segmented using an artificial intelligence–based multiorgan segmentation tool that is able to differentiate 83 anatomic objects. This allows optimal depiction of structures of interest, reduces artifacts, and removes structures that might obscure the anatomy of interest. After segmentation, preset transfer functions were applied, which assigned color and opacity values to the range of attenuation values in the segmentation objects. Batch ranges (either radial or parallel) were created automatically and sent to the PACS. Cinematically rendered images were automatically created for the following CT examinations: chest, abdomen, pelvis, brain, and joints. Work is ongoing to improve the segmentations, add more organs, and expand from CT examinations to volumetric MRI examinations. The decision to incorporate one or more cinematically rendered images into the video radiology report was made by the radiologist who created the report according to the radiologist's determination of whether cinematically rendered images would improve the visibility and the patient's understanding of the imaging finding. Video S2 (available in the online supplement) shows an example of a video report, created for a patient with tarsal coalition, that includes a cinematic 3D image.

Technical Considerations for Distribution of the Video Report to Patients and Referring Physicians

Although many standard DICOM viewers can display video sequences, and some also play back audio, the goal was to make the user experience for the patient and clinician as direct and easy as possible. Therefore, a direct link and a dedicated viewer were created to provide single-click playback and compatibility across a wide range of devices.

For the patient, a link to the video radiology report was embedded in the patient's written report in the online health app and the patient web portal (MyChart, Epic). Special considerations were assessed and testing performed to enable the playback on a variety of devices ranging from PCs to Android (Google) and iOS (Apple) devices. At the beginning of our study, the link to the video report was placed after the full written report. Near the end of the study (after approximately 85% of the video reports were created), the link was moved to the top of the report to increase its conspicuity (Fig. 2).

For faculty practice referring physicians, a link to the video radiology report was added in Hyperspace (Epic) adjacent to the

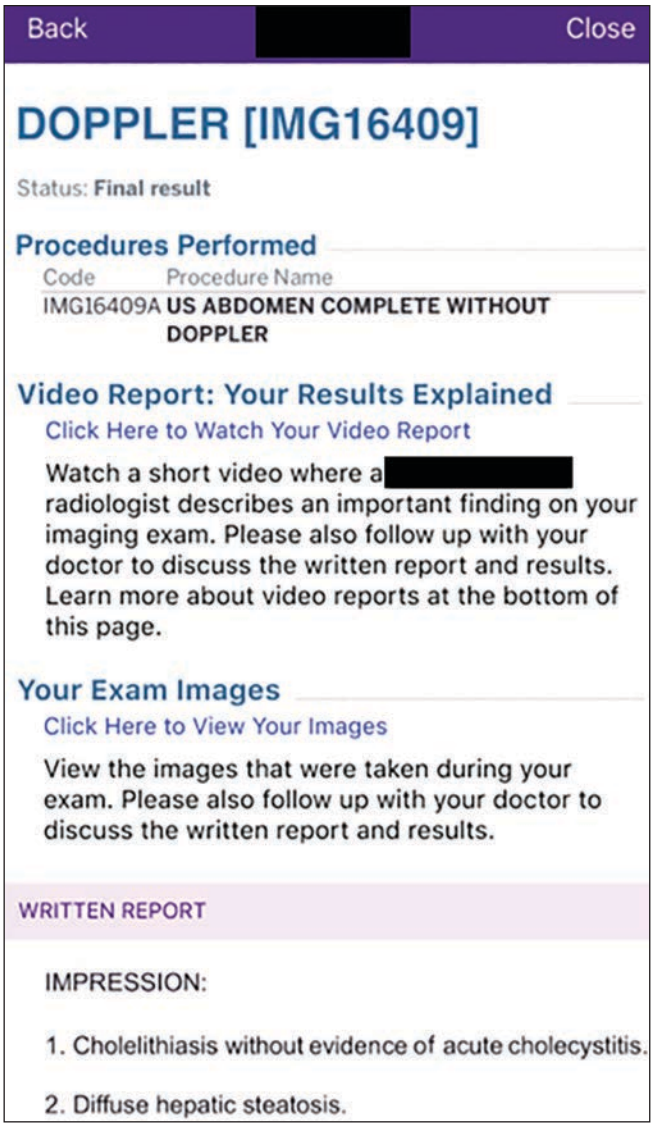

Fig. 2—Screen shot shows revised appearance of link to video radiology report in patient portal, with link at top of report to increase conspicuity. US = ultrasound.

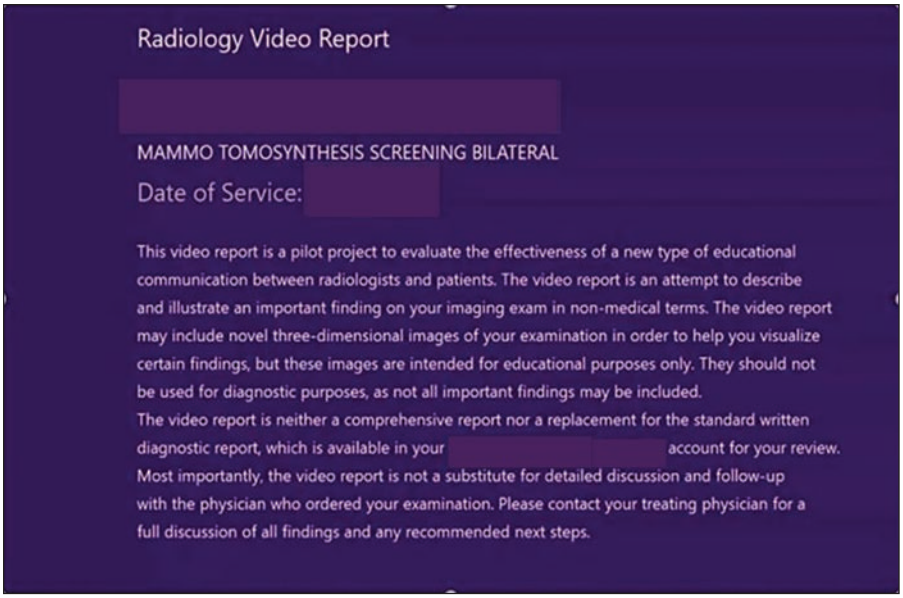

Fig. 3—Screen shot shows disclaimer and explanation that appear at beginning and end of each video radiology report. MAMMO = mammography.

location of the traditional written report and the link to access images from our PACS. For outside referring physicians, a similar link was added to their tool, Care Link (Epic). An explanation and disclaimer (Fig. 3) were added to the beginning and end of each video radiology report to communicate the purpose of the report and that the video radiology report was a complement to, not a substitute for, the comprehensive written report or a discussion with the referring physician.

Patient Survey

To assess patients' perception of video radiology reports and obtain feedback for improvement, a survey consisting of 10 questions was administered through an external service provider (Appendix 1). A unique link to the survey was presented at the end of each video report.

Radiologist Training

Before the pilot study began, radiologists from multiple subspecialties met with referring physicians to inform them of the initiative and to discuss which reports they felt would be appropriate for video radiology reports. For this pilot study, it was decided that video radiology reports would not be created for patients with a new diagnosis of malignancy or any other life-threatening diagnosis. Radiologists were encouraged to use easy-to-understand lay terms in their video radiology reports. They were also instructed to introduce themselves in the beginning of the report as the physician interpreting the examination. Radiologists were given instructions and access to our PACS test system before the start of the pilot study to allow them to practice creating video reports and optimize workflow. Radiologists were also instructed on how to easily identify which patients had active online patient portal accounts to limit the time spent on creation of video reports for patients without accounts. The decision to create a video radiology report for an imaging examination was made by the interpreting radiologist, and video radiology reports were made for both normal and abnormal examinations. The pilot study was rolled out to all of our radiologists at the same time. Radiologists were not required to create video radiology reports. A one-time $1000 incentive was offered during 1 month of the pilot study for radiologists who created at least 50 video radiology reports in that month. Radiology trainees (residents and fellows) were not given access to the video report tool or asked to participate in the pilot study.

Data Collection and Analyses

Data were collected on variables pertaining to radiologists, examinations, and patients. Radiologist variables included subspecialty, sex, and video radiology report creation time and duration. Examination variables were type of examination modality. Patient variables included encounter setting (outpatient, inpatient, or emergency), age, sex, and number of times the report was viewed. Descriptive statistics were calculated for the variables collected and statistical analysis was performed using MedCalc (version 20.027, MedCalc Software) and SAS 9.4 software (SAS Institute).

Results

A total of 3763 video radiology reports were created by 46% (105/227) of our faculty radiologists. Table 1 lists the subspecialties and sex of radiologists who created video radiology reports. The range of the number of reports created by radiologists was 1–223 (mean, 36 ± 27 [SD] reports). Of the 3763 reports created, 3415 (91%) were for patients with online portal access. Thirty (0.8%) reports were created for inpatients, 95 (2.5%) for emergency department patients, and 3638 (96.7%) for outpatients. Video radiology reports were created for examinations on multiple modalities: 1416 (38%) for MRI, 765 (20%) for screening mammography, 607 (16%) for radiography, 474 (13%) for CT, 312 (8%) for US, and 189 (5%) for interventional radiology (IR) procedures. The mean length of a video radiology report was 55 ± 30 seconds, and the mean time to create one was 238 ± 141 seconds. Both the duration of the video radiology reports and the creation time varied depending on the modality of the examination (Table 2). The difference in video report duration between modalities was statistically significant ($p < .001$) for all modality pairs except CT and US ($p = .85$) and radiography and screening mammography ($p = .59$).

TABLE 1: Characteristics of Radiologists Who Did Not Create Versus Those Who Created Video Radiology Reports

Characteristic	Did Not Create Video Radiology Reports	Created Video Radiology Reports
No. of radiologists (*n* = 227)	122 (54)	105 (46)
Sex		
Male	67 (55)	56 (53)
Female	55 (45)	49 (47)
Subspecialty		
Body	28 (23)	22 (21)
Breast	22 (18)	21 (20)
Emergency radiology	17 (14)	1 (1)
Interventional radiology	15 (12)	1 (1)
Neuroradiology	13 (11)	25 (24)
Cardiothoracic	12 (10)	5 (5)
Nuclear medicine	8 (7)	0 (0)
Musculoskeletal	7 (6)	23 (22)
Pediatric radiology	0 (0)	7 (7)

Note—Values are the number of radiologists with percentage in parentheses.

The difference in report creation time was statistically significant ($p < .001$) for all modality pairs except CT and US ($p = .84$), IR and screening mammography ($p = .87$), IR and radiography ($p > .99$), and screening mammography and radiography ($p = .61$).

With respect to number of views, 864 video radiology reports were viewed at least once (23% of all reports, 25% of reports for patients with active portal accounts). Of those, 46% (395/864) were viewed multiple times (range, 2–19 times). When the link to the video radiology report was below the written radiology report, the patient view rate was 20% (632/3183). After the link was placed above the written report and became more conspicuous, the viewing rate increased to 40% (232/580).

Of the 864 reports viewed, 453 were for MRI examinations (32% of all MRI video radiology reports), 108 were for CT examinations (23% of all CT video radiology reports), 99 were for radiographic examinations (16% of all radiograph video radiology reports), 94 were for screening mammography examinations (12% of all screening mammography video radiology reports), 64 were for US examinations (21% of all US video radiology reports), and 46 were for IR procedures (24% of all IR video radiology reports).

The age range of patients whose video reports were viewed was 7 weeks old to 91 years old. A total of 1289 video reports were created for male patients; 338 (26%) of these video radiology reports were viewed. A total of 2474 video reports were created for female patients; 526 (21%) were viewed. A total of 214 unique video radiology reports were viewed by referring physicians, with 55 video radiology reports viewed multiple times (range, 2–5 times).

To evaluate the difference in duration and creation time for video radiology reports created for normal and abnormal examinations, 100 consecutive reports created during the pilot study were analyzed. Sixty-one reports were created for abnormal examinations, 33 for normal examinations, and six for IR procedures. There was no statistically significant difference in mean durations of the normal (68 ± 46 seconds) and abnormal (79 ± 38 seconds) reports ($p = .22$). There was also no statistically significant difference in the mean creation times for the normal (256 ±

TABLE 2: Length of Video Radiology Reports and Creation Time by Modality

Examination Type	No. of Reports	No. (%) of Reports Viewed by Patients	Duration of Report (s)	Time to Create Report (s)
All	3763	864 (23)	55 ± 30	238 ± 141
MRI	1416	453 (32)	69 ± 35	289 ± 206
Screening mammography	765	94 (12)	43 ± 22	177 ± 101
Radiography	607	99 (16)	41 ± 20	196 ± 386
CT	474	108 (23)	57 ± 30	253 ± 179
Ultrasound	312	64 (21)	54 ± 22	239 ± 148
Interventional radiology	189	46 (24)	49 ± 28	182 ± 109

Note—Except where otherwise indicated, values are the mean ± SD.

TABLE 3: Video Radiology Report Survey Results

Question, Response Option	Result	No. of Responses
How well did the video report help you understand your results?		101
1 (Poor) to 5 (excellent)	4.7[a]	
Overall, how was your experience with the video report?		97
1 (Poor) to 5 (excellent)	4.7[a]	
Was the length of the video appropriate, too long, or too short?		97
Appropriate	84	
Too long	0	
Too short	16	
What did you find helpful about the video report?		95
Radiologist pointing to the pertinent findings on the images	92	
Radiologist using language that was easy to understand	92	
Seeing comparisons to normal studies (if applicable)	12	
Seeing comparisons to your older studies (if applicable)	16	
Use of 3D images	34	
Easier to understand than the written report	58	
If you were anxious about your test results, how did this change after watching the video report?		97
Same anxiety after watching	43	
Less anxiety after watching	56	
More anxiety after watching	1	
What type of results would you like to see video reports for?		97
Normal results	1	
Abnormal results	7	
Both normal and abnormal results	92	
What type of reports would you like to receive in the future?		97
Written	2	
Video	7	
Both written and video	91	
Did you experience any technical issues?		98
Yes	4	
No	96	
If you did not find the video report helpful, please check any reasons why		15
Still had questions after watching the video	87	
Prefer to read the detail in the written report	27	
Radiologist did not use language that was easy to understand	7	

Note—Except where otherwise indicated, values denote percentage of responses.
[a]Value is mean rating.

233 seconds) and abnormal (330 ± 205 seconds) reports (p = .12). Patients viewed 24 (39%) of the abnormal reports, three (50%) of the IR reports, and eight (24%) of the normal reports.

Table 3 summarizes the responses of the 101 patients who completed surveys (12% response rate). The mean overall experience rating was 4.7 of 5. The mean rating for how well the video report helped patients understand their findings was 4.7 of 5. Of our survey respondents, 7% favored video radiology reports only, 2% preferred written reports only, and 91% preferred having both written and video radiology reports. A total of 92% of patients wanted video radiology reports for both normal and abnormal results, 7% preferred video reports for abnormal studies only, and 1% preferred video reports for normal results only. A total of 56% of patients had less anxiety about their imaging results after watching the video radiology report, 43% had the same level of anxiety, and 1% had more anxiety. Technical issues occurred for 4% of respondents. Eighty-four percent of respondents thought the video length was appropriate, whereas 16%

would have preferred a longer report. Features of the video radiology report that patients found most helpful included the radiologist pointing to the pertinent findings on the images, the radiologist using language that was easy to understand, comparisons to normal studies (if applicable), comparisons to older studies (if applicable), the video radiology report being easier to understand than the written report, and the use of 3D images. A total of 73 patients left narrative comments that were overwhelmingly positive. Sample comments, both positive and negative, are listed in Appendixes 2 and 3.

Discussion

The radiology report is the primary method of communication by radiologists to both patients and referring physicians. Although the method of creating the reports has evolved and multimedia reports have been developed [22, 23], most reports consist entirely of words with no images. This traditional radiology report has multiple limitations. Radiologists interpret images, and the traditional report does not allow radiologists to use those images to show and describe their findings. The lack of images in the traditional report can also lead to suboptimal characterization of complex abnormalities that can negatively impact patient care [23]. In one study of multimedia reports including images, 66% of referring physicians found the multimedia nature of the report valuable, and 76% preferred the multimedia report over the standard report [23].

Both RSNA and ACR, through the Radiology Cares and Imaging 3.0 campaigns [2], have made patient-centered radiology and improved patient communication priorities. Starting with the OpenNotes initiative in 2011 and continuing to the 21st Century Cures Act [24, 25], patients' online access to their medical records has continually increased. Patients have responded favorably to online portals, with many preferring portal-based methods over traditional methods of receiving results [24].

The limitations of the traditional written report are even more pronounced when patients are the audience. A study by Gunn et al. [5] showed that patients have difficulty understanding their imaging reports. Several strategies have been proposed to improve patient comprehension of report content [7, 9–14, 26–28]. Some publications have advocated direct in-person communication between radiologists and patients [26–28]. Although this approach is routinely used for some select imaging studies, such as diagnostic mammography and IR procedures, it is impractical for most imaging examinations because of the time required and the fact that most examinations are not interpreted in real time. Structured reports and standardized lexicons in radiology have been recommended to improve communication [9]. Although both referring physicians and radiologists have found that the clarity of structured reports is improved compared with conventional reports, that is not necessarily true for patients. Structured reports continue to contain highly technical terms that patients often have little training or context to interpret. The substitution of simplified, nontechnical language for medical terminology in traditional written reports may improve patients' comprehension but may reduce clarity and the necessary granularity for referring physicians to accurately understand findings and establish treatment plans. Automated lay-language translation of radiology reports has been proposed [7] to improve patients' comprehension without the need to simplify language, but this method has not achieved widespread use.

A few pilot studies have shown the feasibility and efficacy of short video radiology reports created to highlight important findings for referring physicians [10, 11]. A small 2016 pilot study by Balkman and Siegal [10] found that preparation of a report less than 2 minutes in length was possible in less than 5 minutes and was viewed favorably by referring physicians. In 2019, Neto et al. [11] reported their results of creating supplemental video radiology reports on musculoskeletal CT and MRI examinations from the emergency department. They also found that creating video radiology reports that were 2 minutes long was possible in less than 5 minutes and that referring physicians found the reports helpful. Neither of these groups made their video radiology reports available to patients. In 2021, Wahab et al. [12] performed a pilot study of creating video radiology reports for patients undergoing screening mammography. Although breast imagers typically meet with all patients regarding diagnostic mammography, this is not practical for screening mammography examinations, which are frequently interpreted in batches. Wahab and colleagues postulated that screening patients would also prefer to receive their results directly from the radiologist rather than through a written report or letter. Their video radiology reports did not include images but were recordings of standard texts. They reported that 73% of patients preferred the video message over traditional methods of receiving their results.

Video radiology reports that include both video and audio specifically tailored for patients offer several potential improvements over the traditional written radiology report for radiologists' communication with patients. A national survey showed that a significant number of patients do not understand the function of radiologists or even that radiologists are physicians [27]. Including an introduction at the beginning of each video report stating that the speaker is the radiologist who is interpreting a patient's study may help patients appreciate that the radiologist is another physician participating in their care. The creation of a short video radiology report using nontechnical lay terms allows increased comprehension by patients without the worry of diluting the clarity and comprehensiveness of the written report; the referring physician (and patient) still have access to the more comprehensive and detailed traditional written report. Including cinematically rendered 3D images that are easier to understand than traditional 2D cross-sectional images could help improve patients' understanding of their findings and the value of imaging.

This study found that patients overwhelmingly preferred a combination of video and written reports over a written report alone. They reported that using nonmedical terminology and having the radiologist point to the pertinent findings on images increased their ability to understand their imaging results. They also liked the ability to compare abnormal images to normal images and appreciated the use of 3D images in addition to standard 2D cross-sectional images. The majority of patients who were anxious about their imaging results reported that the video radiology report decreased their anxiety. Although radiologists and referring physicians were concerned about creating video reports for patients with abnormal findings, 92% of survey respondents preferred to receive video radiology reports for both normal and abnormal results. Patients' free-text comments

were overwhelmingly positive, stating that the video radiology reports were of significant value. Although we did not directly measure the visibility of the radiologist to patients, several patients stated that the video radiology report created the feeling of a relationship between them and the interpreting radiologist.

Although 16% of survey respondents stated that they would prefer more detailed and longer reports, 84% thought the video reports' length was appropriate. This finding was important as creating longer and more comprehensive video reports, in addition to the traditional written report, could make video reports impractical in the context of a large radiologist workload. Only 4% of patients reported technical difficulties with the video report. The most common issue involved problems hearing the audio portions of the reports, though when these reports were checked, the audio portion was present and comprehensible. Although initially only 20% of all video reports were viewed by patients, the percentage increased to 40% after the link to the video report was made more conspicuous in the online portal. Importantly, there was no publicity about the creation of video reports nor communication to patients about the existence of the reports during the pilot study. We expect the viewing rate will further increase as patients and referring physicians become more aware of the existence of video radiology reports.

Although referring physician use of video radiology reports was not a focus of this study, 214 reports were viewed by referring physicians. Anecdotally, some physicians viewed the reports with their patients because they found them helpful in explaining the findings and their treatment plans to their patients. A study of referring physician opinions about multimedia radiology reports found that 80% believed that such reports would be an improvement over traditional radiology reports [29]. In that study, 28% of physicians reported concerns that accessing multimedia reports might be time intensive and interfere with clinical workflow. Our video reports are primarily intended for patients, but a more detailed study of referring physicians' use and opinions of the video radiology report, including the ease of accessing and viewing the video radiology report, is planned.

A major concern that could limit clinical acceptance of video radiology reports is the amount of time report creation would add to radiologists' workload. Although the amount of time needed to create video radiology reports varied among radiologists, the mean was 3 minutes 58 seconds. This amount of time makes it feasible to create a small number of video radiology reports each day, but it is too long to allow widespread clinical use. For example, the creation of 20 video radiology reports per day would add over an hour to the radiologist's workday. Not surprisingly, the creation time varied depending on the type of examination, with the shortest time required for screening mammography and the longest time for MRI. To increase acceptance and use in daily clinical practice, the creation time needs to be further reduced. Most of the creation time was spent with radiologists deciding how to describe the patient's findings, whether normal or abnormal, using simple-to-understand language rather than the medical lexicon they have been trained to use. The use of macros to alleviate this issue is being pilot tested to significantly shorten creation time and allow more widespread use of video radiology reports. The macros are similar to those used to expedite the creation of reports using voice recognition. Each radiologist creates standard audio reports for normal examinations, such as normal screening mammograms, as well as for common abnormalities, such as meniscal tears. These standard audio reports can be stored and linked to a patient's images, with the radiologist using arrows to show normal anatomy or abnormal findings. If the radiologist feels it is necessary, they can also add short audio clips specific to individual patients to these standard audio clips.

A second limitation to the use of video radiology reports is that they might not be appropriate for all examinations. Video reports are intended to highlight and describe one or two important findings, not to be a comprehensive report or a substitute for the traditional written report. Creating noncomprehensive video reports for complex imaging examinations with multiple findings, such as oncologic follow-up examinations, might cause confusion for patients. In addition, they could lead to difficulty for referring physicians, who would need to help patients reconcile the short video radiology report with the more comprehensive traditional written report.

In summary, this study found that patient-centered video radiology reports were valued by patients and aided their understanding of imaging results. Video radiology reports have the potential to play a significant role in increasing the visibility of radiologists and communicating to patients the important role radiologists play in their care. This study also showed the feasibility of creating video radiology reports in under 4 minutes and the ability to integrate these reports into our electronic medical record and online patient portals. Continued development is necessary to further shorten the creation time so that use of video reports can expand from limited use in selected cases to more widespread use in daily clinical practice.

References

1. Liao JM, Emanuel EJ, Navathe AS. Six health care trends that will reshape the patient-provider dynamic. *Healthc (Amst)* 2016; 4:148–150
2. Kemp JL, Mahoney MC, Mathews VP, Wintermark M, Yee J, Brown SD. Patient-centered radiology: where are we, where do we want to be, and how do we get there? *Radiology* 2017; 285:601–608
3. Alarifi M, Patrick T, Jabour A, Wu M, Luo J. Understanding patient needs and gaps in radiology reports through online discussion forum analysis. *Insights Imaging* 2021; 12:50
4. Miles RC, Hippe DS, Elmore JG, Wang CL, Payne TH, Lee CI. Patient access to online radiology reports: frequency and sociodemographic characteristics associated with use. *Acad Radiol* 2016; 23:1162–1169
5. Gunn AJ, Gilcrease-Garcia B, Mangano MD, Sahani DV, Boland GW, Choy G. Structured feedback from patients on actual radiology reports: a novel approach to improve reporting practices. *AJR* 2017; 208:1262–1270
6. Trofimova A, Vey BL, Safdar NM, Duszak R Jr, Kadom N. Radiology report readability: an opportunity to improve patient communication. *J Am Coll Radiol* 2018; 15:1182–1184
7. Cook TS, Oh SC, Kahn CE Jr. Patients' use and evaluation of an online system to annotate radiology reports with lay language definitions. *Acad Radiol* 2017; 24:1169–1174
8. Mityul MI, Gilcrease-Garcia B, Mangano MD, Demertzis JL, Gunn AJ. Radiology reporting: current practices and an introduction to patient-centered opportunities for improvement. *AJR* 2018; 210:376–385
9. Lourenco AP, Baird GL. Optimizing radiology reports for patients and referring physicians: mitigating the curse of knowledge. *Acad Radiol* 2020; 27:436–439

10. Balkman JD, Siegel AH. An audio/video reporting workflow to supplement standardized radiology reports. *J Digit Imaging* 2016; 29:153–159
11. Neto LP, Godoy IRB, Yamada AF, Carrete H Jr, Jasinowodolinski D, Skaf A. Evaluation of audiovisual reports to enhance traditional emergency musculoskeletal radiology reports. *J Digit Imaging* 2019; 32:1081–1088
12. Wahab RA, Brown A, Lee SJ, Zhang B, Sobel L, Mahoney MC. Screening mammogram results in the digital age: video messaging—a pilot study. *Acad Radiol* 2021; 28:487–494
13. American College of Radiology website. Demystifying radiology reports. www.acr.org/Practice-Management-Quality-Informatics/ACR-Bulletin/Articles/December-2021/Demystifying-Radiology-Reports. Published November 22, 2021. Accessed January 16, 2022
14. American College of Radiology website. Patient-friendly radiology reports. www.acr.org/Practice-Management-Quality-Informatics/Imaging-3/Case-Studies/Patient-Engagement/Patient-Friendly-Radiology-Reports. Published March 29, 2021. Accessed January 16, 2022
15. Dappa E, Higashigaito K, Fornaro J, Leschka S, Wildermuth S, Alkadhi H. Cinematic rendering: an alternative to volume rendering for 3D computed tomography imaging. *Insights Imaging* 2016; 7:849–856
16. Eid M, De Cecco CN, Nance JW Jr, et al. Cinematic rendering in CT: a novel, lifelike 3D visualization technique. *AJR* 2017; 209:370–379
17. Recht HS, Fishman EK. Cinematic rendering following a bone marrow harvesting procedure. *Radiology* 2019; 291:299
18. Recht HS, Fishman EK. Cinematic rendering of aberrant vascular supply to the lung (sequestration). *Diagn Interv Imaging* 2022; 103:123–124
19. Rowe SP, Chu LC, Fishman EK. Evaluation of stomach neoplasms with 3-dimensional computed tomography: focus on the potential role of cinematic rendering. *J Comput Assist Tomogr* 2018; 42:661–666
20. Rowe SP, Chu LC, Recht HS, Lin CT, Fishman EK. Black-blood cinematic rendering: a new method for cardiac CT intraluminal visualization. *J Cardiovasc Comput Tomogr* 2020; 14:272–274
21. Rowe SP, Fishman EK. Three-dimensional computed tomography cinematic rendering of mandibular odontogenic myxofibroma. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2019; 128:e122–e125
22. Doshi AM, Moore WH, Kim DC, et al. Informatics solutions for driving an effective and efficient radiology practice. *RadioGraphics* 2018; 38:1810–1822
23. Rosenkrantz AB, Lui YW, Prithiani CP, et al. Development and enterprise-wide clinical implementation of an enhanced multimedia radiology reporting system. *J Am Coll Radiol* 2014; 11(12 pt A):1178–1181
24. Lee CI, Langlotz CP, Elmore JG. Implications of direct patient online access to radiology reports through patient web portals. *J Am Coll Radiol* 2016; 13(12 pt B):1608–1614
25. Mehan WA Jr, Brink JA, Hirsch JA. 21st Century Cures Act: patient-facing implications of information blocking. *J Am Coll Radiol* 2021; 18:1012–1016
26. Miller P, Gunderman R, Lightburn J, Miller D. Enhancing patients' experiences in radiology: through patient-radiologist interaction. *Acad Radiol* 2013; 20:778–781
27. Glazer GM, Ruiz-Wibbelsmann JA. The invisible radiologist. *Radiology* 2011; 258:18–22
28. Pahade J, Couto C, Davis RB, Patel P, Siewert B, Rosen MP. Reviewing imaging examination results with a radiologist immediately after study completion: patient preferences and assessment of feasibility in an academic department. *AJR* 2012; 199:844–851
29. Sadigh G, Hertweck T, Kao C, et al. Traditional text-only versus multimedia-enhanced radiology reporting: referring physicians' perceptions of value. *J Am Coll Radiol* 2015; 12:519–524

APPENDIX 1: Patient Survey Questions and Possible Responses

1) How well did the video report help you understand your results? 1–5 (Poor to excellent)

2) What did you find helpful about the video report? (Check all that apply.)
   a. Radiologist pointing to the findings on the images
   b. Radiologist using language that was easy to understand
   c. Seeing comparisons to normal studies (if applicable)
   d. Seeing comparisons to your older studies (if applicable)
   e. Use of 3D images
   f. Easier to understand than the written report

3) If you did not find the video report helpful, please check any reasons why:
   a. Prefer to read the detail in the written report
   b. Radiologist did not use language that was easy to understand
   c. Still had questions after watching the video

4) Was the length of the video:
   a. Appropriate
   b. Too long
   c. Too short

5) Did you experience any technical issues?
   a. Yes
   b. No

6) If you were anxious about your test results, how did this change after watching the video report?
   a. I was not anxious
   b. Less anxiety after watching
   c. Same anxiety after watching
   d. More anxiety after watching

7) What type of results would you like to see video reports for?
   a. Normal results
   b. Abnormal results
   c. Both normal and abnormal results

8) What type of reports would you like to receive in the future?
   a. Written
   b. Video
   c. Both written and video

9) Please enter any comments or feedback about the video report.
   a. Free text

10) Overall, how was your experience with the video report? 1–5 (Poor to excellent)

APPENDIX 2: Sample Positive Feedback From Patients

- This was FANTASTIC! This is exactly how I would want to receive all of my test results. I understood everything the doctor was explaining and the video made it perfectly clear. It was very interesting to see the inside of my body in that way and I actually learned something new from the video. I hope this format stays in place, I loved it!
- I was very surprised and delighted to discover this new video report. At 70 years old, I'm always suspicious of even small symptoms, and this video, and the excellent narrator, were exactly what I needed to see to calm my fears. Congratulation on an stunning addition to the [redacted] system.
- Amazing to the lay patient. Compliments the written report and reduces anxiety about results. Great addition to receiving the written report!
- I really appreciated this video report. I think it is extremely informative and very helpful. I have a better understanding of my results now. Thank you!
- Excellent way of reporting results. Hearing a nice calm, professional and caring voice is a great benefit with good or bad news!! Patients rely so much on caregivers and amazingly even their professional voices - great idea!
- I think this is great! I like being able to see results prior to Dr. visit so I can gather any questions I may have.
- Verbal results from the interpreting radiologists provides an added level of assurance and feeling that all health care providers are monitoring and managing my health well.
- I was pleasantly surprised to see a video report. I always like "seeing" what's going on (but some procedures are impossible to see) even though the doctor talks you through the procedure as he goes.
- The video makes it more personable. This is an awesome addition!
- This is the first time I've had a good view of the issue AND an explanation that I could easily understand! Thank you so much
- The doctor interpreting the results had such a nice calming voice and explained the images so that I could understand them. It sounded as though we were having an in-person visit. I am so impressed
- Short, concise and helpful to the layman. Well presented by Dr. [redacted]. Very much needed in my case and TIMELY, which is mentally critical right now. My overall impression is [redacted] is doing everything right in trying to raise the bar in communication.
- This is amazing!! Thank you! Really hope this get rolled out across the board.
- This was great, very clear to see the fracture, hard to know what you're looking at some times with still pics. Thanks
- Video report was very very helpful in helping us understanding the fracture and the healing process; as of result, it gave us greater relief in knowing and understanding the X-Ray images. With the help of the doctor who was explaining the results of x ray images in the video report, we can have a better communication with our doctor during the follow up visit. Thank you Dr. [redacted] for taking the time to make the video report.
- Incredibly valuable tool for patients
- Terrific new option for imaging test results, and an outstanding execution. The playback was smooth, and the doctor's comments were clear. Thank you, Dr. [redacted]! The only thing further that I would like to see are some annotations (e.g., circled areas, arrows, etc.) to help me zero in on the areas mentioned.

APPENDIX 3: Sample Negative Feedback From Patients

- Did not include all findings
- The video literally took excerpts from the written report verbatim. It would have been helpful to have the Dr. point out what they were talking about in the images. Otherwise there is no point to even making a video.
- Very little information given
- I would like to have seen comparisons over my last MRI.
- There was no sound on my video so it didn't help. But if there were sound it would have been helpful
- I felt that the doctor spoke too fast for me to understand fully which left me with questions but he summarized well enough to understand what was going on.

Video S1—40-year-old patient with hepatic steatosis. Video shows example of video report created for ultrasound examination. (Video S1 is available in the online supplement.)

Video S2—28-year-old patient with tarsal coalition. Video shows example of video report including both cinematic 3D and 2D CT images. (Video S2 is available in the online supplement.)