

**ORIGINAL PAPER**

A qualitative study exploring the experience of viewing three-dimensional medical images during an orthopaedic outpatient consultation from the perspective of patients, health care professionals, and lay representatives

Emma E. Phelps PhD^{1,2} | Richard Wellings MB ChB, FRCR, FRCS ed³ |
Melina Kunar PhD⁴ | Charles Hutchinson PhD^{1,3} | Frances Griffiths PhD^{1,5}

¹Warwick Medical School, University of Warwick, Coventry, UK

²Kadoorie Centre, John Radcliffe Hospital, NDORMS, University of Oxford, Oxford, UK

³University Hospitals Coventry and Warwickshire NHS Trust, Coventry, UK

⁴Department of Psychology, University of Warwick, Coventry, UK

⁵University of the Witwatersrand, Johannesburg, South Africa

Correspondence

Emma E. Phelps, Kadoorie Centre, John Radcliffe Hospital, NDORMS, University of Oxford, Oxford OX3 9DU, UK.
Email: emma.phelps@ndorms.ox.ac.uk

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Abstract

Rationale, aims and objectives: Three-dimensional (3D) medical images are shown to patients during clinical consultations about certain health conditions. However, little is known about patients' experience of viewing them. The aim of this qualitative study was to explore the impact of sharing 3D medical images with patients during a clinical consultation about hip surgery, from the perspective of patients, health care professionals, and lay representatives.

Method: Interviews were conducted with 14 patients who were shown their own 3D medical images during their clinical consultation and four health care professionals conducting consultations within one orthopaedic outpatient clinic. In addition to interviews, 31 lay representatives participated in six focus groups. The focus groups aimed to gain a broader understanding of the advantages and concerns of showing patients their medical images and to compare 3D and two-dimensional (2D) medical images. Interviews and focus groups were audio-recorded, transcribed verbatim, and analysed using thematic analysis.

Results: Three themes were developed from the data: (a) the truthful image, (b) the empowering image, and (c) the unhelpful image. Focus group participants' preference for 3D or 2D images varied between conditions and groups, suggesting that the experience of viewing images may differ between individuals and conditions.

Conclusions: When shown to patients during an orthopaedic clinical consultation, 3D medical images may be an empowering resource. However, in this study, patients and focus group participants perceived medical images as factual and believed they could provide evidence of a diagnosis. This perception could result in overreliance in imaging tests or disregard for other forms of information.

KEYWORDS

experiences, health services research, patient-centred care

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1 | INTRODUCTION

Patient involvement in managing their own health and making decisions about their care is increasingly encouraged.¹ Patient activation, a measure of patient's knowledge, skill, and confidence in managing their own health, is associated with better health outcomes across all specialities.^{2,3} To participate in their care, patients need to understand the information health care professionals give them.⁴ Communication about surgery can be particularly challenging as surgeons must explain procedures that are technical, that are often complicated, and that may have risks and potential complications.⁵ Fossum et al⁶ found during orthopaedic consultations that patients had difficulty understanding what the clinician asked, said, or did. They also experienced a lack of empathy from the clinician. Pictures,^{7,8} photographs,⁹ and two-dimensional (2D) radiological images such as ultrasound, X-ray, computed tomography (CT), and magnetic resonance imaging (MRI) images (hereafter referred to as medical images)¹⁰⁻¹² have been found to help patients understand medical information and promote behaviour change when shown to patients during clinical consultations or when accompanying medical information leaflets. However, sharing 2D medical images with patients has also resulted in false optimism¹³ and anxiety.^{11,14} Little, if any, research has explored the impact of sharing medical images with patients during consultations about orthopaedic surgery. However Carlin et al¹¹ found that patients were enthusiastic about viewing images of their skeleton during consultations with their general practitioner.

Three-dimensional medical images can be developed from the digital data of 2D scans. Their use in clinical practice within the United Kingdom is fairly limited, but they are shown to patients within clinical consultations about certain health conditions. Research into the impact of sharing three-dimensional (3D) medical images with patients is sparse. Patients with cholesteatoma (abnormal skin cell growth in the middle ear) reported improved understanding of their condition when 3D images were used during the surgical consent process.¹⁵ This is supported by Phelps et al,¹⁶ who found that when medical information was accompanied by a 3D image, healthy participants reported greater understanding, trust, and satisfaction compared with when there was no image. These studies suggest that 3D images might be beneficial to patients as they may aid understanding of medical information. However, patients' experience of viewing their own 3D images has not yet been studied.

Our aim was to understand patients' experiences of viewing their own 3D medical images during an orthopaedic consultation and health care professionals' experiences of sharing medical images with patients. A hip clinic specializing in femoroacetabular impingement (FAI) was used as a case study. FAI is a condition in which the shape of the hip joint is abnormal, and this can limit the range of movement that a patient can make before the acetabulum (hip joint socket) impinges with the head of the femur (ball). This can cause damage to the cartilage and labrum within the joint as well as pain during certain movements or at rest.¹⁷ Active individuals may be more likely to suffer from FAI due to the way in which they use their hips.¹⁸ Treatments include adjustments to lifestyle, physiotherapy, hip arthroscopy

(a key hole operation to alter the shape of the bone), and total hip replacement. Six focus groups with lay representatives from local public, patient, and student groups were also conducted in order to gain a wider perspective on the advantages and concerns of sharing medical images with patients. The use of focus groups enabled us to gain feedback on a wider selection of 3D images that might not be shared with patients at present.

2 | METHODS

This study was conducted as part of a mixed-methods doctoral research project, which aimed to explore the impact of 3D medical images when used during a clinical consultation about orthopaedic surgery. This article presents the analysis of qualitative data collected as part of the project. The quantitative analysis from the project is published elsewhere.¹⁶ The qualitative aspects of this project drew upon principles of phenomenology to allow an in depth understanding of the participants' individual experiences and the meaning they ascribe to them.^{19,20}

A hip clinic was used as a case study. We sought further clinics to study including two knee clinics and a shoulder and elbow clinic. However, the use of 3D images was less widespread than expected at the start of the project. Clinicians were interested in using 3D images and some were already using 2D X-ray images and diagrams during some consultations. In these clinics, patients tended to have CT scans after their clinic appointment, and so it would not be possible for a 3D image to be available at the time of the consultation.

2.1 | Interviews with patients and health care professionals

Patients and health care professionals were recruited from a tertiary care orthopaedic hip clinic in the UK NHS between September 2014 and June 2015. Patients attending this clinic tended to be young and active and were often diagnosed with FAI. During consultations to discuss diagnosis and treatment, medical images including 3D images were often shared with patients.

2.1.1 | Participants

A convenience sample of 14 patients and 4 health care professionals were interviewed. Patients aged 18 years and over, who were having a CT scan before their clinic appointment, were invited to participate. All patients who participated in the study were shown their medical images during their consultation. Patients attending for follow-up after treatment were excluded. Potential participants were sent an information pack from the clinics consultants, which included: a letter of invitation, a participant information sheet, a reply form, and a stamped addressed envelope. Potential participants had at least 2 weeks to decide about participation. Patients who expressed



FIGURE 1 Three-dimensional CT image of the hemi-pelvis. CT, computed tomography

interest in participating met the researcher on the day of their appointment in the clinic and had the opportunity to ask questions and discuss the study before giving informed consent to participate. Health care professionals who conducted consultations with recruited patients were invited to participate.

2.1.2 | Images

During consultations, patients were often shown a selection of images, which included X-rays, MRI images, 2D CT images, and 3D images. Three-dimensional images are generated from the digital data of CT scans. They can be rotated to view the hip from different angles. In this clinic, the 3D images showed only the bone and were used to show patients abnormalities in the shape of their bones and where the shape of the bones could be revised through surgery. An example 3D image is shown in Figure 1. Figure 2 shows an example 2D CT image.

2.1.3 | Data collection

Interviews were semistructured and used a brief topic guide. The research questions and literature were used to develop the initial topic guides, which can be found in Boxes 1 and 2. Interviews were audio-recorded and transcribed verbatim. To fit in within the busy clinic environment, interviews lasted up to 40 minutes. With consent from patients and health care professionals, the interviewer observed participating patients' consultations. Meeting participants in the clinic enabled the interviewer to build a rapport with patients and health care professionals prior to their interviews. Interviews were



FIGURE 2 Axial CT image of the hips. CT, computed tomography

BOX 1 Example patient interview topic guide

Opening questions

- Tell me about yourself?

Prompts:

Occupation
Activities
Family

- Tell me about the health condition that brought you to the clinic?

Prompts:

How long have you experienced it?
What impact does it have on your life?
Have you seen other doctors/received other treatment?
Before your appointment had you seen any images of your hip?

Consultation and image

- Tell me about your visit with Dr insert name?
- Can you tell me about your experience of viewing 3D/2D images?

Prompts:

What did you see?
How was it explained?
How did you feel looking at the image?
Did viewing the image/s change anything for you?

Can you tell me about the treatment you will have?

Prompts

- How did you come to the decision?
Were the images important to your decision?
Is there anything else that could have helped you?
- Is there anything else you would have liked during your consultation?

Closing questions

- Is there anything else you would like to add?
- Is there anything you would like to ask me?

conducted by a female doctoral student (E.E.P.) with a background in psychology and sociology and interview experience.

Interviews with patients covered their experience of (a) their condition, (b) their consultation, and (c) viewing their medical images. Interviews with patients were conducted face-to-face, by telephone, or via Skype depending on the patient's preference.

Interviews with health care professionals explored the use of 3D images within the clinic and with each participating patient. Interviews

BOX 2 Example clinician interview topic guide

General questions

- Can you tell me about the use of images in the clinic?

Prompts:

Do you always use these images?

From your perspective how to patients find this?

Consultation and image

- Tell me about your consultation with insert name?
- Can you tell me about the use of the images in the consultation?

Prompts:

Can you tell me about the use of the 3D image?

Did the 3D image change anything in the consultation?

Can you tell me about the other images used in the consultation?

- Is there anything else you would like to add about the consultation

Closing questions

- Is there anything else you would like to add about 3D images?
- Is there anything you would like to ask me?

with health care professionals tended to be conducted face-to-face, immediately after each clinic session in which one of their patients was participating in the study.

2.2 | Focus groups

Focus groups are used within exploratory research to elicit a collective view of a phenomenon from a group of individuals.²¹ The aim of the focus groups was to gain a wider perspective on the potential impact for patients of viewing their own medical images by understanding: (a) whether there are potential advantages or concerns about sharing medical images with patients; and (b) how 3D images compare with 2D images.

2.2.1 | Participants

Thirty-one participants were recruited to six focus groups from two community orthopaedic patient groups, two local public groups with an interest in science, and two groups were formed of students from the University of Warwick Psychology Department. Kruger and Casey²¹ recommend conducting three or four groups with a target audience. The student focus groups were conducted first, allowing the materials to be piloted. They did not generate rich data, so a further four groups were conducted. Groups included four to eight participants. Small groups were selected as they have been argued to allow for greater discussion and diversity of opinions as participants may have more confidence to disagree with one another, enable quieter participants to speak up, and prevent one participant becoming too dominant.²² Participants were recruited by email for four of the six groups, and the other two groups were recruited at regular group meetings. These groups were selected to achieve variation in characteristics of the focus group participants. Students were selected, as they are a similar population to those who may experience FAI along

with orthopaedic injuries. Orthopaedic patient groups were made up of patients with different orthopaedic conditions to the patients seen within the clinic but who may be shown or be interested to see their own medical images in the future. Two local public groups were also included to access the views of potential patients who may not have a specific focus on orthopaedics.

2.2.2 | Data collection

During the focus groups, participants were shown a selection of anonymized 2D and 3D images. They were first shown orthopaedic images specifically 2D and 3D images of FAI, avascular necrosis (AN), and a hip fracture. Then they were shown 2D and 3D images of soft tissues, specifically images that did or could present gastrointestinal cancers. This included a 2D image and a 3D image that presented liver cancer and a 3D virtual colonoscopy, which showed no pathology but was used to present how bowel cancer could be presented in the image. For each condition, participants were shown 2D and 3D images and were provided with an explanation of the images and the condition (eg, the symptoms a patient with this condition may experience and possible treatments). Materials for the focus groups were prepared with assistance from a Consultant Radiologist.

Focus groups explored the potential impact for patients of viewing their own medical images as well as wider considerations that may arise from sharing medical images with patients. Prompts for the discussions included: (a) do you have a preference for viewing the 2D or 3D image for this clinical condition, (b) how would you feel viewing these images during a clinical consultation, and (c) are there any concerns about showing these images to patients. Focus group discussions lasted up to 1 hour 45 minutes. They were audio-recorded and transcribed verbatim.

2.3 | Data analysis

Nvivo 10.0 was used to manage the data. Interview and focus group data were initially analysed separately. Interview data were analysed using thematic analysis as described by Clarke et al.²³ This method included familiarizing oneself with the data and coding the data inductively line-by-line based on meaning. Semantic and latent codes were derived from the data, and coding was an iterative process with new codes added and existing codes developed as more data were added. Codes were compared and organized into groups to develop categories. Themes were developed by exploring the categories in-depth and by comparing within and across transcripts. Categories and themes were revised and defined through discussion. E.E.P. coded the data and codes; categories and themes were discussed and examined by E.E.P. and F.G. throughout analysis.

Multiple methods were used to analyse the focus group data. First, each group's preference for 2D or 3D images for the four clinical conditions was quantified. Qualitative analysis used both inductive and deductive coding.²³ This involved: (a) searching the data for

TABLE 1 Participant characteristics

Patients	Number
Age	
20-29	4
30-39	2
40-51	8
Gender	
Male	9
Female	5
Race	
White	13
Mixed	1
Education	
Degree	5
A level	2
Other	5
None	1
Unknown	1
Diagnosis	
FAI	10
Other	4
Health care professionals	Number
Gender	
Male	4
Role	
Registrar	3
Physiotherapist	1
Number of patient consultations	
HCP 1	6
HCP 2	3
HCP 3	2
HCP 4	3
Focus group participants	Number
Age	
18-19	4
20-25	3
26-30	2
50-59	2
60-59	3
70-75	9
Unknown	8
Gender	
Male	8
Female	23
Race	
White	16
Asian	5
Mixed	1
Black	1

(Continues)

TABLE 1 (Continued)

Patients	Number
Education	
Students	12
Degree (or higher degree)	9
Other	3
Unknown	7

Abbreviations: FAI, femoroacetabular impingement; HCP, health care professional.

sentences or paragraphs relating to the initial codes developed from the interview data to check for similarities and differences, and then (b) coding the data inductively using thematic analysis.

In order to develop and refine the initial themes and categories developed from the interview data, the two data sets were combined. Categories developed from the interview data were compared and developed with categories from the focus group data. This aided the development of conceptual themes, which are evident in both data sets.

Several strategies were adopted to ensure rigour and transparency. These included (a) a clear description of the context and methods, (b) immersion in the data, (c) the inclusion of data to illustrate the authors interpretations, and (d) regular discussion of the data throughout analysis.

2.4 | Ethics

This study was approved by the NHS Research Ethics Committee (Study Number: 150177). All patients, health care professionals, and focus group participants provided written informed consent to participate.

3 | RESULTS

3.1 | Participant characteristics

3.1.1 | Patient

Fourteen patients (nine male, mean age = 38.3) participated in an interview. Participant characteristics are presented in Table 1. All patients had previously seen other health care professionals about their hip, with the onset of their symptoms or initial injury ranging from 12 months to 12 years before their appointment. Ten patients had FAI and four had other hip complaints. Eleven patients mentioned previous experience of viewing their own medical images, but no patient reported having previously seen a 3D image. During their consultation, 12 of the 14 patients were shown 3D images and 7 of these 12 were also shown other images. Two patients were shown only 2D images. Seven patients were interviewed face-to-face in the clinic immediately after their consultation, and two patients were interviewed face-to-face 13 and 20 days later (one in their own home and one when they returned to hospital for treatment). Five patient

interviews were conducted over the telephone or skype up to 7 days after their consultation.

3.1.2 | Health care professionals

Four health care professionals were interviewed. One was a physiotherapist and three were doctors who were nearing completion of their specialist training in orthopaedics. All were male. Interviews with health care professionals were conducted face-to-face immediately after the clinic session, where possible. In two cases, this was not possible, with one interview conducted 2 weeks after the consultation and the other completed in writing within 3 days of the consultation.

3.1.3 | Focus groups

Thirty-one individuals participated in six focus groups. This included 12 students, 9 participants from community patient groups, and 10 participants recruited from local groups with an interest in science. Focus group participant characteristics are included in Table 1. Six participants spoke about their own experience of viewing their medical images or their relatives' images during the focus groups.

3.2 | Thematic analysis findings

Three themes were developed from the data: (a) the truthful image, (b) the empowering image, and (c) the unhelpful image. Three-dimensional images were perceived as truthful images, they could provide evidence of a diagnosis and were trusted by patients and focus group participants but there were concerns that this perception could lead to an overuse of imaging. Three-dimensional images could empower patients, enabling them to make sense of their hip condition, make a decision about treatment, and move forward. However, images could potentially be unhelpful for some patients, causing distress and disempowering them. Health care professionals, at times underestimated the impact of the image for patients, highlighting the difficulty in determining when an image is helpful or not. Table 2 presents the three themes with descriptions and categories.

3.2.1 | The truthful image

Patients and participants spoke of "the truthful image." They perceived the images as evidence that they could trust but there were concerns from focus group participants that this perception could result in an overuse of imaging.

The image as evidence

Patients expressed considerable faith in their 3D images, believing them to convey the truth about their condition. They described their 3D image as "evidence" (Patient 1) or "proof" (Patient 3) of their diagnosis. One

health care professional and five focus groups also spoke of the image as factual, explaining "it (*the image*) takes the guess work out of it" (HCP4), "there is no doubt about it" (FG3), and "it's a true record" (FG5). These descriptions of the image reveal that to patients and participants, the images were not open to interpretation, they were facts that provided an answer or a diagnosis. They seem to ignore the role of the radiologist in interpreting the image and the role of the health care professional in integrating the image with their orthopaedic knowledge and knowledge of the patients' history and symptoms and in a sense give the image agency.

Trust in the image

For some patients, viewing their 3D image increased their confidence in their health care professional and diagnosis. They implied that without the image they would feel uncertain about the information that they were given and suggested that seeing their image provided them with greater confidence than hearing a diagnosis alone. They described the image as "backing up" (Patient 6) the information they received or explaining that without the image "it is purely trust" (Patient 1) or "blind faith" (Patient 14). Health care professionals and two focus groups agreed that the 3D image could increase patients' confidence in their clinician, diagnosis, and treatment.

One patient and focus group participants indicated that an image could provide a sense of certainty that is missing when hearing a diagnosis alone, suggesting greater trust in the images than in health care professionals. The patient contrasts the image which he considered evidence to the uncertainty of listening to a consultant, explaining that doctors make mistakes:

I think sitting and listening to your consultants simply give advice you are left with a big question mark ... it's purely trust. I think whilst Joe public are supposed to hold the medical professional in awe, they're fallible and... I think if you have seen an image like that it provides concrete evidence. It's satisfying my curiosity and any question marks that remain as to whether it's the right decision or not (Patient 1).

Focus group participants explained that by viewing their image, patients would know that their clinicians have quality information and that their condition is being looked at properly. They explained that "it's (*the image*) also a demonstration that they know precisely what's wrong and where rather than saying we think we have got the problem" (FG3) and that they might question "how do you know exactly?" (FG3) if they had not seen an image.

Furthermore, one group explain that the image allows patients to "to see it with your own eyes and not having the doctor put a spin on it" (FG2). This suggests a belief that health care professionals may intentionally mislead patients and that the image can in some way prevent or challenge this.

Overuse of imaging

One focus group were concerned about the potential for overuse of imaging and the high levels of ionizing radiation required to



produce 3D images arguing that “if people became aware that pictures of your insides can be taken they may choose to disregard the radiation aspect” (FG4) and ask for more CT scans. There was also concern that health care professionals might request more imaging tests for patients if they believed that sharing images with patients might make them appear more patient friendly.

3.2.2 | The empowering image

Viewing their own 3D image could be empowering for patients, helping them to make sense of their condition, giving them confidence in the decision they made about treatment, and helping them to move forward.

Making sense

Viewing their own 3D images helped the majority of patients to make sense of their condition. The images helped patients to understand and visualize why they were experiencing certain symptoms.

I immediately understood what he was talking about and I could envisage it relative to the movement... if he had described it as being anterior I would not have got it (Patient 8).

Patients, health care professionals, and focus group participants felt the images enabled patients to make sense of the information they received. They felt the image reduced the use of medical jargon or rendered the jargon that was used insignificant.

When you could then physically see what they were looking at and you could see it, the terminology then sort of went in to insignificance because you then knew and you could see what it was that they were talking about (Patient 13).

Seven patients wanted a copy of their image either for reference or to show their family, friends, or employer. They wanted to view their image again in their own time or use it to help communicate their condition to others. Health care professionals and focus group participants were conflicted, some thought this would help patients, whereas others were uncomfortable with this. There was concern that patients might start to misinterpret their image while viewing it at home especially if they cannot recall the information that accompanied the image.

Making decisions

Patients, health care professionals, and focus group participants spoke about the impact of the image on decisions about treatment. For some patients, viewing their image confirmed the decision they had made, giving them the confidence to go ahead with surgery.

TABLE 2 Overview of themes

Theme	Description	Categories
The truthful image	Patients and participants spoke of “the truthful image.” They perceived the images as evidence that they could trust but there were concerns from focus group participants that this perception could result in an overuse of imaging.	<ul style="list-style-type: none"> • The image as evidence • Trust in the image • Overuse of imaging
The empowering image	Viewing their own 3D image could be empowering for patients; helping them to make sense of their condition, giving them confidence in the decision they made about treatment and helping them to move forward.	<ul style="list-style-type: none"> • Making sense of their hip • Making decisions • Moving forward
The unhelpful image	At times, the use of images might be unhelpful to patients. They could cause distress or inadvertently disempower patients. It was not always clear to health care professionals when the image was helpful or not as HCPs at times underestimated the impact of the image for patients.	<ul style="list-style-type: none"> • The distressing image • Disempowering image • Underestimating the image

Abbreviations: 3D, three dimensional; HCP, health care professional.

It (the image) confirmed the fact that I did need to go ahead with the surgery (Patient 6).

For other patients who were not expecting to need surgery, the image helped them to reach a decision about treatment and accept that they may need to have an operation. Being able to see what was wrong with their hip in the image aided their decision.

When we looked at the 3D scan it became very apparent what the issues were and then straight away it gave me a lot of confidence in what I wanted to do. It (the image) made my mind up more or less on the spot... I knew what I wanted to have done in that I wanted to have it operated on (Patient 13).

When he actually said surgery, I was a little bit shocked because it wasn't what I'd been expecting. But because of the imagery I very rapidly... it did not take much time to align myself with the suggestion (Patient 8).

Similarly, one health care professional and three focus groups also believed that viewing 3D images might encourage patients to have the treatment recommended to them describing the image as a “medical tool” and explaining, “when they actually see something there that probably shouldn't be there ...I think it sort of tips them towards that [surgery]” (HCP 4).

In contrast, one health care professional and one patient felt that the image had no role in patients' decisions about treatment. For the patient, this was because he had already decided upon the treatment he wanted before attending the clinic. The health care professional found patients tended to trust their clinicians to make treatment decisions for them.

I don't think it (the image) will change anything for the patient because patients come and they expect us as their health care professionals to make the correct decisions about what to do (HCP3).

Moving forward

For patients who were shown a 3D image that depicted an abnormality during their consultation, the experience was “brilliant” (Patient 14) and “fascinating” (Patient 1). Viewing their image could help patients “move forward” (Patient 14) as they learnt something could be done for their hip. Being able to see what was wrong with their hip could evoke a sense of relief and reassurance for patients and could reduce their anxiety about treatment.

I am a bit more relaxed about treatment because being able to see it I understand it better so I am not maybe as anxious about it (Patient 2).

For one patient viewing their image reassured them that the symptoms they experienced were not their fault and that they had not damaged their hip. For another patient, seeing his hip and its abnormal shape in the image justified the journey he had endured to reach a diagnosis.

I felt justified in pushing and going back every time to sort of get to this point... knowing that something was wrong and even though people couldn't find... couldn't sort of nail it down and they being able to nail it down sort of justified everything that I have done up until now (Patient 13).

Focus group participants felt that viewing their image could be comforting for patients as they may feel “relieved there was a reason for your pain” (FG6) and could help them to accept their limitations such as limitations to daily activities and move on.

3.2.3 | The unhelpful image

At times, the use of images might be unhelpful to patients. They could cause distress or inadvertently disempower patients. It was not always

clear to health care professionals when the image was helpful or not as health care professionals at times underestimated the impact of the image for patients.

For a minority of patients, the image could cause distress. One patient felt more anxious after viewing their image and the extent of their abnormality and questioned “whether it is better to be in the dark about that or not” (Patient 10). Another patient hypothesized that their image may have made them more anxious should their condition have been more serious.

Focus group participants believed that while viewing images of bones might be a helpful experience for some patients, there might be a difference in emotional impact between viewing images of orthopaedic conditions and other conditions. The question whether viewing images of cancer or viewing images when there was no curative treatment available example may evoke a sense of vulnerability or have a long lasting impact: would patients say “I keep waking up and seeing that picture?” (FG3).

Focus group participants' responses when viewing the images suggest that some orthopaedic images may also be distressing for patients to view. A 3D image depicting AN was described as frightening and upsetting by some participants, with one participant explaining that “I think that some probably would be distressed to see that- it has a cancerous look about it”(FG3). Another participant said they would feel disheartened to see the image of AN. This image was described as “horrendous” (FG5), “terrible” (FG6), and “revolting” (FG6) in comparison to the 3D image of FAI, which was described as fantastic” (FG6) and “amazing” (FG6).

Disempowering patients

Medical images were not considered helpful in all contexts and there were circumstances in which they could disempower patients. One patient found his 3D image unhelpful as there was no known abnormality and nothing to see in the image.

Three focus groups discussed the use of medical images to persuade patients to have a recommended treatment and participants tended to support this use. Participants spoke of the image making patients' condition more real and frightening them into reality. Using the image to pressure and evoke fear in patients even if it led them to have a recommended treatment could be disempowering. One group described feeling “nervous about it (*the image*) being used as a shock tactic” (FG4), which they felt was “brow-beating the patient” (FG4) if they do not follow the suggested treatment.

Three focus groups believed patients should decide if they wish to view their images and emphasized the importance of respecting patient's wishes. However, one group argued doctors have a duty to explain medical conditions to patients in a way that they understand and an image may be needed to achieve this.

I think the healthcare professional has some sort of duty to make sure they understand... so the mere fact that someone says “I don't want to know” isn't necessarily the end of the consultation... and pictures might help (FG3).

TABLE 3 Image favoured by each focus group for the orthopaedic conditions discussed

Group	FAI	Healing fracture	Avascular necrosis
FG1 (student group)	2D	2D	2D
FG2 (student group)	N/R	3D	3D
FG3 (local public group)	3D	N/R	3D
FG4 (local public group)	N/R	2D	N/R
FG5 (community patient group)	3D	3D	2D
FG6 (community patient group)	3D	3D	N/R

Abbreviations: 2D, two dimensional; 3D, three dimensional; FAI, femoroacetabular impingement; FG, focus group; N/R, not reported.

Underestimating the impact

At times, health care professionals underestimated the impact of the image, identifying a concern, such as the size of the abnormality or quality of the image, which they felt could make the 3D image less helpful to patients. The following quotes from a patient and health care professional both refer to the same image. Although the health care professional was unsure of the value of the image in this instance, the patient describes viewing it positively. This highlights the difficulty in judging when it might be helpful to share images with patients.

I am not sure how much she could really appreciate that subtle abnormality. It was a bit difficult to appreciate on that scan (HCP 2).

What was nice was that you can actually see it in the sense that you can actually see the bony ridge on the scan so it's interesting because then you can actually piece together as to why you're getting the pain (Patient 6).

3.3 | Comparing the 3D image to 2D images

Table 3 presents which type of image (2D or 3D) was preferred by each focus group for each condition. Where groups did not discuss which image they preferred or a clear preference could not be determined, their preference is recorded as not reported (N/R).

Preference varied between conditions and groups, and only one group favoured one image type across all conditions. This suggests that the experience of viewing images may differ between individuals and conditions. Overall, the 3D image was slightly favoured to the 2D image. Participants tended to prefer the 3D image as the abnormalities were not as obvious on the 2D images. Two groups contrasted their understanding of the 2D image to that of the 3D image, explaining that from the 2D image, they understood there was a problem, but from viewing the 3D image, they understood what the problem was. Additionally, two groups explained that the 3D image was more recognizable. Three groups would want to view both 2D and 3D images, with one group explaining the more information the better and the other appreciating the simplicity of the 2D image, which they would like to view before seeing a 3D image.

4 | DISCUSSION

Three data sources (patients, health care professionals, and lay representatives) were used to understand the impact of 3D medical images when shown to patients during clinical consultations about hip surgery. Patients trusted their image, which they believed provided them evidence and certainty of the information they were given. For the majority of patients, viewing their own 3D images was empowering. Sharing images with patients during a consultation could help patients to make sense of their symptoms and medical information by reducing jargon and could give patients confidence in their treatment decision. However, there were times in which sharing an image with patients might be unhelpful and could cause distress.

This study highlighted the importance of considering the context in which the images are shown. We found that for some conditions, 3D images were considered "amazing" by lay representatives, whereas for others they provoked fear or concern and were described as "horrendous." Two studies examining the experience of viewing 2D medical images have identified benefits for patients,^{10,11} whereas other studies have raised concerns about this practice.^{13,14} For the majority of patients in this study who viewed their own 3D image, the image was empowering. This study focused on 3D images using a younger sample than previous studies, where the mean participant age was typically >60. Previous studies, which raised concern of showing 2D images to patients, examined women's experience of viewing hysteroscopy images during the procedure and the impact of showing images to terminally ill patients. The context in which medical images have been shown in this study differs to the studies in which concerns were raised. This study focused on the impact of images for symptomatic patients to present information about a nonlife-threatening diagnosis and its treatment. It may be that this type of consultation is well suited to sharing images with patients.

Focus group participants highlighted the potential for images to be used to disempower patients. Some participants expressed concern about using images to pressure patients when deciding upon treatment; however, many participants felt that using images in this way was acceptable. The et al¹³ found that 2D images were used to convince lung cancer patients that they had a tumour and that their treatment was working when they began to feel worse from the side effects of chemotherapy. Using medical images to convince patients of their health status could be helpful as it could aid their understanding of their condition and their need for treatment. However, using

images in this way could result in patients feeling unable to evaluate their own symptoms.¹³ Focus group participants also suggested health care professionals should seek verbal consent before showing patients their imaging results. Not all patients want information about their condition and prognosis despite medical professionals being encouraged to give it.^{24,25} In contrast, some focus group participants felt that it is the health care professionals' duty to ensure their patients are fully informed and they believed images might enable this to be achieved. Health care professionals considering seeking verbal consent before sharing images with patients should consider discussing the implications of not receiving all the available information with patients. This could help patients to make a more informed decision about how much they want to know while allowing health care professionals to respect the wishes of patients who do not want to view their images.

Patients and lay representatives perceived 3D images as evidence. This perception has been previously described by Joyce^{26,27} who examined the depiction of MRI (the technology and the images) by the media and by medical professionals. Joyce found MRI was presented: (a) as authoritative and considered more accurate than information provided from the patient or interpreted by the doctor; (b) to have agency and considered able to reveal information about a patient's health status without interpretation from a human; and (c) to provide a window into the human body.^{26,27} However, medical images are susceptible to interpretation errors and diagnoses are reached by integrating information from medical images with other sources of information (such as physical examinations). Concerns resulting from this perception have been raised and include overuse of imaging²⁸ and disregard for other forms of information.^{29,30} To address these concerns, it might be important for patients and the public to be made more aware of the uncertainty that accompanies medical images. From an ethical perspective, it could also be important to ensure patients understand any uncertainty associated with their imaging results. However, the perception of medical images as evidence may in part explain why viewing a 3D image increased patient's confidence in their diagnosis and treatment. If patients believe the image reveals the truth about their condition, they could arguably have more trust in their diagnosis and confidence in their planned treatment. These benefits might be diminished if patients and the public had a more accurate perception of the uncertainty that accompanies medical images.

4.1.1. | Strengths and limitations

Qualitative data collection methods were used to allow participants to describe their experience and views in their own words. Interviews with patients and health care professionals provided two accounts of the consultation from both parties participating in the interaction. Gaining feedback from six focus groups with lay representatives allowed corroboration of ideas. As participants volunteered to participate, there may be a degree of self-selection bias, with participants more interested in viewing medical images potentially more likely to participate.

4.1.2. | Future research

This study focused on consultations about hip surgery. As the impact for patients of viewing their own 3D images may differ depending on the nature and severity of the condition, future research should explore the impact of sharing 3D medical images with patients in different clinical contexts. Furthermore, investigating the impact of viewing 3D images during a consultation on health outcomes such as patient activation should be considered.

5 | CONCLUSIONS

When presented alongside a diagnosis about hip problems, 3D images may be an empowering resource for patients. They could help patients to make sense of their condition, which may enable patients to participate in shared decision making and be more involved in their care. Patients trust 3D images, with some patients considering them to be evidence of the information they are given. This could increase their confidence in their diagnosis, treatment, and health care professional. However, as medical images are susceptible to interpretation errors, health care professionals should be careful when communicating with 3D images to avoid presenting them as certain. Furthermore, in some contexts, viewing an image might be unhelpful or distressing. Before sharing images with patients, health care professionals should consider whether the use of images is appropriate for their patients and consider seeking consent from patients first.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

E.E.P. was responsible for designing the study, data collection, data analysis, and writing the results into manuscript form. F.G. was responsible for overseeing the project and assisting in the design of the study, overseeing data collection, data analysis, and writing up the results into manuscript form. R.W. prepared the materials for the focus groups. M.K., R.W., and C.H., contributed to the design of the study and were responsible for overseeing the project and editing the manuscript.

ORCID

Emma E. Phelps  <https://orcid.org/0000-0003-4810-3650>

Melina Kunar  <https://orcid.org/0000-0003-0384-376X>

Frances Griffiths  <https://orcid.org/0000-0002-4173-1438>

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