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Impact of bone quality on surgical decision-making in total hip arthroplasty: a qualitative analysis in the UK

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ABSTRACT

Introduction For total hip arthroplasty (THA) to be successful, surgeons need to make several decisions ranging from implant choice to impaction force. It is unclear, however, whether and how bone quality affects surgeon's decision-making and how surgeons evaluate bone quality.

Objectives This inductive/deductive qualitative hybrid study aims to explore the impact of bone quality on the decision-making of surgeons performing elective primary THA. This study will evaluate: (1) whether surgeons consider bone quality as an important factor for surgical decision-making; (2) how bone quality influences surgical decision-making; and (3) how surgeons assess bone quality preoperatively and intraoperatively.

Design This is a qualitative study, involving inductive/deductive hybrid thematic analysis.

Setting Semistructured interviews were conducted virtually via Microsoft Teams and on hospital premises.

Participants Purposive and snowball sampling methods were used to recruit consultant orthopaedic surgeons specialised in elective lower limb arthroplasty.

Results 10 surgeons from eight centres in the UK were interviewed. Thematic saturation was achieved after eight interviews. 5 main themes and 13 subthemes were identified. Bone quality impacted decisions around preoperative planning, surgical procedure, implant choice, concerns of iatrogenic injury and hip biomechanics. Many surgeons (7/10) described changing surgical procedure based on their intraoperative assessment of bone quality. There was consensus that cemented femoral fixation is superior in patients with poor bone quality and on the importance of assessing radiographs preoperatively. There was, however, a lack of consensus on optimal acetabular fixation method, the radiographs metrics used to measure bone quality and attitudes towards current guidelines.

Conclusions Bone quality has a significant impact on the decision-making of experienced arthroplasty surgeons, though there are significant limitations and divergence in current methods of assessing bone quality. Further work to identify intraoperative and preoperative imaging metrics that correlate with bone mechanical properties could enhance surgical decision-making.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study supplements limited prior qualitative research exploring surgical decision-making in primary total hip arthroplasty.
⇒ Most surgeons (n=8) were recruited from a narrow geographic area (South East of England), limiting the study's generalisability.
⇒ Owing to its qualitative nature and use of semistructured interviews, the data obtained are influenced by the rapport established with participants.

INTRODUCTION

Primary total hip arthroplasty (THA) constitutes one of the most common elective surgeries in the UK.[1] The main indication for primary THA is the replacement of the arthritic hip in end-stage osteoarthritis.[1] On average, outcomes following surgery are strongly positive, with an overall revision rate of 3.0% in the UK in 2021.[1] While only a small percentage of surgeries require revision, surgical complications and revision surgery still present a burden, with rates of revision varying among surgeons.[2] Revision surgery is more expensive and complex and is associated with a higher rate of failure.[3 4] Given the challenges associated with revision surgery, there is increasing interest in optimising outcomes in primary joint replacement. Initiatives such as Getting It Right First Time (GIRFT) have aimed to improve outcomes following primary joint replacement, guiding some aspects of surgical decision-making based on patient age.[5]

Aseptic loosening, dislocation and periprosthetic fracture are the three leading causes for revision in primary THA, accounting for 24.7%, 17.4% and 15.7%, respectively, of all revisions documented in the National Joint Registry for 2021.[1] While rates of loosening are lowering internationally,[6] the incidence of dislocation is increasing[6] and rates of periprosthetic fracture are rising nationally.[7] The pathophysiology of aseptic loosening, postoperative dislocation and periprosthetic fracture are multifactorial, influenced by patient and non-patient factors.[8–15] Poor bone quality

and a low bone mineral density, most commonly due to osteoporosis, are increasingly being identified as a key modulator of these complications.[16–21] It is the leading cause of poor bone quality and is a condition on the rise globally.[16–21] Osteoporosis confers worse outcomes following primary THA and is associated with increased rates of aseptic loosening, dislocation and periprosthetic fracture.[16–22] There is, therefore, a clinical need to optimise outcomes in this challenging patient cohort.[22]

The impact of bone quality on decision-making in primary THA has not previously been reported in the literature. There is strong evidence that postoperative bone quality and implant survival are impacted by the femoral and acetabular components, fixation method and impaction force chosen by surgeons.[23–26] However, the optimal choice of acetabular and femoral prostheses in patients with osteoporosis is contested.[19 27] The decision to use either an uncemented or cemented cup varies among surgeons, with the evidence for either being equivocal.[25 26] Given its impact on rates of aseptic loosening, dislocation and periprosthetic fracture, the bone quality of the femur and acetabulum is a major factor surgeons must evaluate and factor into their decision-making to guide implant choice during primary THA. In the UK, decisions on fixation method of femoral and acetabular components in patients undergoing elective primary THA are guided by GIRFT guidelines. Current guidelines state that patients aged 70 or over should receive cemented (both stem and cup) or hybrid (cemented stem, cementless cup) prostheses.[5] This guidance is based on a perceived correlation between age and osteoporosis, with evidence supporting this association.[28 29] There is however limited research exploring the attitudes of surgeons towards these guidelines, with previous research being of limited scope.[30]

Surgeons may use several methods to assess bone quality. Preoperatively, radiographs are commonly used to assess the bone quality of the acetabulum and pelvis, with the shape and cortical thickness of the proximal femur quantitatively assessed.[31] A number of indices have been proposed to assess bone quality radiographically, including the Singh Index, though it is limited at identifying more subtle differences in bone quality of the proximal femur.[31] The Dorr Index is a widely used metric to assess bone quality and has been shown to correlate with the results of dual-energy X-ray absorptiometry scans.[32] Bone quality may also be assessed intraoperatively, using tactile feedback and novel instrumentation.[33] Direct mechanical measurement of bone quality has been evaluated, but due to the subjective endpoint of maximum force, the reliability of this method is limited.[34–38] In arthroplasty, advances have been made in tools to quantify local bone quality, though at present, results are preliminary.[33] Despite having a range of methods to assess bone quality, evidence of the preferred methods used by high-volume arthroplasty surgeons is currently limited.

Decision-making in primary THA is technically demanding. Surgeons must balance patient and non-patient factors across several domains to optimise patient outcomes and mitigate the risk of operative complications. Despite extensive research on the optimal approach, prosthetic choice and fixation method, this is little prior research exploring how bone quality influences the decision-making of experienced arthroplasty surgeons. There is limited previous qualitative research exploring surgical decision-making, with most focusing on surgeons of other surgical specialities or on emergent decision-making.[39–41] However, previous research exploring decision-making among arthroplasty surgeons showed significant differences in intraoperative decision-making.[42] That said, there is no prior qualitative research evaluating decision-making based on bone quality and there is a need for such evaluation to better inform surgeons and to generate themes for research questions that can be subject to quantitative analysis. Given the increasing incidence of osteoporosis and limited previous literature, there is a need to better understand the impact of bone quality on decision-making among experienced hip arthroplasty surgeons.

Aim

This qualitative study aims to evaluate the influence of bone quality on decision-making in THA.

Research objectives

The research objectives are as follows:

1. To investigate whether surgeons consider bone quality as an important patient factor for surgical decision-making in THA.
2. To investigate how bone quality influences surgical decision-making.
3. To investigate whether, and how, surgeons assess bone quality preoperatively and intraoperatively.

METHODS

Design

This is a qualitative study, involving inductive/deductive hybrid thematic analysis conducted in accordance with the Consolidated criteria for Reporting Qualitative research publication guidelines.[43]

Prior to study commencement, a rapport was established with eligible surgeons over email and LinkedIn. Participants were told of the researcher's personal goals and motivations for undertaking this research. The potential biases of the interviewer were acknowledged, given their potential impact on interactions with interview participants in qualitative research.[44]

Participants and procedures

Purposive sampling was used to recruit consultant orthopaedic surgeons subspecialised in elective lower limb arthroplasty and/or hip surgery. Surgeons were identified through the coauthor's professional network through email in addition to snowball sampling and networking with LinkedIn.

Participants were eligible for recruitment if they were consultant orthopaedic surgeons with a subspecialisation

in hip surgery and/or elective lower limb arthroplasty. Surgeons below consultant grade, those not subspecialised in elective lower limb arthroplasty and/or hip surgery, were ineligible for inclusion. 10 eligible surgeons were recruited.

Data collection

Semistructured interviews were carried out between the colead researchers and eligible participants. Before the study, an interview question guide was developed with a psychologist experienced in qualitative research (SM). Pilot interviews were then conducted with two senior orthopaedic trainee surgeons: one with a female senior orthopaedic registrar, over telephone, and one with a male arthroplasty senior fellow, face to face.

An inductive/deductive hybrid approach was used, in keeping with research evaluating surgical decision-making.[40 45 46] Deductively, an interview question guide was formulated based on a prior understanding of the four key stages of decision-making in THA: preoperative decision-making, intraoperative decision-making and decisions on the acetabular and femoral components. An inductive approach was employed during surgeon interviews, whereby surgeons spoke at length after being asked preplanned questions, which partially structured each interview. Additional follow-up questions were then asked as themes were identified inductively, as is common practice with a hybrid approach.[45 46] Demographic questions were also asked.

Interviews were conducted between one interviewer and one participant between 21 March 2023 and 26 April 2023. No one else was present. They were conducted face to face on hospital premises (n=5), online via Microsoft Teams (n=3) or via telephone (n=2), depending on surgeon preference. The average interview duration was 19 min, 57 s. Repeat interviews were not conducted. Interview audio was recorded on two devices. Field notes were not collected. Audio was transcribed manually, using Microsoft Word (V.16.72). In-built transcription software during interviews on Microsoft Teams (V.1.6.00.7354.) was used to transcribe interviews, with transcripts then manually checked. Interview transcripts were then sent to all participants, giving them the option to comment and/or make any corrections. The beginning of one transcript was partially redacted. No other transcript changes were made.

Data analysis

An iterative inductive/deductive approach was used to analyse qualitative data obtained from interviews, this involved thematic analysis with NVivo (V.14.23.0) digital coding software. The use of an inductive/deductive hybrid approach was chosen due to its utility in exploring complex clinical decision-making, in keeping with research evaluating surgical decision-making.[40] Prior to coding, one interview transcript was reviewed and cross-checked by a psychologist experienced in qualitative research to assess for any questioning biases, to ensure analysis was robust and biases were minimised.

Inductively, qualitative data were analysed using open coding. This process involved assessing transcript data, starting with words and phrases and then sentences, coding topics as they were mentioned by participants.[47] After open coding, axial coding was conducted. Coding was inclusive and iterative. All coding was conducted by cofirst author (AA) and cross-checked by cofirst author (MK). Coding was conducted after each interview, until thematic saturation was reached, to ensure an appropriate sample size of surgeons was interviewed.

Deductively, an understanding of the four key points of decision-making in elective primary THA, preoperative decision-making, intraoperative decision-making and decisions on the femoral and acetabular components, based on a prior knowledge of the literature, was used to develop questions for surgeon interview and was considered during thematic analysis. Interviews were conducted and analysed until thematic saturation was reached.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Participant characteristics

There were 13 email invitations and 15 LinkedIn invitations sent to eligible surgeons. Of these, two surgeons declined to participate. Of the remaining 26 surgeons, 16 did not respond. The remaining 10 eligible surgeons gave consent to participate and were successfully recruited. Of these, eight were from teaching hospitals in the South East of England, one was from the home counties and one was from the North West of England. The demographic characteristics of the 10 participating surgeons are shown in table 1. The type of hospital participants worked at was excluded to preserve participant anonymity.

Themes from thematic analysis

Thematic saturation was assessed and confirmed after close inspection and coding of the eighth surgeon interview led to no new codes, themes or subthemes being identified. This was further confirmed after coding interviews 9 and 10 led to no new codes being identified. Analysis led to the identification of 5 main themes and 13 subthemes (table 2). After thematic analysis, the relationships between themes and subthemes were then mapped to present relationships between them (figure 1).

Theme 1: preoperative planning

All participants spoke of the impact of bone quality on preoperative planning. A patient's medical history, age, imaging preoperatively and frailty were assessed, informing a preoperative assessment of bone quality, in turn informing preoperative surgical decision-making.

Table 1 Participant characteristics (n=10)

Characteristic	Category	N (%)
Gender	Male	10 (100%)
Age (years)	40–45	6 (60%)
	46–50	0 (0%)
	51–55	1 (10%)
	56–60	2 (20%)
	61–65	1 (10%)
Ethnicity	White British	7 (70%)
	British Asian	1 (10%)
	British Indian	1 (10%)
	British Arab	1 (10%)
Highest level of training	Fellowship	8 (80%)
	No further training post FRCS	2 (20%)
Additional degrees	None	4 (40%)
	MSc	1 (10%)
	PhD	4 (40%)
	Not recorded	1 (10%)
Years of experience as a consultant	0–5	5 (50%)
	6–10	2 (20%)
	11–15	1 (10%)
	16–20	1 (10%)
	21+	1 (10%)
Annual number of primary THAs performed	50–70	1 (10%)
	71–90	2 (20%)
	91–110	3 (30%)
	111–130	2 (20%)
	131+	2 (20%)

FRCS, Fellowship of the Royal College of Surgeons; THAs, total hip arthroplasties.

Bone morphology was also deemed an important metric of bone quality by all.

The patient's medical history, and its bearing on bone quality, informed preoperative decision-making among most surgeons (7/10), influencing implant and fixation choice. Many surgeons (5/10) discussed how a history of osteoporosis or fragility fractures informed their preoperative planning, while a history of kidney disease (4/10), steroid use (3/10) and bisphosphonate use (3/10) were factors discussed by some surgeons to guide their preoperative planning.

> If they've got previous fractured neck of femur or a fragility fracture…I just switch to cemented. (Surgeon 6)

Patient age was identified by 8/10 surgeons as a key factor in influencing preoperative planning, in addition to being used as an approximate metric of bone quality.

> I…amend my decision-making about the choice of implants on the basis of age and gender. (Surgeon 5)

Some surgeons (3/10) also reflected on the influence of GIRFT guidelines on their preoperative decision-making.

> In the NHS we have a structure whereby we have to decide on fixation based on age. (Surgeon 4)

The use of imaging preoperatively to assess bone quality was discussed by all surgeons, influencing the choice of implant and fixation method, based on the appearance of bone. All surgeons used radiographs to guide their decision-making. 5/10 used the Dorr Index and 2/10 used the Singh Index to assess bone quality radiographically. However, there was divergence on the utility of radiographs as measures of bone quality. CT imaging was discussed by 5/10 surgeons. 2/10 described occasionally using them to assess bone quality, while the remaining surgeons did not see their use (3/10) or made no mention (5/10).

> I think actually X-rays are actually pretty good at telling the truth. (Surgeon 10)

> There aren't many good metrics of assessing it, particularly on X-ray. (Surgeon 9)

> I don't usually use DEXA scans or CT scans. (Surgeon 3)

> I wouldn't routinely get CT scans. (Surgeon 9)

The appearance, shape and thickness of bone on imaging was discussed by all surgeons and was central to preoperative and intraoperative decision-making. The shape of the proximal femur and its cortical thickness on X-ray was used by all surgeons to qualitatively assess bone quality and inform preoperative and intraoperative decision-making. Cortical thickness was directly related to the decision of whether to cement the femoral component.

> I tend to go on bone quality and bone shape. (Surgeon 2)

> If I feel that the morphology of the proximal femur doesn't work with the cementless implant then I won't use it. (Surgeon 5)

Some surgeons (3/10) reflected on the relationship between poor bone quality and frailty. Some noted how

Table 2 Themes and subthemes identified from thematic analysis

Main theme	Subtheme
Preoperative planning	Age
	Medical history
	Imaging
	Bone morphology
	Frailty
Surgical procedure	Surgeon flexibility
	Tactile feedback
Implant choice	Fixation
	Longevity
Iatrogenic injury	Caution
	Periprosthetic fracture
	Dislocation
Biomechanics	Load transfer

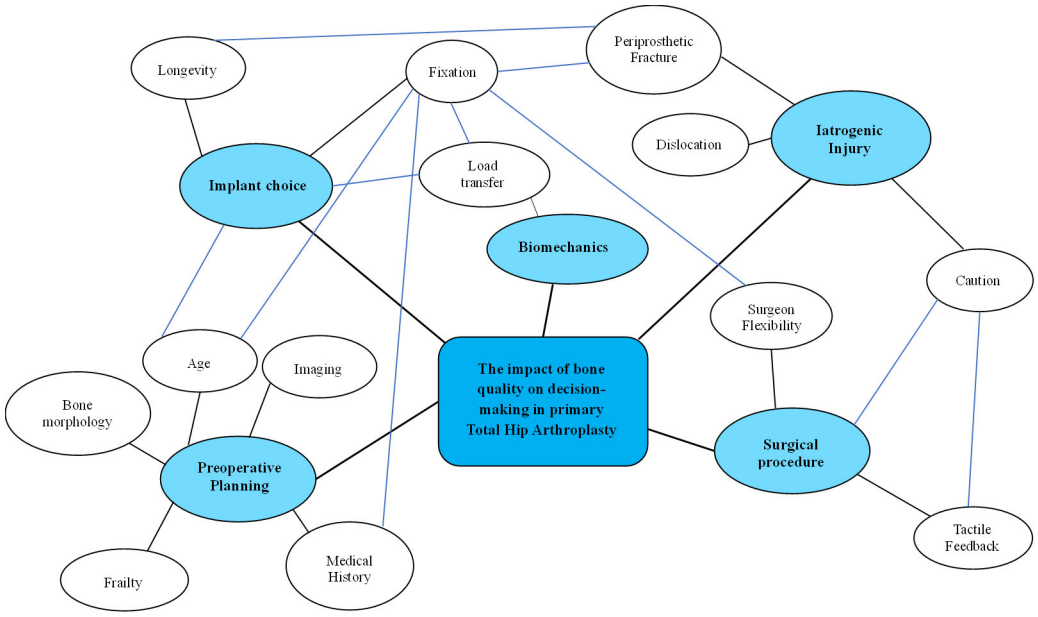

Figure 1 Thematic map showing five main themes and subthemes (blue lines show associations between separate themes and subthemes).

patient frailty was directly related to the presence of osteoporosis. Intraoperative decisions, such as cement pressurisation and use of dual mobility cups, were also considered based on patient frailty.

> I do vary how much I pressurise…based on the frailty of the patient, of which osteoporosis would be an indicator. (Surgeon 6)

Theme 2: surgical procedure

The impact of bone quality on surgical procedure was a key theme discussed by all surgeons. Most surgeons (8/10) described using tactile feedback to assess bone quality intraoperatively. Many surgeons (7/10) stated that operative technique was similar in patients with poor bone quality, though additional caution was exercised when broaching the femur and reaming the acetabulum. One surgeon also spoke of hammering prostheses in more gently, to prevent periprosthetic fractures. The flexibility of surgeons intraoperatively to change from one implant or fixation method to another based on an assessment of bone quality was identified as another subtheme, discussed by 7/10 participants.

Most surgeons (8/10) spoke of how tactile feedback intraoperatively informed their assessment of bone quality. 5/10 surgeons spoke of how intraoperative decision-making, in terms of fixation and implant choice, was guided by tactile feedback, particularly when broaching, reaming and assessing the responsiveness of a patient's bone to digital pressure, in addition to its physical appearance.

> On the acetabular side, it's the feel of the reamer, in the bone. (Surgeon 10)
>
> It's really a feel thing. (Surgeon 2)

One surgeon noted that current metrics of assessing bone quality intraoperatively were limited and predominantly subjective.

> It's [X-ray] not very objective. (Surgeon 9)

7/10 surgeons spoke of how an intraoperative assessment of bone quality often lead to a change in their choice of implant or fixation method. This centred around an initial decision to use cementless fixation of the cup and stem, changing to cemented fixation intraoperatively. Some surgeons (3/10) focused on flexibility around cup fixation, considering the need for acetabular screws based on an intraoperative assessment of cup stability.

> I will keep…cemented implants on standby, because if there is any doubt, just convert into cemented. (Surgeon 3)
>
> If I'm a little bit worried I will put a couple of screws up. (Surgeon 6)

There was divergence among surgeons on acetabular fixation intraoperatively. Many described changing from an uncemented to a cemented cup if bone quality was judged to be poor intraoperatively (5/10). 2/10 surgeons used cementless cups in all patients, while some (3/10) said they would continue to use a cementless cup, but would under-ream to achieve an improved press fit.

> I also tend to make decisions on fixation…based on my assessment at the time. (Surgeon 5)
>
> If the bone is weak, and I'm worried about bone stock, um I might under-ream by one. (Surgeon 8)

The decision among some to change from cementless to cemented cups was closely linked to increased caution to prevent iatrogenic injury intraoperatively.

Uncemented is my default. However, if bone quality is poor, and…I'm worried that I will end up penetrating into the pelvis… I will change to a cemented cup. (Surgeon 1)

Theme 3: implant choice

The theme of implant choice was heavily discussed by all surgeons and strongly influenced by a patient's bone quality. Two subthemes were identified: implant fixation and longevity. The impact of bone quality on the choice of fixation was identified by all surgeons (10/10) as a key aspect of preoperative and intraoperative decision-making, with consensus among surgeons that bone quality determined whether to use cemented or cementless fixation of the femoral stem. There was consensus among surgeons that cemented fixation of the femoral component is superior in patients with poor bone quality.

The main thing that bone quality matters for me is fixation. (Surgeon 4)

The choice of fixation strategy was influenced by the age of patients and the flexibility of surgeons preoperatively and intraoperatively. Most surgeons (9/10) discussed how age and patient history were used as rough guides of anticipated bone quality, and by extension, the need for cemented fixation of the stem.

I do tend to as a rule of thumb, amend my decision-making about the choice of implants on the basis of age and gender. (Surgeon 5)

Three surgeons (3/10) also spoke of the role GIRFT guidelines in informing stem fixation based on age.

If you're over 70 you get a cemented stem, if you're under 70 you don't. (Surgeon 4)

6/10 surgeons spoke of how their preference for a cemented femoral component was linked to a reduced risk of periprosthetic fracture with cemented fixation. 2/10 surgeons also spoke of the advantages of cemented femoral fixation in improved load transfer.

The longevity of implants and fixation methods chosen in patients with poor bone quality was identified by some surgeons (2/10) as a factor in their decision-making, particularly when planning preoperatively.

Preoperatively you spend sufficient time making decisions…based on their bone quality now… but also the short, medium, long term. (Surgeon 10)

Theme 4: iatrogenic injury

Preventing surgeon-induced iatrogenic injury was a key theme identified in all interviews. Poor bone quality led surgeons to be more cautious and take steps to mitigate the risk of periprosthetic fracture intraoperatively and reduce the risk of postoperative fracture. Some surgeons (3/10) also spoke of how patients with poor bone quality tended to be older, frailer and at greater risk of dislocation, which was identified as a subtheme.

Most surgeons (7/10) noted that in patients with poor bone quality, additional caution was required intraoperatively to mitigate the risk of surgeon-induced injury, particularly periprosthetic fracture. Increased caution was closely linked to changes in operative technique and lead many surgeons (5/10) to adopt additional caution when rasping and broaching the femur. 7/10 surgeons spoke of adopting additional caution when reaming the acetabulum, with some (3/10) stating they ream less bone. One noted that when impacting implants into osteoporotic bone less force was required.

If the bone quality is poor, I would go slower, and be more cautious with inserting larger rasps. (Surgeon 1)

If you've got poor quality bone, um, you need to be careful…certainly with the first reamer. (Surgeon 8)

Intraoperative caution in patients with poor bone quality was closely related to the use of tactile feedback intraoperatively, which also emerged as a subtheme, key to many surgeons' (5/10) intraoperative assessment of bone quality.

One's being incredibly cautious, feeling the bone with the reamer, um and the same with the rasps on the femur. (Surgeon 10)

Periprosthetic fracture, particularly when preparing the femoral canal during broaching, removing bone from the acetabulum during reaming and inserting femoral and acetabular prostheses, was identified as the key iatrogenic injury in patients with poor bone quality surgeons sought to avoid, discussed by 9/10 surgeons.

You're a bit more alert for intraoperative fractures. (Surgeon 1)

The increased risk of periprosthetic fracture in patients with poor bone quality led most surgeons away from using an uncemented stem, which confers a greater risk of periprosthetic fracture.

I think there's just going to be a higher fracture risk with an uncemented stem. (Surgeon 9)

Some surgeons (2/10) noted how patients with poor bone quality tended to be older, therefore steps were taken to reduce the risk of dislocation at the expense of polyethylene wear, particularly the use of lipped liners, which improve hip stability and reduce dislocation risk.

I'm not worried about 30 years survival of the Poly, and I am worried about whether or not they're going to dislocate. (Surgeon 7)

Theme 5: biomechanics

The impact of poor bone quality on the biomechanics of the hip joint, and its subsequent impact on implant choice and fixation method, was a theme discussed by some surgeons (2/10). Concerns over the transfer of loads through the joint following surgery was identified as a subtheme.

Some surgeons (2/10) spoke of how poor bone quality impacted concerns over safe load transfer through the hip following surgery and how this influenced the implants and fixation method chosen.

> If bone quality is poor, you have to think about…how to transfer the load, across the bone-implant interface, safely. (Surgeon 10)

DISCUSSION

This qualitative study explored the impact of bone quality on the decision-making of surgeons performing elective primary THA. This analysis highlighted that preoperative planning, surgical procedure, implant choice, considerations of joint biomechanics and steps to mitigate iatrogenic injury were all areas of decision-making impacted by a patient's bone quality. These findings supplement the limited pool of current qualitative research exploring the decision-making of experienced arthroplasty surgeons.

All surgeons highlighted the significant impact a patient's bone quality had on their preoperative planning. Most surgeons (7/10) outlined the importance of a patient's medical history on their assessment of bone quality, with some (3/10) noting a history of poor bone quality, particularly osteoporosis, to suggest increased patient frailty, leading some to modify their operative technique. The importance of modifying surgical technique in frail patients is highlighted in the literature, with more invasive surgery shown to confer poorer postoperative outcomes.[48] While all identified the importance of radiographs to guide their assessment of bone quality, there was divergence on the utility of X-rays as a measure of bone quality. One surgeon described X-rays as a 'coarse' measure of bone quality and 'not reliable', while another described X-rays as 'pretty good' for assessing bone quality preoperatively. At present, metrics of assessing bone quality radiographically rely on indices that assess the morphological appearance of bone. Evidence that the Singh Index can accurately predict osteoporosis is mixed, though there is more evidence of the predictive accuracy of the Dorr Index.[49–51] The divergence among surgeons interviewed and division in the literature highlights the need for improved bone quality metrics.

Valuable insights were gained on the impact of bone quality on intraoperative decision-making and the importance of tactile feedback among most (8/10) surgeons to assess bone quality intraoperatively. 5/10 surgeons spoke of how intraoperative decision-making, particularly in terms of fixation and implant choice, was guided by tactile feedback, particularly when broaching and reaming. Intraoperative assessments of bone quality have been shown to impact the fixation method chosen intraoperatively in the setting of orthopaedic trauma,[52] though there is comparatively little previous evidence highlighting the importance of tactile feedback in guiding intraoperative decision-making in THA. The flexibility of surgeons to modify their choice of implant or fixation method based on an intraoperative assessment of bone quality was discussed by most surgeons (7/10) and was based on an intraoperative assessment of component fixation and stability. The importance of making changes to a surgical procedure, based on a surgeon's assessment intraoperatively, has been shown to be important in optimising patient outcomes.[53]

All surgeons described how bone quality informed their implant choice. There was consensus among surgeons that cemented fixation of the femoral component is superior in patients with poor bone quality, while concerns over the longevity of implants and fixation methods chosen in patients with poor bone quality were identified by some surgeons (2/10) as a factor in their decision-making, particularly when planning preoperatively. Osteoporotic bone has been shown to osseointegrate less well and is more prone to intraoperative and postoperative periprosthetic fracture.[8 54 55] Given the increased risks associated with cementless femoral fixation in osteoporotic patients, there is consensus in the literature that cemented femoral fixation is superior in patients with osteoporotic bone. Given the reduced risks of periprosthetic fracture and aseptic loosening,[54 56] these conclusions mirrored the attitudes of all surgeons interviewed.

While there was consensus on stem fixation, attitudes towards acetabular implant choice and fixation method differed. Most surgeons (9/10) stated a preference for cementless acetabular implants, with some (2/10) citing advantages in their modularity compared with cemented cups. However, many surgeons (5/10) acknowledged the need to be flexible on the acetabular side in osteoporotic patients and described changing from cementless to cemented acetabular implants if bone quality was judged osteoporotic intraoperatively, though 2/10 surgeons described using cementless cups in all patients. Surgeons did note that uncemented cups confer an increased risk of periprosthetic fracture. This additional danger with cementless cups is mirrored in the literature, with an increased risk of fracture in cementless cups.[57] There was also notable division among surgeons on the utility of screws to improve acetabular fixation. Some surgeons (3/10) felt that screws improved implant stability in cases of poor fixation, though one surgeon disagreed, arguing they could worsen fixation and contribute to osteolysis. The divisions among surgeons on acetabular component and fixation choice and the role of screws to augment cup fixation are reflected in the literature. Some researchers suggest they improve stability,[57 58] though others have disputed this[59] with some suggesting screws increase acetabular bone loss.[60] There is scope for future research to address this controversy.

Concerns over an increased risk of surgeon-induced iatrogenic injury in patients with poor bone quality was a theme identified by all surgeons. Most (7/10) spoke of adopting increased caution, particularly due to the increased risk of periprosthetic fracture in this patient cohort. The presence of osteoporosis is a significant predictor of increased fracture risk, while the

morphological appearance of osteoporotic bone on X-ray has been shown to correlate with an increased risk of periprosthetic fracture.[61] Many surgeons (5/10) noted they are particularly cautious during broaching, reaming and insertion of the femoral component. All were averse to using cementless femoral stems, which rely on a press fit in patients with osteoporotic bone. This is supported in the literature, with evidence press-fit insertion of cementless femoral stems causes more periprosthetic fractures compared with cemented femoral components.[62] Cemented implants have also been shown to confer a higher survival rate and lower rate of failure compared with cementless implants in elderly patients.[63]

This qualitative analysis of surgical decision-making has several strengths. There is limited qualitative research exploring the decision-making of experienced arthroplasty surgeons. This analysis, therefore, is a novel addition to the literature, which has revealed consensus among interviewed surgeons on the superiority of cemented fixation in patients with osteoporotic bone and on the use of radiographs to assess bone quality, in addition to the importance of tactile feedback to guide intraoperative decision-making in elective primary THA. This analysis has also highlighted divergence among surgeons on the utility of X-rays as metrics of bone quality, which are mirrored in the broader literature, while differing opinions on the viability of GIRFT guidelines were revealed and merit further research. It has also highlighted the limitations in current preoperative metrics of bone quality and has shown how surgeons are at present guided heavily by tactile feedback to assess bone quality intraoperatively, often changing the procedure based on their intraoperative findings.

There are, however, several limitations to this analysis. Owing to its hybrid inductive/deductive design, the questions formulated and thematic analysis conducted were partially influenced by a prior understanding of the four key decision-making points in elective primary THA: preoperative decision-making, intraoperative decision-making and decisions on the femoral and acetabular components. Despite influencing the question guide formulated before interviews, a prior understanding of the key decision-making points for surgeons led to more detailed, richer data being collected, with a hybrid design in keeping with similar previous research exploring complex surgical decision-making.[40] Owing to its qualitative nature, the data obtained from participants was highly dependent on the rapport established between participants and interviewer, which may limit its validity. The inclusion criteria were also broad—with one surgeon performing below the average number of annual THAs for 2021–2022. This was due to challenges in recruitment. That said, all surgeons included were either high volume, performing above national average of 59, or highly experienced consultants, with over 10 years at consultant level. This lead to a range of surgeons being interviewed, potentially providing a spectrum of perspectives and insights more applicable to the average hip surgeon. All surgeons were men, it would have been valuable to have interviewed female surgeons.

While thematic saturation was reached, this study had a relatively small sample size, interviewing 10 surgeons, with most (n=8) from the South East of England. The cohort of surgeons sampled was relatively homogenous, in age and gender. It is therefore unlikely this study accurately charts the true breadth and diversity of opinion among experienced arthroplasty surgeons. However, this study did provide rich data from a cohort of 10 experienced surgeons, with most from differing centres. The homogeneous surgeon cohort and broad inclusion criteria were influenced by challenges in recruitment. This analysis also focused primarily on the impact of osteoporosis, the most common cause of poor bone quality, on surgical decision-making. Other causes for poor bone quality have not been formally discussed, which limits the generalisability of this study's findings.

The need to assess bone quality intraoperatively and reliance on tactile feedback, which was described by one surgeon as a 'not very objective' measure of bone quality, demonstrate the significant limitations in current metrics of assessing bone quality preoperatively and intraoperatively. Tactile feedback has been shown to be a subjective, inaccurate metric to assess bone quality.[34–38] Many surgeons spoke of the importance of minimising intraoperative decision-making to optimise patient outcomes, though current methods of assessing bone quality meant that surgeons often described changing their procedure intraoperatively on discovering osteoporosis, a condition that increases the risk of periprosthetic fracture and other surgical complications.[16–21] This highlights the scope for improvement in current preoperative bone quality metrics. There is a need to better identify patients with poor quality bone preoperatively, to prevent surgeons adopting cementless fixation methods in such patients. Doing so would reduce the rate of periprosthetic fracture and translate into fewer complications and improved patient outcomes.

Interviews also revealed differing attitudes on the relationship between patient age and degree of osteoporosis, with differing opinions of its impact on surgical decision-making. As part of this, GIRFT guidelines, which stipulate femoral fixation choice based on a patient's age, were discussed in several interviews (3/10). Some surgeons reflected on how their decision-making was limited by these guidelines, with one expressing a view that the evidence underpinning current guidelines was limited. Some expressed the wish to use cementless fixation in patients over the age of 70 based on their assessment of good bone quality, though due to GIRFT guidelines, cemented femoral fixation was used. There is limited previous evidence exploring the attitudes and adherence of arthroplasty surgeons towards GIRFT guidelines, with previous research indicating good adherence to GIRFT policies of limited scope,[30] though previous analysis of registry evidence research has shown a shift away from cemented fixation.[64] There is scope for further research

to assess the attitudes and adherence of a larger cohort of surgeons to GIRFT guidelines.

CONCLUSION

Bone quality impacts surgeon's decision-making in THA, both preoperatively and intraoperatively across several domains. This includes the use of cement and adherence to GIRFT guidelines. There is, however, a lack of consensus on how to optimally assess bone quality preoperatively, leading many surgeons to rely on intraoperative assessment, such as tactile feedback, to guide their decision-making. Further work to identify intraoperative and preoperative imaging metrics that correlate with bone mechanical properties could enhance surgical decision-making.

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