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Original Article

Visualising a Possible Postoperative Body: Patient Experiences of 3D and AI-Generated Simulations in Reconstructive Plastic Surgery

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ABSTRACT

Background: Three-dimensional (3D) and artificial intelligence (AI)-generated visualisations are increasingly used to communicate possible reconstructive surgical outcomes. Although visual representations may improve anatomical understanding, photorealistic imagery can imply greater predictive certainty than reconstructive surgery permits. Qualitative evidence is limited regarding how patients interpret these representations in relation to expectations, identity, trust, and decision-making. Objective: To explore how adults with reconstructive surgery experience interpret anatomy-based 3D and synthetic AI-generated visualisations and to identify conditions influencing their perceived usefulness and ethical acceptability. Methods: An interpretive qualitative study using semi-structured interviews and visual elicitation was conducted in Medan, Indonesia, from January to May 2026. Twelve adults aged 24–62 years with experience of considering, planning, revising, or undergoing reconstructive surgery were purposively sampled for maximum variation. Participants viewed an anatomy-based 3D representation and a synthetic, illustrative, non-predictive AI-generated image. Interviews were analysed using reflexive thematic analysis. Results: Six themes were generated: movement from abstraction to an imaginable body; hope that could become a visual promise; recognition, estrangement, and embodied fit; trust borrowed from the surgeon; unequal redistribution of agency; and ethical acceptability through boundaries. Participants generally regarded 3D visualisation as a provisional anatomical aid, whereas photorealistic AI imagery was more readily interpreted as a possible outcome and was more susceptible to expectation anchoring. Trust increased when uncertainty, provenance, clinician responsibility, privacy, and patient control were explicit. Conclusion: Patient-facing visualisation should prioritise bounded, transparent communication rather than photorealism. Clinician accountability, explicit uncertainty, representational fit, privacy safeguards, and patient control over viewing and reuse are central to ethically acceptable implementation. Keywords: reconstructive plastic surgery; three-dimensional simulation; artificial intelligence; body image; shared decision-making; qualitative research

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INTRODUCTION

Reconstructive plastic surgery requires patients to make decisions about a postoperative body that does not yet exist and whose eventual form, function, sensation, and psychosocial meaning cannot be known with certainty before surgery. Explanations involving tissue transfer, implants, osteotomies, donor sites, scars, staged procedures, and revision can therefore remain spatially abstract despite detailed verbal counselling. Three-dimensional (3D) visualisation has increasingly been used to make anatomical relationships and proposed reconstructive changes more understandable; a randomized trial in breast reconstruction reported improved patient-reported spatial understanding after exposure to 3D simulation, while broader evidence from virtual surgical planning demonstrates growing clinical use but considerable heterogeneity in technologies, purposes, and reported outcomes (1,2).

Artificial intelligence (AI)-generated imagery introduces a different form of visual communication. Whereas conventional anatomy-based 3D models generally expose recognisable anatomical structures and modelling assumptions, generative systems can produce highly plausible images whose visual realism may exceed the certainty of the clinical information underlying them. Task-specific systems such as BreastGAN demonstrate the technical feasibility of generating postoperative visual representations, while studies of generative AI in plastic and reconstructive surgery have shown that image quality and clinical plausibility vary according to the model, task, prompt, training data, and validation context (3–5). Consequently, photorealism should not be interpreted as equivalent to patient-specific prediction. Ethical analyses of AI in plastic surgery similarly emphasise transparency, human oversight, accountability, privacy, informed consent, and appropriate limits on automated representation (6).

The clinical meaning of reconstructive visualisation also extends beyond surface appearance. Reconstructive outcomes are experienced through body image, identity, sensation, movement, scars, social recognition, functional ability, and adaptation to illness or injury. Qualitative research in breast reconstruction has shown that bodily alteration and complications may involve continuing negotiation of identity, femininity, normality, loss, and embodied self-recognition rather than a discrete adjustment to postoperative appearance alone (7,8). A visual representation that appears anatomically or aesthetically desirable may therefore remain unacceptable to a patient if it does not correspond with anticipated function, sensation, personal identity, cultural representation, or the meaning attached to the reconstructed body.

Decision-support literature further indicates that visual or informational tools acquire meaning through the clinical relationships and organisational settings in which they are used. Decision aids can improve knowledge and reduce decisional conflict in breast reconstruction, but qualitative implementation research demonstrates that the usefulness of such tools depends on timing, clinician involvement, workflow, available treatment options, and how information is framed during decision-making (9,10). Similar concerns arise in healthcare AI. Patients may be more willing to accept AI when it complements rather than replaces professional judgement, while trust depends on perceived responsibility, self-determination, transparency, and the type of explanation provided (11–13). Ethical reviews of generative AI in healthcare additionally identify privacy, consent, misinformation, accountability, and human control as recurrent concerns, which become particularly salient when visual data may reveal recognisable bodily characteristics even in the absence of conventional personal identifiers (14).

Despite increasing technical interest in 3D planning and AI-generated visualisation, existing research has focused predominantly on technical performance, planning utility, decision support, or broad attitudes toward AI rather than on how reconstructive patients themselves interpret a visually represented future body (1–6,9–14). In particular, limited qualitative evidence explains how patients distinguish an anatomical aid from an apparent prediction, how realism shapes hope and expectation, how representations interact with identity and embodied experience, or how clinician involvement changes the authority attributed to an image. The present study therefore used an interpretive qualitative design with visual elicitation to explore how adults with reconstructive surgery experience interpreted anatomy-based 3D and synthetic AI-generated postoperative visualisations. The objectives were to examine how these representations influenced understanding and expectations; explore their perceived effects on identity, trust, agency, and decision-making; and identify the relational, embodied, ethical, and organisational conditions under which patient-facing visualisation was considered acceptable and clinically useful.

MATERIALS AND METHODS

An interpretive qualitative design using semi-structured individual interviews and visual elicitation was employed to examine how patients understood and assigned meaning to 3D and AI-generated representations of possible reconstructive outcomes. Reflexive thematic analysis was selected because the study sought to identify patterned meanings, tensions, contradictions, and contextual influences within participants' accounts rather than estimate prevalence or causal effects (15,16). Data were collected between January and May 2026 in a university-based clinical and educational setting in Medan, Indonesia.

Participants were adults with experience of considering, planning, or undergoing reconstructive plastic surgery. Purposive maximum-variation sampling was used to obtain analytically diverse perspectives across reconstructive context, operative stage, sex, age, and digital confidence rather than to achieve statistical representation. Twelve adults aged 24–62 years participated, including seven women and five men. Reconstructive contexts comprised breast reconstruction (n=4), facial or craniofacial reconstruction (n=3), burn-scar reconstruction (n=2), hand or lower-limb reconstruction (n=2), and abdominal-wall reconstruction (n=1). Five participants were awaiting or planning reconstruction, four were considering revision after a previous procedure, and three had completed reconstruction. Participants' reported confidence with digital technologies ranged from low to high. The heterogeneity of the sample was used to support comparison of contrasting experiences across different reconstructive circumstances.

Individual semi-structured interviews lasted approximately 45–70 minutes. Before any visual material was presented, participants were invited to describe their reconstructive history, expectations, concerns, and understanding of the proposed or previously experienced procedure. Each participant was subsequently shown two non-identifiable visual prompts in randomized order: a rotatable 3D example explicitly labelled as anatomy-based and uncertain, and a photorealistic AI-generated example explicitly labelled as synthetic, illustrative, and non-predictive. The visual prompts did not use photographs or scans obtained from the participating individuals. Interview questioning explored first impressions of each representation, perceived credibility, emotional responses, identity and bodily fit, usefulness for comparing options, preferred forms of clinician explanation, privacy and secondary use of visual information, equity of representation, and the participant's right to decline viewing. Interviews were audio-recorded with permission.

The interviews were analysed in Indonesian so that interpretation remained grounded in the language in which participants expressed their experiences. Selected quotations used for publication were translated into English and checked against the corresponding transcript material. Participant identifiers P01–P12 were used when presenting quotations. Analysis followed the recursive phases of reflexive thematic analysis: familiarisation with the interview material, coding, development of candidate themes, review of candidate themes against the complete dataset, refinement and definition of themes, and analytic writing (15,16). Cross-case matrices were used to examine similarities and contrasts in relation to reconstructive context, previous complications, digital confidence, family involvement, and functional priorities. Accounts that challenged dominant interpretations—including preferences for verbal explanation and rejection of photorealistic representation—were retained during analysis rather than treated as exceptions to be removed. The final analysis generated six themes describing how participants interpreted and negotiated the visual representations.

Ethical approval for recruitment was obtained from Universitas Prima Indonesia. Participation and engagement with the visual prompts were voluntary, and participants could pause the interview, decline to view a prompt, or discontinue participation. Consent covered audio recording and the use of anonymised quotations. No participant photographs or other participant-specific images were uploaded to publicly accessible generative AI systems. During interviews, the distinction between immediate clinical use of visual information and potential secondary uses of visual data was explicitly discussed.

RESULTS

Twelve participants contributed accounts spanning different reconstructive contexts and stages of care. Analysis generated six interconnected themes: (1) moving from abstraction to an imaginable body; (2) hope that could become a visual promise; (3) recognition, estrangement, and embodied fit; (4) trust borrowed from the surgeon; (5) redistribution of agency through visualisation; and (6) ethical acceptability through boundaries. Across the themes, participants distinguished the accessibility of a visual representation from its clinical authority. The 3D representation was generally interpreted as a provisional aid for understanding anatomy, whereas the photorealistic AI-generated representation was easier to read as a possible future appearance but also more liable to be interpreted as carrying certainty that participants believed could not be justified.

From abstraction to an imaginable body

Participants described reconstructive terminology as difficult to convert into a mental representation until visual information linked surgical language to anatomical relationships. For some, the rotatable 3D representation transformed an otherwise abstract explanation into something that could be interrogated. P01 explained, “Reconstruction had just been a word and a list of dangers. When I was able to rotate the model, I knew where the new form would be formed and where it would fit.” P06 similarly described seeing the relevant anatomical deficit as making surgery feel “less magic-like and more plan-like.”

The usefulness of the model extended beyond appearance. Participants used visualisation to ask what reconstruction might mean for movement, staged procedures, and practical recovery. P09 focused on a restricted anatomical space and asked how the reconstructed area might behave when raising the arm, while P11 distinguished between operative stages concerned with coverage and those directed toward restoration of walking. At the same time, participants recognised important limits to what an apparently complete visual model could communicate. P10 commented, “It demonstrated where the fingers were but not how I would feel them and how long I would require help back at home.” The accounts therefore distinguished visualising anatomical form from understanding the broader functional, sensory, and everyday consequences of reconstruction.

Hope that could become a visual promise

Both forms of visualisation could make a future after injury, cancer, or bodily loss easier to imagine, but the photorealistic AI-generated image carried a particular emotional force. Participants described the possibility that an illustrative image could support hope while simultaneously becoming an unintended target or promise. P02 described the AI image as providing a sense of direction after repeated discussion of complications and donor sites, but resisted treating it as a predicted endpoint: “I had not decided to make it a target because bodies do not heal a la photographs.”

The distinction became more difficult when images circulated beyond the consultation. P12 described family members treating the AI representation as a definitive outcome and saying, “This is how you will appear.” Previous experience of complications appeared to encourage more guarded interpretations. P03 observed, “The picture has no infection, no waiting and no disappointment; after one of the implants failed, I think it is a perfect picture.” These accounts suggested that participants valued hopeful visualisation when uncertainty remained explicit and when the image did not conceal possible variation in healing, complications, or postoperative experience.

Recognition, estrangement, and embodied fit

Participants did not assess personalisation solely according to physical similarity. Instead, they judged whether a representation corresponded with anatomy, identity, family resemblance, scars, skin colour, age, posture, function, and anticipated sensation. P05 contrasted the two visual formats by stating, “The 3D model was touching my bones; the AI face was touching a person with my face.” For this participant, the less photorealistic representation felt more personally relevant because its relationship to underlying anatomy was easier to understand.

Photorealistic personalisation could also produce estrangement. P07 described an AI-generated face as smoother and slimmer and felt that it had removed features associated with her mother and sisters: “It was a pretty effect, though it was not entirely to my credit.” Participants with burn-related reconstruction questioned whether generated imagery adequately represented darker skin and post-healing pigment change. Others emphasised aspects that visual appearance could not represent. P03 stated, “It can demonstrate form, but not whether I will cease to guard that side.” P04 described an acceptable outcome as, “I was still me, only after I made a difficult decision.” Personal fit was therefore expressed as an embodied and value-based judgement rather than simple visual resemblance.

Trust borrowed from the surgeon

Participants rarely described confidence in a visualisation as independent of the clinician presenting it. The perceived authority of an image was shaped by whether a surgeon could explain what was known, what was generated, what remained uncertain, and how the image related to the proposed procedure. P06 expressed greater confidence when the surgeon could explain what the technology could and could not determine. P01 contrasted guided explanation with receiving an image without professional interpretation: "If put on my phone, I would see it and come up with the meaning to it." Explicit acknowledgement of uncertainty was generally interpreted as professional honesty rather than as a weakness of the visual tool.

Clinician endorsement could, however, amplify rather than simply regulate technological authority. Participants were concerned that the authority attributed to the clinician and the apparent sophistication of the image could make disagreement more difficult. They preferred conditional descriptions and alternative possibilities to statements implying a fixed postoperative appearance. Participants also wanted practical provenance information: whether their own measurements had informed the representation, which components were modelled or generated, what degree of variation might be expected, and who had reviewed the output. P05 summarised the importance of human accountability: "The computer cannot apologise to me."

Visualisation redistributed agency, but not equally

Visualisation could make participation in consultation easier by allowing patients to point, compare, and formulate questions without mastering specialist terminology. P04 explained, "I would be able to weigh the choices around without feeling that I was conjecturing." For some participants, the representation exposed issues that they had not known to ask about previously. However, this increase in agency was conditional on digital confidence, consultation pace, access to alternative formats, and the clinician's willingness to treat the image as open to questioning.

Interface and presentation choices also shaped the apparent neutrality of the options shown. Participants interpreted a more centrally displayed or more photorealistic option as implicitly preferred. P07 stated, "The real one triumphs before anybody gets to account for the threats." Family sharing could support discussion but could also transform an illustrative image into an expectation. Preferences therefore extended beyond the content of the representation to control over pace, format, circulation, and exposure. P08 articulated the right to decline visualisation: "Not looking is itself a choice. I need not demonstrate that I know this, by looking at myself changed."

Thematic summary

Theme	Central analytic pattern	Illustrative participant evidence
From abstraction to an imaginable body	3D visualisation made anatomy interrogable but could not communicate the full functional or sensory experience	P01, P06, P09, P10, P11
Hope that could become a visual promise	Visualisation supported hope, while photorealism risked being interpreted as a predicted endpoint	P02, P03, P12
Recognition, estrangement, and embodied fit	Personalisation depended on identity, anatomy, family resemblance, skin, scars, function, and sensation rather than visual similarity alone	P03, P04, P05, P07
Trust borrowed from the surgeon	Image credibility was mediated by clinician explanation, uncertainty disclosure, and accountability	P01, P05, P06, P10
Visualisation redistributed agency, but not equally	Images facilitated questioning but agency depended on presentation, digital confidence, consultation conditions, and the right not to view	P02, P04, P07, P08, P10, P11
Ethical acceptability depended on boundaries	Participants required consent, privacy, representation, human accountability, optionality, and limits on secondary data use	P01, P05, P07, P12

Ethical acceptability depended on boundaries

Participants regarded bodily visual data as qualitatively different from ordinary clinical information because faces, scars, breasts, body contours, and other features could remain personally meaningful or recognisable even after conventional identifiers were removed. P05 asked, "A face is not like a blood test number. I would like to know what happens to it once it goes out of the hospital, and can it be put back in picture form?" Participants wanted explicit information about storage, retention, access, reuse, and third-party involvement. They also distinguished consent to treatment from consent for secondary technological use. P01 stated, "When I agree to surgery, it does not mean that my body agrees to become a software teacher."

Fairness was similarly understood as more than equal technical performance. Participants questioned whether visual systems adequately represented darker skin, complex scarring, older bodies, and culturally or familially meaningful facial features. P07 warned, “The computer must not unquestioningly make the choice of face normal.” Participants also resisted the use of visualisation as an authority capable of overriding subjective experience. P12 stated, “It may assist us to communicate, yet not to be the proof that my worry is incorrect.” Across these accounts, ethical acceptability depended on meaningful consent, representational fit, equitable access, human accountability, optional viewing, control over reuse and sharing, and recognition that a visual representation could not substitute for the patient's experiential knowledge of their body.

DISCUSSION

This study explored how adults with experience of reconstructive plastic surgery interpreted anatomy-based 3D and synthetic AI-generated visualisations of possible postoperative outcomes. The findings indicate that the clinical value of visualisation was not determined simply by realism or technical sophistication. Participants valued visual representations when they converted abstract surgical explanations into something that could be questioned and discussed, but they also distinguished anatomical understanding from understanding how a reconstructed body might move, feel, function, or fit within everyday life. This interpretation is consistent with evidence that 3D and virtual visualisation can improve spatial understanding and support surgical communication while not necessarily capturing the wider experiential outcomes that matter to patients (1,2). The present findings therefore suggest that patient-facing visualisation should be evaluated not only according to geometric or visual accuracy but also according to whether it facilitates meaningful discussion of uncertainty, function, sensation, recovery, and patient priorities.

The contrast between the two visual formats was particularly important. Participants generally interpreted the anatomy-based 3D representation as a provisional map, whereas the photorealistic AI-generated image was easier to interpret as a possible future appearance and therefore more susceptible to expectation anchoring. Generative visual systems can produce convincing outputs, but their apparent realism does not establish patient-specific anatomical validity or predictive accuracy, and their performance depends on the model, task, prompt, training data, and validation context (3–5). Ethical guidance for AI in plastic surgery similarly emphasises transparency, human oversight, accountability, and explicit communication of technological limitations (6). The present findings extend these concerns by showing how epistemic uncertainty may become a patient-experience problem: when uncertainty is not visually or verbally apparent, an illustrative image may acquire the status of an expected outcome. Calibrated visualisation should therefore make clear what is anatomically measured or modelled, what has been synthetically generated, and what remains inherently uncertain.

Participants also evaluated visualisations through identity and embodied experience rather than through appearance alone. Their accounts referred to family resemblance, scars, skin colour, age, posture, sensation, function, and continuity of self. Previous qualitative studies of breast reconstruction similarly demonstrate that reconstruction involves ongoing negotiation of body image, identity, normality, loss, and adaptation rather than a single judgment of cosmetic appearance (7,8). The current study broadens that interpretation across several reconstructive contexts and suggests that technically personalised imagery can nevertheless feel personally inaccurate when it suppresses characteristics that patients understand as meaningful components of themselves. Representational fairness should therefore extend beyond conventional measures of image performance to include whether patients recognise themselves within the assumptions embedded in the representation.

Trust in the visualisation was closely linked to trust in the clinician presenting it. Participants were more comfortable with images when clinicians explained what the technology could and could not establish, whereas apparently authoritative images presented without contextual explanation could encourage patients or relatives to assign greater certainty than was warranted. This finding corresponds with wider research showing that patients' acceptance of healthcare AI depends partly on continued human responsibility, professional judgement, self-determination, and clarity about the role of the technology (11,12). Explainability is likewise not uniformly beneficial; its effect on trust depends on the user, task, and form of explanation provided (13). In reconstructive consultations, explanation may therefore be most useful when it is dialogic rather than purely technical: the clinician should establish what the patient thinks the image represents, distinguish observation from generation and prediction, and explicitly invite disagreement or alternative interpretations.

Visualisation also appeared to redistribute agency rather than simply increase it. Participants described benefits such as being able to point to anatomical features, compare possibilities, and ask questions without mastering specialist terminology. Decision aids in breast reconstruction can improve knowledge and reduce decisional conflict, but implementation studies show that their effects depend on timing, professional behaviour, workflow, and the choices made available through the clinical system (9,10). Similar dynamics were evident in the present study. More realistic or prominently presented options could appear implicitly recommended, digital confidence affected how participants engaged with the information, and family circulation could transform an illustrative image into an assumed outcome. Reconstructive recommendations are themselves influenced by surgeon experience and available service options, further emphasising that visual presentation cannot be separated from the clinical environment in which choices are constructed (17). Patient agency therefore requires not only access to visual information but also equivalent presentation of alternatives, sufficient time for reflection, access to non-digital forms of explanation, and an explicit right not to view or retain an image.

The findings support a model of bounded visualisation in which the usefulness of patient-facing simulation depends on maintaining several interconnected boundaries. An epistemic boundary distinguishes measured or anatomically grounded information from generated and uncertain content. A relational boundary maintains clinician accountability and prevents technological authority from replacing dialogue. An embodied boundary recognises that identity, function, sensation, scars, and culturally meaningful characteristics cannot be reduced to surface appearance. A decisional boundary protects balanced comparison, freedom from visual coercion, and the patient's right not to view. Finally, an organisational boundary addresses consent, privacy, secondary data use, validation, traceability, equitable access, and the resources required to implement advanced visual technologies. These boundaries are consistent with wider concerns regarding human oversight, privacy, consent, and accountability in healthcare AI (6,14). They are also relevant to implementation because virtual surgical planning can affect operative workflows, time, resource use, and cost, meaning that technical sophistication alone cannot determine whether a system is appropriate for routine patient-facing care (18,19).

The study has several strengths. Visual elicitation enabled participants to respond to concrete representations rather than hypothetical descriptions of AI and 3D technologies, while maximum-variation sampling allowed contrasting accounts to be explored across different reconstructive contexts, operative stages, digital confidence levels, and prior experiences. The analysis also retained accounts that challenged dominant interpretations, including preferences for verbal explanation, scepticism toward photorealism, and the decision not to view a visual representation. These features supported an interpretive analysis concerned with patterned meaning and contradiction rather than numerical prevalence, consistent with the principles of reflexive thematic analysis (15,16).

Several limitations should nevertheless constrain interpretation. The purposive sample was small and drawn from a single university-based setting in Medan, Indonesia, and therefore supports analytic rather than statistical transferability. Participants represented heterogeneous reconstructive experiences, which enriched comparison but limited the depth with which any one reconstructive population could be examined. The study also combined prospective, revision-stage, and postoperative experiences, and participants responded to non-participant-specific visual prompts rather than personalised simulations generated from their own clinical imaging. Responses to hypothetical or illustrative visualisations may differ from reactions when an image is presented during an actual treatment decision involving the participant's own body. Translation of selected quotations from Indonesian into English may also have altered nuances of meaning. In addition, any prior or perceived relationship between participants, recruiters, interviewers, and the clinical institution could have influenced accounts of surgeon trust or technological authority and should be considered when assessing the findings once the research-team and recruitment details are fully reported.

Future research should examine patient-facing visualisation longitudinally and across multiple reconstructive settings, with transparent standardisation of the images presented and the accompanying clinician explanation. Comparative qualitative and mixed-methods work could investigate how different levels of realism, uncertainty labelling, personalisation, viewing format, and clinician mediation influence expectations, decisional confidence, identity fit, and subsequent appraisal of actual postoperative outcomes. Such research should evaluate function, sensation, privacy, decisional regret, and representational acceptability alongside visual accuracy rather than treating photorealism as the principal indicator of usefulness.

CONCLUSION

Three-dimensional and AI-generated visualisations can support reconstructive consultations when they help patients convert abstract surgical information into a form that can be questioned, compared, and discussed, but their value does not depend on depicting a patient as they will supposedly appear after surgery. Participants generally interpreted anatomy-based 3D representations as provisional maps, whereas photorealistic AI-generated imagery was easier to understand visually but more susceptible to being interpreted as a promised or predicted outcome. Acceptable patient-facing visualisation therefore requires bounded use: uncertainty should be explicit; measured, modelled, and generated information should be distinguishable; clinicians should retain responsibility for interpretation; identity, function, sensation, and appearance should be discussed together; and patients should retain control over whether images are viewed, stored, shared, or reused. Under these conditions, visualisation may function most appropriately as a shared and revisable object for communication rather than as evidence of a predetermined postoperative future.

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