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Google Glass In Orthopaedic And Spine Surgery

Applications Clinical Evidence Limitations And Future Directions

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Abstract

Google Glass introduced a lightweight, monocular, head-mounted platform capable of point-of-view recording, wireless communication, and near-eye information display. These functions attracted early interest in orthopaedic and spine surgery, where surgeons must alternate attention among the operative field, fluoroscopic monitors, imaging, physiologic data, and trainees. This narrative review evaluates PubMed-indexed evidence concerning Google Glass and functionally related smart-glass systems in orthopaedic and spinal procedures. Early Google Glass studies demonstrated feasible hands-free recording, resident coaching, remote consultation, and display of fluoroscopic images. A cadaveric hand-fracture study reported shorter fixation time and fewer fluoroscopic images for selected fractures, whereas a randomized orthopaedic simulation trial found no objective advantage of video-assisted coaching over verbal coaching alone despite favorable learner perceptions. In spine surgery, Google Glass was convenient and lightweight for recording but provided lower image quality than dedicated action cameras. Later smart-glass studies reported marked reductions in head turning, feasible remote mentoring, and potential reductions in fluoroscopy exposure and surgeon fatigue. However, much of this later evidence involves devices other than Google Glass, small cohorts, simulation, or nonrandomized designs. Important barriers include limited battery life, image quality, display size, compatibility with loupes and radiation-protective eyewear, distraction, cybersecurity, consent, and uncertain clinical governance. Google ended sales and support of Glass Enterprise Edition in 2023, making the original device a historical platform rather than a current procurement option. Nevertheless, its evidence base established the principal use cases now being pursued with newer head-mounted displays. High-quality comparative trials should prioritize patient safety, technical accuracy, radiation dose, ergonomics, workflow, and cost effectiveness.

Keywords: Google Glass; smart glasses; orthopaedic surgery; spine surgery; augmented reality; fluoroscopy; surgical education; telementoring

Introduction

Orthopaedic and spine operations are visually intensive. The surgeon may need to look repeatedly from the wound to fluoroscopic images, navigation screens, neuromonitoring data, implant information, and the operating team. Each gaze shift interrupts direct visualization of the surgical field and may increase head movement, cognitive switching, and ergonomic load. A head-mounted display can place selected information near the surgeon's line of sight while preserving the use of both hands.

Google Glass was among the first widely studied consumer-derived smart-glass platforms in surgery. It combined a monocular display, camera, microphone, speaker, wireless connectivity, voice input, and touch controls in a lightweight frame. The device supported several distinct functions: recording the surgeon's view, streaming video to a remote observer, displaying images or alerts, and enabling bidirectional communication. These functions are often grouped under "augmented reality," although simple video capture or a floating two-dimensional display does not constitute spatially registered surgical navigation.

This distinction matters. Google Glass literature should not be conflated with studies of Microsoft HoloLens, Moverio displays, purpose-built surgical headsets, or newer mixed-reality systems. This review therefore treats Google Glass as the primary subject and uses later smart-glass evidence to show how its original concepts evolved in orthopaedic and spine surgery.

Review Approach

A focused narrative search of PubMed and related full-text records was undertaken through 9 September 2026 using combinations of "Google Glass," "smart glasses," "head-mounted display," "orthopaedic surgery," "orthopedic surgery," "spine surgery," "fluoroscopy," "education," and "telementoring." Original orthopaedic and spine studies were prioritized. Systematic and narrative reviews were used to define the broader evidence base, and selected non-Google smart-glass studies were included when they evaluated the same clinical function. Because the literature is heterogeneous and the search was not designed as a registered systematic review, findings are synthesized qualitatively.

Clinical Applications

Point-of-view recording and documentation

The most immediate value of Google Glass was hands-free recording from the surgeon's perspective. Unlike a fixed operating-room camera, a head-worn camera follows the operator's gaze and may capture instrument handling and exposure as the surgeon sees them. In a posterior lumbar laminectomy and fusion, Lee and colleagues compared Google Glass with GoPro Hero 4 and Panasonic HX-A100 cameras. Google Glass was the lightest and most convenient for prolonged wear and uniquely supported integrated two-way communication, but it did not provide the high-definition image quality available from the other cameras.¹ This trade-off—wearability and connectivity versus optical quality—recurred across early surgical studies.

Point-of-view footage can support postoperative debriefing, quality review, teaching libraries, and self-assessment. However, the surgeon's gaze is not identical to the camera's field, and head motion may produce unstable footage. Recording also creates a clinical data asset that requires explicit consent, secure storage, access control, retention rules, and protection from unintended capture of faces, displays, conversations, or identifiers.

Education coaching and assessment

Orthopaedic education provides the strongest controlled Google Glass study. Dickerson and colleagues randomized 42 residents from four institutions performing a simulated intra-articular distal tibial fracture reduction. Both groups received structured coaching; the intervention group also reviewed Google Glass point-of-view video. Objective Structured Assessment of Technical Skills scores, global ratings, fluoroscopy use, and reduction quality did not improve more than with verbal coaching alone. Nevertheless, most participants perceived video coaching as useful for understanding goals, developing strategies, and self-reflection.² The result suggests that recording may enrich feedback without guaranteeing measurable short-term performance gains.

Neurosurgical proof-of-concept studies similarly found that Google Glass could capture footage suitable for resident review, including during international surgical missions, while noting battery, image-quality, and loupe-compatibility limitations.³ For orthopaedic training, the greatest value may lie in structured use: a defined competency rubric, short indexed clips, faculty annotation, and repeated longitudinal assessment rather than passive recording.

Fluoroscopy and near-eye image display

Fluoroscopy requires the surgeon to divide visual attention between the operative field and a remote monitor. Chimenti and Mitten compared conventional mini C-arm visualization with Google Glass during cadaveric percutaneous fixation of hand fractures. For proximal phalanx fractures, Google Glass reduced mean fixation time

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from 127 to 86 seconds and radiographs from 5.3 to 2.2. For metacarpal fractures, radiographs decreased from 6.4 to 3.6.⁴ These promising findings were procedure- and model-specific and did not establish clinical safety in patients. The concept has been extended with newer displays in spine surgery. In a prospective randomized pilot involving 20 patients undergoing L5–S1 posterior lumbar interbody fusion with percutaneous pedicle screws, Matsukawa and Yato transmitted fluoroscopic images to a wearable display attached to ordinary glasses. Surgeon head turns fell from 82.4 ± 32.5 to 0.10 ± 0.31 per procedure. Operative time and radiation exposure time were numerically lower but not significantly different, and the study was not powered for complications or screw accuracy.⁵ A later synthetic-spine study reported that smart glasses could reduce fluoroscopy exposure during percutaneous pedicle-screw insertion, with a greater apparent benefit for the less experienced operator.⁶ These devices were not Google Glass, but they test its core heads-up-display premise.

Remote consultation and telementoring

Google Glass allowed a remote mentor to see approximately what the operating surgeon saw and communicate in real time. This was attractive for urgent consultation, low-resource settings, and training across geographic boundaries. Yet early blinded evaluation concluded that Google Glass video quality was insufficient for safe open-surgery telementoring despite useful two-way communication.⁷ Later purpose-built smart glasses improved streaming and were used to support spine surgery from East Africa with remote experts in the United States, demonstrating feasibility under real clinical conditions.⁸ Telementoring should remain advisory unless connection reliability, image quality, latency, escalation pathways, local accountability, and patient consent are explicitly addressed.

Physiologic data and workflow support

Google Glass has also displayed vital signs during simulated procedures, with users reporting improved situational awareness and perceived usefulness.⁹ A spine-specific prototype streamed electromyographic responses to a wearable headset during selective dorsal rhizotomy, illustrating how near-eye displays might reduce dependence on verbal relaying of neuromonitoring data.¹⁰ These applications may shorten the information loop, but alerts must be prioritized carefully to avoid clutter, alarm fatigue, or inappropriate diversion of attention from the operative field.

Summary of Key Evidence

Study	Setting	Device function	Main finding	Key limitation
Lee et al 2017	Lumbar decompression and fusion	Google Glass recording	Best wearability and two-way communication; lower video quality than action cameras	Single surgeon and procedure
Dickerson et al 2019	Distal tibial fracture simulation	Google Glass video coaching	Positive learner perception; no superior objective improvement	Immediate simulated outcome
Chimenti and Mitten 2015	Cadaveric hand fixation	Google Glass fluoroscopy display	Fewer images and faster fixation for selected fractures	Cadaveric pilot
Matsukawa and Yato 2021	20 PLIF procedures	Wearable fluoroscopy display	Nearly eliminated monitor-directed head turns	Not Google Glass; small pilot
Sommer et al 2022	East African spine surgery	Smart-glass remote support	International intraoperative consultation was feasible	Case-series evidence and network dependence
Sakai et al 2023	AIS deformity correction	AR smart-glass assistance	Improved selected correction metrics and lower surgeon fatigue	Non-Google platform; controlled but nonrandomized

Hiranaka et al 2024	Synthetic lumbar model	Smart-glass fluoroscopy display	Potential radiation reduction, greater for less-experienced operator	Model study; limited operators
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Potential Benefits

Smart glasses may improve workflow by reducing gaze shifts, keeping hands free, and placing selected data within the surgeon's visual envelope. They can provide authentic point-of-view teaching material, allow remote observers to understand the operator's perspective, and support immediate review. In fluoroscopy-dependent procedures, near-eye display may reduce head turning and could reduce image acquisition if the surgeon can interpret images without repeatedly reorienting. In remote settings, the same hardware may connect a local team to subspecialty expertise. The technology may also have ergonomic benefits. Minimizing repeated head turns and awkward monitor viewing could reduce fatigue during long procedures. In adolescent idiopathic scoliosis correction, a controlled study using lightweight AR smart glasses—not Google Glass—reported better selected deformity-correction measures, lower pedicle-screw violation rates, and lower surgeon fatigue scores.¹¹ These results are encouraging but require independent replication and should not be attributed to Google Glass itself.

Limitations Safety and Governance

Technical and ergonomic constraints

Early Google Glass studies repeatedly identified short battery life, heat, limited display size, variable image quality, head-motion artifact, voice-control difficulty in noisy environments, and unreliable wireless connectivity. The monocular display can also compete with the operative scene, particularly when dense images or alerts are presented. Compatibility with prescription lenses, magnifying loupes, microscopes, headlights, masks, and face shields is procedure dependent. Some smart-glass systems cannot be worn with leaded protective eyewear, potentially exchanging one radiation-safety problem for another.



Figure 1 Operating-room use of prescription spectacles beneath a face shield. The image illustrates the limited space available for combining corrective lenses, smart-glass hardware, masks, and protective equipment.

Source: Author-provided photograph.

Human factors and clinical risk

Information placed near the line of sight may reduce monitor checking but can also obscure anatomy, divide attention, or create cognitive overload. Display latency, loss of signal, incorrect image selection, registration error, or freezing must fail safely. The operator must always be able to continue the procedure without the device. Formal usability testing should include distraction, visual occlusion, nausea, eye strain, neck load, communication with the team, and performance under bleeding or other high-workload conditions.

Privacy consent and cybersecurity

A head-worn camera can record continuously and may capture more than intended. Patient consent should specify recording, streaming, storage, education, publication, and whether remote participants are involved. Protected health information should remain within institutionally approved systems with encryption, authentication, audit logs, minimum necessary access, and a defined retention policy. Consumer cloud accounts and informal video calls are inappropriate substitutes for a governed clinical platform.

Device lifecycle and terminology

Google stopped selling Glass Enterprise Edition on 15 March 2023 and ended support on 15 September 2023; no further software updates were planned.¹² Existing devices may still function, but procurement, security maintenance, repair, and long-term clinical support are problematic. Consequently, contemporary papers often use “smart glasses” to describe other products. Reviewers and authors should identify the exact device, software, display type, data pathway, and whether content is merely displayed or spatially registered to the patient.

Implementation Framework

Define one use case. Begin with recording, remote consultation, fluoroscopy display, or alerts rather than combining all functions.

Validate the visual task. Test image resolution, latency, field of view, contrast, working distance, and visibility under operating-room lighting.

Protect the fallback. The operation must proceed safely if the display, battery, network, or application fails.

Integrate protective equipment. Confirm compatibility with loupes, prescription lenses, headlights, face shields, and leaded eyewear.

Govern the data. Use written consent, approved storage, role-based access, encryption, audit trails, and deletion rules.

Measure meaningful outcomes. Record accuracy, complications, radiation dose, task time, head movement, fatigue, usability, and cost rather than satisfaction alone.

Introduce in stages. Progress from bench testing to simulation, cadaveric validation, supervised clinical feasibility, and comparative trials.

Future Research

The next generation of evidence should move beyond feasibility. Orthopaedic trials could compare conventional monitors with near-eye fluoroscopy during percutaneous fracture fixation, intramedullary nailing, and minimally invasive instrumentation. Spine trials should stratify by surgeon experience and evaluate cumulative radiation dose, pedicle-screw accuracy, workflow interruption, neck motion, and fatigue. Educational studies should use delayed retention and transfer to the operating room rather than immediate simulation scores alone.

Device reporting must be standardized. Publications should specify optical design, display position, resolution, latency, battery duration, connectivity, sterilization approach, compatibility with protective equipment, software version, cybersecurity architecture, and failure rate. Economic studies should include hardware replacement, integration, staff training, data storage, maintenance, and downtime. Multicenter trials with independent outcome assessment are required before a smart-glass system can be recommended as routine clinical equipment.

Conclusion

Google Glass established the feasibility of hands-free point-of-view recording, near-eye display, and bidirectional communication in orthopaedic and spine surgery. The strongest direct orthopaedic findings are a cadaveric fluoroscopy-display pilot and a randomized resident-coaching trial; direct spine evidence showed good wearability for recording but inferior image quality to dedicated action cameras. Later smart-glass systems have produced more compelling signals for reduced head turning, remote support, radiation reduction, and lower surgeon fatigue, but these results should not be mislabeled as Google Glass evidence. Because the original platform is discontinued and unsupported, its principal importance is conceptual and historical. Clinical adoption should focus on validated, supported devices embedded within robust safety, privacy, and human-factors systems.

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