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A systematic review of the uses and benefits of three dimensional printing in orthopaedic surgery

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Introduction: Three-Dimensional (3-D) printing was first used in the medical field in the early 1990s to create a model of the cranial anatomy and has seen a rapid increase in use over the last decade. The objective of this systematic review was to analyse the uses and benefits of 3-D printing in orthopaedic surgery. Key areas of focus were highlighted such as pre-operative planning, patient specific implants, instruments, and orthoses.

Method: The PRISMA methodology was followed and literature searches were conducted on Medline, Embase and the Cochrane library. MeSH search terms and Boolean operators included '3-D printing', 'orthopaedic', 'pre-operative plan', 'implants', 'patient specific instruments' AND 'orthosis'. Duplicate studies, literature from before 2015 and non-human subjects were all excluded from the review.

Results: The searches resulted in 36 studies included in the final review for analysis (8 case reports, 7 case series, 9 case-control studies and 12 randomised control studies). The increasing interest in the use of 3-D printing in orthopaedics is reflected in the rise in the number of publications between 2015 (1 study) and 2020 (11 studies). The most common application of 3-D printing reported by 75% of the studies was the use of 3-D printed anatomical models to aid in pre-operative planning. The 3-D printed anatomical models were also utilized for surgical simulation (31%), intraoperative navigation (8%), and patient/family and surgical education (8%). The use of 3-D printing to manufacture patient specific orthoses, implants and instruments was reported in 14%, 11% and 8% of the studies respectively. The advantage of 3-D printing reported most (56% of studies) was the educational and training opportunities the 3-D printed models provided for junior surgeons. Doctor-patient communication and improved consenting was a reported benefit in 28% of the studies. Objective benefits of using 3-D printing such as significantly reduced operating time (42%), instrumentation time (11%), fluoroscopy time (31%) and intraoperative blood loss (33%) were also reported.

Conclusion: Orthopaedic surgery can be complex and technically challenging. The literature shows 3-D printing of anatomical models has improved pre-operative planning, allowed for surgical simulation, training and education. These benefits have led to improved operating metrics in patient where 3-D printed models were used. There are currently no studies which demonstrate these reported benefits have led to improved patient outcomes.

Figure 1 - PRISMA flow chart of included studies

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