Computer technology applications in surgical implant dentistry: a systematic review

Jung RE, Schneider D, Ganeles J, Wismeijer D, Zwahlen M, Hammerle CH, Tahmaseb A

CRD summary
The authors concluded that at the time of the review evidence to suggest that computer-assisted surgery was superior to conventional procedures in terms of safety, outcomes, morbidity and efficiency was lacking. The possibility of missed studies and the unclear statistical methods and unknown study quality suggest that these conclusions should be interpreted cautiously.

Authors' objectives
To investigate the accuracy and clinical performance of computer technology applications in surgical implant dentistry. This abstract is focused on the clinical performance aspect of the review.

Searching
PubMed (1966 to 2007) was searched for studies in English, German, Italian and French. Search terms were reported. Reference lists were searched.

Study selection
Clinical studies of computer applications in surgical implant dentistry were eligible if they had at least five participants and reported clinical, radiologic or patient-centred outcomes. No specific follow-up period was required for evaluation of intraoperative complications or unexpected events during the operation; at least 12 months follow-up was required for the evaluation of implant and prosthetic survival and complication rates. Studies with zygoma implants, pterygoid implants or mini-implants for orthodontic planning were excluded, as were studies that reported exclusively on radiographic planning.

Where reported, participants in the included studies had a mean age of 56.1 years (range 18 to 89 years). Most of the studies were of edentulous participants in the maxilla and mandible; single tooth gaps and partially edentulous participants were included. Immediate restoration of the implants was performed in six of 13 studies using a flapless procedure. Ten different dynamic and static systems were evaluated; a CT scan was used for preoperative planning in all but one study. Most studies described intraoperative complications and reliability of the implant placement after computer-assisted assessment of pain; other studies reported pain assessment, operating room time and marginal bone remodelling.

Two independent reviewers were involved in study selection.

Assessment of study quality
The authors did not report that study quality was assessed.

Data extraction
The event rate, total exposure time and total number of events were calculated for each outcome by two independent reviewers. Disagreements were resolved by discussion (data were included only if there was agreement between the two reviewers).

Methods of synthesis
Event rates were summarised using Poisson regression with a logarithmic link function and total exposure time for each study used as an offset variable. Pooled failure rates were calculated for the five studies with at least 12 months follow-up. It appeared that risk ratios (RR) were calculated. Heterogeneity was assessed using Spearman goodness-of-fit statistics; if heterogeneity was indicated (p<0.05) a random-effects Poisson regression (with g-distributed random-effects) was used.

Results of the review
Thirteen studies were included (n=580 patients, range five to 142, total of 1,243 implants after drop-outs). Two studies were RCTs (n=76). Eleven studies were prospective designs (n=504). Five studies (n=121 patients, 506 implants after drop-outs) had a follow-up period of at least 12 months and were included in the analysis of failure rates.

Mean annual implant failure rate was 3.36% in five studies (range zero to 8.45%); in immediately restored participants the failure rate was significantly lower by a factor of five (p=0.0018). Intraoperative complications (reported in 10 of 13 studies) were observed in 4.6% (95% CI 1.2% to 16.5%) of implant placements. Dynamic systems had a 2.2 times higher incidence of complications, but this was not significant. The rate ratio for complications was significantly lower (seven times lower) in flapless procedures compared to those with an open flap 0.15 (95% CI 0.03 to 0.88, p=0.035). The rate ratio for complications was non-significantly lower in edentulous than partially edentulous participants. One RCT (n=60 patients with 152 implants) showed significantly higher pain measurement scores with open flap surgery compared with flapless surgery.

**Authors' conclusions**

Differing levels and quantity of evidence were available for computer-assisted implant placement. These revealed high implant survival rates after only 12 months of observation in different clinical indications. There is not yet evidence to suggest that computer-assisted surgery was superior to conventional procedures in terms of safety, outcomes, morbidity and efficiency.

**CRD commentary**

The research question was supported by inclusion criteria for study design, outcomes and intervention. The search was limited to one database and restricted to four languages, and it appeared that unpublished studies were not sought, so relevant studies may have been missed. Study quality was not formally assessed and so the reliability of the results of the studies was unknown. Data extraction and study selection were performed by two reviewers, which reduced risks of error and bias in these processes. The method of synthesis appeared unclear. Heterogeneity was not reported.

The possibility of missed studies and the unclear statistical methods and unknown study quality suggest that the authors' conclusions should be interpreted cautiously.

**Implications of the review for practice and research**

**Practice:** The authors stated that in future, reductions in radiation doses through improved radiographic techniques and greater accuracy might increase the number of indications for computer-assisted implant placement.

**Research:** The authors stated that the finding that the rate of intraoperative complications and unexpected events was lower in flapless procedures should be further evaluated in future study designs. Long-term clinical data were needed to identify clinical indications and justify additional radiation doses, efforts and costs associated with computer-assisted implant surgery.

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.