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Meta-Analysis
TMJ Disorders

Total temporomandibular joint replacement prostheses: a systematic review and bias-adjusted meta-analysis

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Abstract. The aim of the present study was to determine which prosthesis has resulted in the best outcomes after total temporomandibular joint replacement (TMJR). A comprehensive electronic search was undertaken in September 2015. Inclusion criteria encompassed studies that described one of the three current TMJR systems and that had pre- and postoperative data on at least two of the following TMJR indications: pain, diet, function, and maximum inter-incisal opening (MIO). Sixteen papers were included in the systematic review, reporting 10 retrospective studies and six prospective studies (no randomized controlled or case-controlled trials). A total 312 patients with 505 TMJ Concepts prostheses, 728 patients with 1048 Biomet prostheses, and 125 patients with 196 Nexus prostheses were included in the analysis. There was no real difference between the various TMJR systems in terms of pain or diet scores. Function scores improved with the TMJ Concepts, but this was the only prosthesis for which data were available. Biomet prostheses appeared to have a greater increase in MIO mean gain compared to TMJ Concepts and Nexus prostheses; however this was heavily biased by one study. Without this study, there was no real difference in MIO. It is concluded that the prostheses are similar, but most data are available for the TMJ Concepts prosthesis, with results being favourable.

Key words: temporomandibular joint; surgery; joint replacement; prosthesis; TMJ Concepts; Biomet; Christensen; Nexus; systematic review.

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Temporomandibular joint replacement (TMJR) is generally a last resort in the surgical management of end-stage joint disease. The prerequisite for consideration of TMJR is failed conservative management including arthroscopy, where the diagnosis has been confirmed using computed tomography or magnetic resonance imaging.[1] Indications for TMJR (Table 1) have been set out by the United Kingdom TMJR surgeons on behalf of the British Association of Oral and Maxillofacial Surgeons and are generally accepted in most countries.[2–11]

Three TMJR systems are currently available: the patient-fitted TMJ Concepts system (previously Techmedica Inc.; Ventura, CA, USA), the stock and custom (except in the USA) Biomet Microfixation systems (Jacksonville, FL, USA), and the stock and patient-specific Nexus CMF systems (previously Christensen, TMJ Implants Inc.; Salt Lake City, UT, USA). Each has three components: (1) a

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Table 1. Indications for TMJR reported by UK TMJR surgeons.[1]

Diseases including condylar bone loss	Indications (usually a combination)
Degenerative joint disease	Dietary score <5/10 (liquid score 0, full diet score 10)
Inflammatory joint disease	Restricted mouth opening (<35 mm)
Ankylosis	Occlusal collapse
Condylar loss either traumatic or postoperative	Excessive condylar resorption
Previous prosthetic or tissue graft failure	Pain score >5/10 on visual analogue scale
Congenital deformity	Other quality of life issues
Multiple previous procedures	

TMJR, total temporomandibular joint replacement.

condyle and ramus component that is all cobalt–chromium (Co–Cr) alloy (Biomet and Nexus), or an all titanium alloy ramus component with cobalt–chromium–molybdenum (Co–Cr–Mo) condyle (TMJ Concepts); (2) an all ultrahigh molecular weight polyethylene (UHMWPE) fossa component (Biomet), or a commercially pure titanium mesh backed UHMWPE fossa (TMJ Concepts), or a thin cast all Co–Cr fossa (Nexus); (3) titanium alloy screws (TMJ Concepts and Biomet), or Co–Cr screws (Nexus).[5] The main difference between the three systems is that the Concepts prosthesis is custom-made (computer-assisted design/computer-assisted manufacture, CAD/CAM), whereas the Biomet and Nexus systems comprise 'stock' prostheses of various sizes. However, Aagaard and Thygesen[2] and Machon et al.[8] also describe a custom-made Biomet prosthesis.[2]

Mercuri, one of the developers of the TMJ Concepts prosthesis, has argued that the custom TMJR is more favourable than the stock TMJR for a number of reasons. With stock device components, the host fossa and ramus bone must be altered, or the components must be bent or shimmed with bone or alloplastic cement to develop a close adaptation. Mercuri has suggested that these manoeuvres can lead to material fatigue or overload, resulting in micromotion, which will cause loosening of the implant leading to failure.[12,13]

These TMJR systems were reviewed qualitatively by Guarda-Nardini et al. in 2008,[5] with nine papers included.[9,14–21] Taking into consideration case selection, the follow-up period, main findings, manufacturer, and success rate in this qualitative review, the indications for TMJR were re-affirmed. The aim of this study was to systematically review the TMJR prosthesis literature and document the magnitude of the measurable outcomes (dietary scores, mouth opening, pain scores, and function scores) across the different prostheses.

Methods

Search strategy

This systematic review and meta-analysis was performed using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist.[22] Details of the protocol for this systematic review were registered in the international prospective register of systematic reviews, PROSPERO (CRD42015030060).[23]

A comprehensive electronic search was undertaken in September 2015 of the MEDLINE, Cochrane Library, and Google Scholar databases, using at least one or a combination of the following search terms: 'temporomandibular joint', 'joint replacement', 'alloplastic', 'surgery', 'TMJ Concepts', 'Techmedica', 'Biomet', 'Lorenz', 'Nexus' and 'TMJ implants' (Supplementary Material, Table S1). The reference lists of the studies identified were also evaluated for additional studies.

Supplementary Table S1 related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ijom.2016.08.022.

Inclusion and exclusion criteria

Any randomized controlled trial (RCT), controlled clinical trial (CCT), retrospective/prospective study, or review paper describing one of the three current TMJR systems and for which pre- and postoperative data were available for at least two of the TMJR outcomes 'function score', 'pain score', 'diet score', and maximum interincisal opening (MIO), were included.

Case reports and small case series of fewer than 10 patients, animal studies, and papers not published in English were excluded.

Data collection

The eligibility of all studies retrieved from the databases was assessed. The following data (where available) were extracted from the included studies: authors, year of publication, study design, number of patients, gender, mean age in years, follow-up period (years), pre- and postoperative data on pain, function, diet, and MIO (millimetres), and major complications. Visual analogue scale (VAS) scores (scale of 0–10) were reported for pain, function, and diet, where a score of zero represented 'no pain', 'normal function', and 'no diet restriction', and a score of 10 represented 'severe pain', 'no function', and a 'liquid diet', respectively. Every attempt was made to contact authors for clarification of study design/patient inclusions, along with any missing data.

Quality assessment

The Methodological Index for Non-Randomized Studies (MINORS), as described by Slim et al.,[24] was adapted to assess the methodological quality of the non-randomized studies (Supplementary Material, Table S2). Along with the initial 10 criteria, seven additional TMJR-specific criteria were added and applied to determine a quality score for each individual paper for use in the quality-effects meta-analysis.

Supplementary Table S2 related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ijom.2016.08.022.

Statistical analysis

The outcome measures assessed between the TMJR systems were the weighted mean gain in scores for pain, diet, and function, and the weighted mean gain in MIO.

The meta-analysis was performed using MetaXL 4.0 (http://www.epigear.com). Mean gain estimates were pooled using bias-adjusted (quality-effects) and non-bias-adjusted inverse variance heterogeneity model (IVhet) methods.[25–27] The mean gain effect size ($ES_{\mu g}$) and standard error ($SE_{\mu g}$) were calculated using the following formulae:

$$ES_{\mu g} - X_{T2} - X_{T1} - G -$$

$$SE_{\mu g} = \sqrt{\frac{2s_p^2(1-r)}{n}}$$

$$S_p^2 = (S_{r1}^2 + S_{r2}^2)/2$$
(r was imputed to be 0.5)

Study effect sizes (ES) were deemed to be heterogeneous when τ^2 was greater than zero, or the Q-statistic achieved