ARTICLE

Morphologic and Functional Changes in the Temporomandibular Joint and Stomatognathic System after Transmandibular Surgery in Oral and Oropharyngeal Cancers: Systematic Review

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Background: **Interruption of mandibular continuity in transmandibular (mandibulotomy and mandibulectomy) surgery for tumour resection in the oral cavity and oropharynx may alter oral and temporomandibular joint (TMJ) morphology and function.**

Objective: **To critically analyze available evidence regarding the effects of transmandibular surgeries on morphologic and functional changes in the TMJ and stomatognathic system.**

Data Sources: **Electronic search of *Medline, Embase, Evidence-Based Medicine Reviews, Ovid HealthStar,* and *Scopus* and hand searches.**

Inclusion Criteria: **Any article investigating the TMJ morphologic changes and/or functional outcomes following transmandibular surgeries.**

Results and Synthesis Methods: **Two hundred seventy-one articles were obtained through the electronic database scan and six articles via a hand search. Twelve full articles were initially selected as potentially meeting the eligibility for this review; however, only five articles finally fulfilled the study inclusion criteria and were analyzed for their methodology. All articles used clinical records and/or patient reports to evaluate TMJ pain, motion, dental occlusion, mouth opening, and deflection during opening as outcome measures. In only four articles was a clinical examination conducted after surgery, with associated patients' interviews and reports. The quality of all included articles was considered poor with a high risk of bias according to the Research Triangle Institute item bank quality of assessment.**

Conclusion: **Based on the limited available evidence for this systematic review and a high risk of bias of the analyzed articles, no firm conclusions can be established regarding the effects of transmandibular surgery on morphologic and functional changes in the TMJ and stomatognathic system.**

Key words: *evidence based, mandibulectomy, mandibulotomy, stomatognathic, temporomandibular joint*

Oral cavity and oropharyngeal cancers are some of the most common cancers in the head and neck region.[1] Treatment of upper aerodigestive tract cancers can involve surgical intervention and/or chemoradiotherapy based on the type and stage of cancer.

The mandible is the skeletal frame that supports the muscles of mastication and is important in speech, chewing, and swallowing functions. In addition, the mandible is fundamental to the cosmetic appearance of the lower third of the face. Surgical manipulation of the mandible, particularly the temporomandibular joint (TMJ), during cancer tissue removal has been reported to have implications for mastication, swallowing, and cosmetic appearance.[2]

Access to oral cavity and oropharyngeal tumours can be achieved with different surgical approaches, which demonstrate different levels of invasiveness. Transoral surgery has no mandibular involvement and can be considered the least invasive method when it comes to oral functions.[3] Transmandibular surgery to treat oral cavity and oropharyngeal tumours can be either mandibulotomy (split mandible) to gain access to tumour tissue or mandibulectomy (mandibular resection) in the case of

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osseous tumour involvement. Mandibulotomy was first introduced in 1836, and the oncologic value of the transmandibular approaches has been well established in the surgical literature.[4]

The type and technique of surgical intervention affect mandibular and TMJ functions postsurgery.[5] It has been reported that patients undergoing mandibulotomy or mandibulectomy have impaired speech and TMJ functions compared to patients who do not.[6] Although mandibulotomy is known to provide suitable access to most regions of the upper aerodigestive tract, some authors believe that its complications outweigh the surgical benefits.[7] Common complications include plate exposure or failure, soft tissue missing, orocutaneous fistula, mandibular fracture, osteoradionecrosis, and malunion or misaligned bony union. Interruption of mandibular continuity results in functional disturbance, and the extent of the defect varies according to the tumour location, extension, severity, and stage and the soft and hard tissues involved.[8] Free flap reconstruction of the mandible provides various degrees of success in rehabilitating oral function and restoring the lower face contour.[9,10]

During the last two decades, many treatment options have become available in the area of head and neck surgery. The matter of which surgery or reconstructive technique is providing the best functional and cosmetic treatment outcome has been debated in the literature.[11–14] Changes in the TMJ internal morphology and functions and mandibular movements after transmandibular surgery appear to have been poorly investigated.

The purpose of the present systematic review was to critically and systematically analyze the available literature regarding the effects of different transmandibular surgeries on morphologic and functional changes in the TMJ and stomatognathic system. The PICO question (Problem, Intervention, Comparison, Outcome) was as follows: The purpose of the present systematic review was to critically and systematically analyze the available literature regarding the effects of different transmandibular surgeries (ie, mandibulotomy and mandibulectomy) on morphologic and functional changes in the TMJ and stomatognathic system in patients with oral and oropharyngeal cancers.

Materials and Methods

Search Strategy

Medline (1948 to first week of June 2011); *Embase* (1980 to week 23 2011); *Evidence-Based Medicine Reviews-Cochrane Database of Systematic Reviews*, *ACP Journal Club*, and *DARE* (1980 through 2second quarter of 2011); *Ovid HealthStar* (1966 to May 2011); and *Scopus* (1965 through June 16, 2011) were systematically searched in all languages. Key words used in the search were *mandibulotomy*, *osteotomy*, *mandibular osteotomy*, *mandibular swing*, *mandibular surgery*, *oropharyngeal surgery*, *otorhinolaryngologic surgical procedures*, *oral surgical procedures*, *maxillofacial surgery*, *surgery*, *oral*, *temporomandibular joint*, *TMJ, mandibular condyle*, *neoplasms*, *cancer*, *tumour*, *malignant*, *carcinoma*, *squamous cell*, *pharynx*, *oropharynx*, *oropharyngeal*, *mouth*, *oral*, *palate*, *parotid*, *tonsillitis*, *tongue*, *cheek*, *mouth mucosa*, *gum*, and *gingiva*. Key words were also searched in a selection of both truncated and MeSH terms with the help of a librarian who specializes in health science databases. Additionally, the literature search was complemented by manually searching the bibliographies of the identified articles.

Criteria for Considering Articles for This Review

Study Design

Any type of study design (eg, clinical trials, cohort studies, case-control studies, cross-sectional studies, prospective and retrospective studies) investigating functional or morphologic changes in the TMJ after transmandibular surgery (mandibulotomy and mandibulectomy) in patients with oral cavity or oropharyngeal cancers was included. Case reports with fewer than 10 cases; case series, editorial and personal opinion letters, and literature reviews were not included.

Participants

Inclusion in this review was restricted to articles with participants meeting the following criteria: (1) humans; (2) no limitations on age and gender; (3) patients with oral or oropharyngeal cancer treated with transmandibular surgeries; (4) patients with TMJ trauma or infectious or rheumatic diseases. Neurologicl problems requiring surgery were not included.

Outcome Measures

Any morphologic, physiologic, or biomechanical changes in the TMJ and associated structures (degenerative joint disease, disk displacement and perforation, change in condylar position, capsular ligaments, effusion, and inflammation) were included. Functional limitations of the stomatognathic system (eg, trismus, limited mouth

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movement, loss of mandibular rotations, joint pain, alterations in swallowing and speech) were considered.

Method for Considering Articles for This Review

The published abstracts or titles (in case of unavailable abstracts) that appeared in the database search were screened thoroughly by two independent reviewers (M.A. and N.T). They selected articles that appeared to be potentially relevant for full-article evaluation. In case of vague abstracts or disagreement between reviewers' selections, full articles were selected for consideration. Full-text articles were obtained and analyzed by two independent reviewers (M.A. and S.A.-O.) according to the inclusion criteria. Accordingly, each criterion was rated on a yes or no basis. Articles with doubtful criteria underwent reevaluation by the two reviewers (M.A. and S.A.-O.), and if no consensus was reached, a third reviewer (N.T.) was involved to reach consensus by discussion.

Critical Appraisal

The final selected articles were involved in a critical appraisal process to determine their risk of bias and methodological quality.

Viswanathan and Berkmann developed a Research Triangle Institute (RTI) item bank based on 1,492 questions included in earlier instruments and organized by the quality domains identified by Deeks and colleagues.[15,16] Items were refined through face validity, cognitive, content validity, and interrater reliability testing. This process gave rise to 29 items or questions for evaluating the risk of bias and precision of observational studies of interventions or exposures. According to the authors, this RTI item bank can capture most of the domains of this type of research, is easy to use, can be adapted to different designs, and has guidelines for scoring.

Due to the observational nature of the selected articles in the present review, the Deeks and colleagues tool to determine the risk of bias[16] was applied. Each study was given a score and graded as low, moderate, or high methodological quality/risk of bias based on the number of critical appraisal items met. The cut-ff score was determined, based on previous systematic reviews and meta-analyses,[17,18] as follows; 0 to 0.40, low quality/high risk of bias; 0.41 to 0.70, moderate methodological quality/moderate risk of bias; and 0.71 to 1.0, high methodological quality/low risk of bias.

Two reviewers (M.A. and S.A.-O.) independently completed the critical appraisal, and the results were compared. At this stage, kappa and percentage of agreement were calculated using *Stata* version 10 (Stata Corp., College Station, TX) to determine the agreement between the reviewers for grading an article.

OMERACT Quality Outcome Measures

The OMERACT[19] process was adopted in this review to establish the validity of each TMJ-related clinical outcome. OMERACT is the acronym for the International Initiative to Improve Outcome Measurement in Rheumatology.

Results

The electronic database search yielded a total of 271 articles. The primary review of titles and abstracts from database searches resulted in 30 potential abstracts or titles that were considered for inclusion. Based on the full-text review of the 30 articles, only 6 articles were selected.[20–25] The selection process is presented in Figure 1. Six articles were identified by manual search as well.[2,13,14,26–28] Finally, only five articles fulfilled the inclusion criteria of our review.[20–23,26] The other seven articles were excluded for the following reasons[2,13,14,24,25,27,28]:

1. The TMJ outcome data (eg, pain, clicking, movement, mouth opening, deflection, and deviation) were not provided.[13,14,27,28]
2. The study purpose was to determine the TMJ functional outcome following orthognathic surgical treatment and did not include any tumour-related work.[25]
3. The study did not attempt to measure any TMJ and stomatognathic system functions.[2,24]

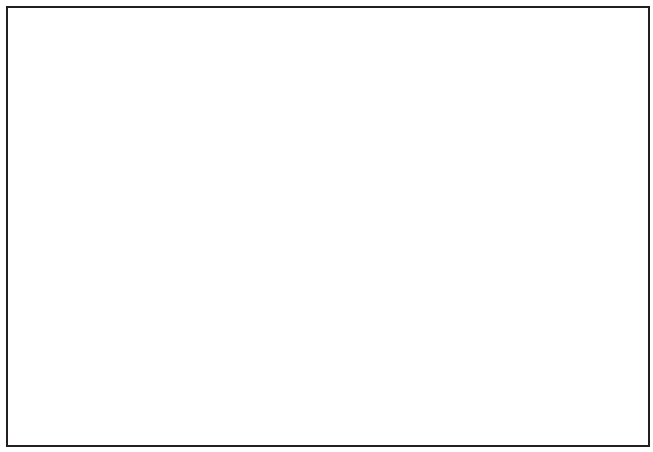

Figure 1. Flow diagram of the selection process.

Characteristics of Included Articles

Information on the study patients' demographics, study design, tumour type, surgery type, adjuvant treatment, and method and time of data collection of the selected articles is outlined in Table 1. The five included articles mainly investigated TMJ and oral function outcome following different models of tumour resection.[20–23,26] All selected articles were published between 1990 and 2002 by different authors at different research centres. Included articles consisted of cohort patients with different oral cavity and head and neck tumours. Tumour histologic types were reported in three articles only.[20,21,23] All articles reported outcome based on clinical records or operative log data, three studies executed a clinical examination,[20–22] and three studies undertook patient interviews.[21,23,26] Riddle and colleagues and Gellrich and colleagues reported outcome measures by means of a standardized rehabilitation questionnaire.[21,23] In total, four articles reported postoperative pain impairment including TMJ pain[20–23]; two articles reported limited mouth and TMJ movements due to muscle tenderness[20,21]; four articles evaluated interincisal opening, mouth deflection, dental rehabilitation, and occlusion[20–22,26]; and three articles reported speech and swallowing impairment, lip sensation, scar formation, and cosmetic complaints.[21–23]

TMJ Pain

Christopoulos and colleagues found that patients who underwent mandibulectomy experienced more TMJ pain than patients who underwent mandibulotomy.[20] Riddle and colleagues reported symptoms of local pain and discomfort after mandibulotomy surgical intervention on a yes and no basis without comparing them to the control group.[21] Only 6% of the evaluated patients reported persistent pain at the mandibulotomy site and 32% patients reported TMJ pain associated with chewing or speaking. Bertrand and colleagues reported TMJ pain on the basis of frequency of occurrence.[22] TMJ pain was considered a postoperative complication that affected 30% of the study's patients. A standardized rehabilitation questionnaire also showed that oral function impairment was caused by pain before and after surgery and at a 6-month follow-up appointment.[23] Patients with a higher incidence of pain before treatment showed significantly higher oral function impairment during and after treatment. Only 20% of patients reported TMJ impairment due to the painful experience of disease and treatment.

All of the analyzed articles found that TMJ pain could be identified after the surgical intervention and gradually subsided with time. Based on one study that compared the mandibulectomy and mandibulotomy results, postoperative TMJ pain was found to be higher in the mandibulectomy group, but this difference was not significant.[20]

Masticatory Muscle Tenderness, TMJ Motion, Interincisal Opening, and Mouth Deflection

Only two articles evaluated the TMJ-related muscular condition of patients after surgery.[20,21] Christopoulos and colleagues reported that 4% of patients were diagnosed with muscular tenderness after mandibulotomy.[20] Riddle and colleagues reported that 41% of patients had muscular tenderness at at least one site of the temporalis and masseter muscle origins and insertions as a sign of trismus, which resulted in pain and discomfort during TMJ movements.[21]

Four articles objectively measured TMJ border movements and deflections.[20–22,26] Urken and colleagues measured the interincisal opening of two groups of patients who underwent mandibulectomy in comparison with two control groups.[26] The authors detected significant clinical differences between the patients who underwent mandibulectomy and the healthy control groups. The interincisal opening average was 29 to 39 mm for the mandibulectomy patients and 47 mm for the controls. Christopoulos and colleagues found no significant difference in mouth opening between patients who underwent mandibulotomy (average 40 mm) and patients who underwent mandibulectomy (average 50 mm).[20] Mouth deflection of 3.3 and 9.5 mm was detected during mouth opening in patients who underwent mandibulotomy and mandibulectomy, respectively. Riddle and colleagues reported that 30% of patients self-reported diminished range of motion on opening the mouth compared to their preoperative motion.[21] Patients who self-reported diminished opening had an average mouth opening of 41 mm, whereas patients without a sense of decreased range of motion showed an average opening of 44 mm.

Bertrand and colleagues classified the TMJ lateral movement and the interincisal distance (ID) into three levels according to the severity of the restriction: normal: slight difference in lateral motion and ID $>$ 40 mm; moderate: significant difference in lateral motion and ID $>$ 30 mm; and severe: no lateral motion, ID $<$ 25 mm (pure rotation).[22] Seventy-three percent of patients had severe mouth opening limitation due to postoperative radiotherapy.

Dental Occlusion and Rehabilitation

Four included articles reported the outcome of the postoperative prosthesis in terms of existence and retention.[20–22,26] Urken and colleagues compared the retention of dental prostheses in patients who underwent mandibulectomy with reconstruction versus no reconstruction.[26] Patients were instructed to perform a series of mandibular movements, and the prosthetic stability and retention were evaluated. The authors reported that regardless of the surgery type; none of the patients (seven with complete dentures and complete with partial dentures) were able to function with the prosthesis in place. Christopoulos and colleagues reported that 48% of patients had a dental prosthesis after surgery.[20,26] Over 97% of the patients were found to have adequate occlusion; however, no information on their functional performance was provided. Riddle and colleagues reported that 77% of the mandibulotomy patients noticed a shift in their occlusion with their new postoperative prostheses.[21] Bertrand and colleagues reported premature contact of teeth on the mandibulotomy side in 3% of patients.[22] At the 6-month recall evaluation, a periodontal infection with a 5 mm deep pocket was detected on teeth adjacent to the osteotomy line in 2 of 64 cases.

Speech, Chewing, and Swallowing

Three of the included articles reported the functional impairment of speech and swallowing.[20,23,26] Urken and colleagues objectively evaluated speech and swallowing.[26] Patients who underwent mandibulectomy were asked to answer a series of questions. Language pathologists rated patients' speech intelligibility based on a 7-point scale, where a score of 7 represented normal speech. The mean score of reconstructed patients was 5.66 ($\pm$ 1.1), whereas the unreconstructed patients score was 4.8 ($\pm$ 1.6). Patients were asked to compare their postsurgical masticatory ability to their memory of the 1-year predisease state. Almost all reconstructed patients reported that their enjoyment of eating was equal to their predisease state. Patients were instructed to bite forcefully against a force transducer to measure the bite force. Reconstructed patients had significantly greater average bite force (18 kg vs 2.3 kg). The chewing stroke was assessed with a video recording of the chewing motion. Reconstructed patients demonstrated a full free range of masticatory movements, whereas unreconstructed patients demonstrated chewing strokes with side-to-side grinding motions. The authors reported no significant differences in detectable abnormalities in the swallowing mechanism between reconstructed and unreconstructed patients.

Christopoulos and colleagues compared dysphagia and diet consistency between patients who underwent different surgeries (mandibulotomy and mandibulectomy).[20] They reported that patients who underwent mandibulectomy had more common dysphagia, and 57% of mandibulectomy patients reported having soft diets versus only 43% of mandibulotomy patients.

Gellrich and colleagues found that the highest impairment reported was in chewing, swallowing, and tongue mobility functions shortly after surgery in all surveyed patients.[23]

Lip Sensation, Scar Formation, and Cosmetics

Three included articles evaluated lip sensation and cosmetics.[21,22,26] Urken and colleagues reported that patients who underwent mandibulectomy without reconstruction downgraded their aesthetic ratings due to asymmetry of the lower third of the face.[26] In mandibulotomy cases, Riddle and colleagues reported that 45% complained of a tingling sensation and a decrease in sensitivity of the lower lip.[21] Bertrand and colleagues reported that 52% had lower lip sensation disturbances; 18% were objectively categorized as nerve injury.[22] Cosmetic complaints were encountered in only 9% of patients, which was related to a "string effect" during cervical extension movements.

Quality Assessment

The five included articles were assessed and scored following RTI item bank quality assessment guidelines and the OMERACT quality outcome measurement.[20–23,26] The results of the assessment are reported in Table 2 and Table 3. The agreement between reviewers in scoring the five articles with the item bank was 93.5% with a kappa score of 0.88, which are both considered very good agreement as per Byrt.[29]

All articles were rated as poor quality/high risk of bias. Several biases were evident, such as selection, information, performance, attrition, and reporting bias, in addition to threats to precision.[30] Moreover, articles failed to clearly provide details regarding inclusion or exclusion of the population under investigation, which further increases the risk of selection bias. Three included articles did not have a comparison group and analysis was mainly descriptive, with no statistical testing or previous hypotheses.[21–23]

Based on the OMERACT assessment, the validity, reliability, and feasibility of most of the outcomes measures were considered questionable.

Discussion

Of 271 articles that discussed oral function and cosmetic outcome measures following head and neck cancers, only 5 articles met the inclusion criteria and were included in this review.[20–23,26] All included articles were published between the years 1990 and 2002, and this finding highlights the relatively short interest in postoperative functional outcomes.

TMJ Pain and Muscular Tenderness

Clinicians and researchers should ensure that they use a valid, reliable, and responsive pain measure to capture changes after an intervention. In addition, it should allow the clinician to discriminate a variety of pain conditions. Four of the five included articles subjectively evaluated TMJ pain following surgical treatment in terms of questionnaires and on the basis of yes or no answers.[20–23] This approach is unable to discriminate pain severity or frequency. An increase in TMJ pain was noticed after mandibulectomy. This pain might be a result of large tissue resection or the instability of the mandibular complex.[20] Oral and oropharyngeal cancer patients experience a different pain perspective than noncancer patients. It has been suggested that patients' rating of pain is highest at the beginning of the cancerous disease.[23] The psychosocial aspect is considered a strong factor to control pain as well, especially when patients realize that they are likely cured.

TMJ Motion, Interincisal Opening, and Jaw Deflection

All articles included in this review evaluated mandibular movements and deflection during opening and closing following surgeries.[20–23,26] Evaluation of mandibular vertical and border movements by simply measuring interincisal, protrusion, and lateral excursion distances in millimetres appears to be a valid, reliable, and feasible method based on OMERACT quality assessment. Limitation in mandibular movement in both vertical opening and lateral movements following mandibulectomy was attributed to the scarring and prolonged muscle immobility.[26,27] Unlike mandibulectomy, mandibulotomy was found to have no influence on vertical or excursion movements, especially with dentate patients.[20] Bertrand and colleagues reported that patients who did not require radiotherapy did not have limited TMJ motion,[22] suggesting that surgery itself was not the direct cause of restricted jaw movement.

Concurrent resection of the tongue, palatal, and pharyngeal soft tissues may interfere with mandibular movements and/or TMJ stability. In spite of successful microvascular reconstruction, the relative insensibility and weak nature of these tissues can still influence normal TMJ function. Moreover, postoperative adjuvant therapy (chemoradiotherapy) further complicates the situation.

It was clear from the included articles that limited jaw movements were detected after mandibulectomy. The decrease in mouth opening and movement limitation was likely attributed to the simultaneous soft tissue resection, such as pterygoid muscles, with attendant reconstruction and/or radiation therapy.

Dental Occlusion and Rehabilitation

Occlusion disturbance after mandibulotomy was attributed to the torque effect of the rigid plate resulting in a slight internal rotation of the mandible segments, which leads to premature contact of teeth.[22] The ability to restore preoperative occlusion can be easily accomplished using the assistance of advanced visual modeling techniques.[31,32]

Dental implants and implant-borne dentures are common and stable postoperative prosthetic rehabilitation.[26] Postoperative dental rehabilitation may be necessary after changes involving extractions, pulp exposure, and mandibular osteotomy. Dental prostheses were found to be stable and retentive based on the amount of oral tissue removed and the reconstruction. Less bone resection is associated with more retentive prostheses. Of the literature reviewed, other than merely descriptive data, no objective evaluation was performed to evaluate the function of the postoperative prostheses. Therefore, the data reported were weak and inconclusive.

Speech and Swallowing

Tissue reconstruction after mandibulectomy interferes with patients' masticatory ability when compared to that of healthy subjects. Successful dental rehabilitation was extrapolated to be responsible for the high level of functional and patient compliance.[26] Changes in swallowing and speech after mandibulectomy were not found to be significant in reconstructed and unreconstructed patients.[20] The fact that speech and swallowing were

mainly determined by the involvement of oral cavity soft tissues, especially the mobility of the remaining tongue, explained the weak influence of the reconstruction on these functions.[26] Reconstructing the gingival sulcus with skin grafts demonstrated better speech and swallowing functional results.[33]

According to the reviewed articles, postoperative dysfunction is more related to the amount of oral tissue resected in mandibulectomy patients. Reconstructed patients were found to chew and speak slightly better than unreconstructed patients. The more oral tissue that was removed, especially the tongue, the more impaired speech and swallowing functions were reported in the patients assessed.[23,26]

Lip Sensation, Scar Formation, and Cosmetics

In the reviewed articles, lip sensation and numbness were found to diminish over time after mandibulotomy. Most patients were pleased with their final lip appearance and reported significant improvement with the physical therapy exercise program 1 year postmandibulotomy. The most accepted cosmetic appearance resulted from the mandibulotomy; however, postoperative decreased lip sensation is still a concern for some patients. Dziegielewski and colleagues examined the impact of midline mandibulotomy on lower lip sensation and movements.[13] The authors found that unlike other incision shapes and sites, the straight midline incision spares the mental and marginal mandibular nerves from any direct damage.

After mandibulectomy, patients suffered from a lack of sensation in the denervated reconstructed areas of the oral cavity. These sensory deficits assist in multiple functional problems such as food trapping, reduced levels of mastication, and oral incontinence. Kapur and colleagues evaluated the sensory feedback to muscles by selectively anesthetizing the oral cavity in dentulous subjects.[34] The authors reported that altering sensation in the oral cavity negatively influenced the levels of mastication in the tested patients. Few authors suggested restoring the sensation to the lower lip through sensate cutaneous flaps. However, these proposed techniques were considered preliminary and required further analysis.[35,36]

Facial scaring is known to influence patients' self-consciousness toward their appearance; consequently, this may affect patients' quality of life. Cancer patients, however, seem to have less concern and anxiety regarding their appearance compared to cancer control and post-operative functioning.[13]

Quality of the Analyzed Articles

The RTI item bank used to evaluate the quality/risk of bias of the analyzed articles was a more recently developed tool to be used for observational studies. Although the authors stated that this tool could be used for many different designs because of its flexibility,[15] many of the items from the item bank were not applicable. Future studies should test the applicability of this item bank in other similar systematic reviews to guide its use and improvement.

The risk of bias of the articles analyzed in this review was high. Lack of information regarding histologic diagnosis, tumour stage, exact location of the lesion, surgical treatment applied, psychometric properties of the outcome measures, control of confounding factors, blinding of outcome measures, rate of dropouts, subject comparability, and isolation of the effect of the intervention on patients' outcomes are very important methodological factors that were missing in the selected articles. The above-mentioned methodological flaws raised serious concern regarding the confidence of the reported outcomes. Therefore, based on a methodological standpoint, the drawbacks of the analyzed articles make the information inconclusive and limited. However, the reviewed articles opened areas for further research.[21,22,26]

OMERACT Assessment and Recommendations for Future Research

The application of OMERACT principles is an area of work that needs to be seriously considered to establish appropriate clinical outcome measures for head and neck cancer care. In the OMERACT process, an outcome measure is endorsed when it passes the OMERACT filter, which has three criteria: truth, validity, and feasibility. Each criterion represents a question to be answered for the use of the measure in its intended setting on a yes or no basis. Clinical outcome measures approved by OMERACT are suggested for use in Cochrane Systematic Reviews.[19]

Based on the OMERACT assessment, major limitations were identified. Detected limitations and some suggestions for future research are as follows:

1. Ideally, a randomized, controlled trial would be the best approach because the sample size is large enough to be clinically meaningful; individuals are randomly allocated to treatment and follow a standardized protocol. However, it is acknowledged that randomization in the area of surgical care of cancer is unethical.[11,37]

2. TMJ and facial pain were reported based on dichotomous yes or no answers and sometimes compared to the pain before treatment. For valid and reliable pain measurement, a numerical scale such as the pain visual analogue scale (VAS) can be applied. An advantage of the pain VAS is its ease of scoring and strong validity and reliability across patient groups.[38,39]
3. Muscle soreness was also evaluated based on patient self-reporting. More objective, valid, and reliable measurement of the muscle soreness can be conducted using algometry.[40,41]
4. TMJ lateral and protrusive movements can be simply measured in millimetres to achieve a valid and reliable evaluation. Limited mandibular movement subjective assessment is clearly biased.
5. Subjective evaluation alone for speech and swallowing is inadequate. Swallowing function assessment via modified barium swallows, diet history, weight, and the use of a gastrostomy tube leads to the most valid and reliable outcome.[37] Speech intelligibility assessment does not provide a complete indication of the social impact of the reconstructive surgery. An interactional model that includes the impact of speech perception should be considered.[42]
6. Subjective reporting of the cosmetic appearance and scar formation by the patients can be overstated or sometimes understated. A universal standardized assessment tool is necessary to avoid any bias and increase the outcome validity and reliability. Two validated objective scar assessment scales have been reported to be employed in observational studies[37]: (1) the Vancouver Scar Scale (VSS)[43] and (2) the Patient and Observer Scar Assessment Scale (POSAS).[44]
7. Intra- and/or interrater reliability of the examiners performing outcomes measures should always be reported in primary research to determine the accuracy of the results.
8. Using standard and valid functional assessment tools to measure TMJ functional ability, such as the RDC/TMD and Jaw Function Disability Scale, would lead to a better understanding of functional outcomes after head and neck cancer treatment.[45–47]

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Conclusions

Based on the limited available evidence for this systematic review and a high risk of bias of the analyzed articles, no firm conclusions can be established regarding the effects of transmandibular surgery on morphologic and functional changes in the TMJ and stomatognathic system.

The results of this systematic review demonstrate the need for well-designed prospective research evaluating oral function associated with transmandibular surgery in cancer treatment. There is a need to establish clinical outcome measures that are valid, reliable, and feasible. The application of the OMERACT principles to clinical outcomes measures in head and neck care was considered valuable for the future.

Using magnetic resonance imaging and/or computed tomography in addition to clinically meaningful outcomes with recognized psychometric properties is suggested to objectively identify these changes after transmandibular surgery.

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