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Comparison between magnetic resonance and computed tomography in detecting mandibular invasion in oral cancer: A systematic review and diagnostic meta-analysis
MRI x CT in mandibular invasion

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ABSTRACT

Background: Suspicion of mandibular invasion directly influences perioperative strategy, requiring marginal or segmental mandibulectomy, or reconstruction in some cases. This has a considerable impact on outcome and quality of life. The aim of this study was to evaluate the accuracy of magnetic resonance and computed tomography in the prediction of mandibular invasion in patients with oral cavity cancer.
Method: A systematic review was conducted, including diagnostic studies comparing magnetic resonance imaging with computed tomography in the prediction of bone invasion. Sensitivity, specificity, positive and negative likelihood values and summary receiver operating characteristic (sROC) curves were calculated.
Results: The electronic and manual search identified 346 articles. Of these, 11 studies were included in the systematic review for a total of 477 patients. The sensitivity, specificity, and positive and negative likelihood values for MRI were 78%, 86%, 5.29 and 0.23, respectively. For CT, they were 76%, 89%, 6.00 and 0.28, respectively. The sROC curves for MRI and CT were 82.3% and 82.5%, respectively.
Conclusion: No superiority was observed between the diagnostic methods regarding mandibular invasion detection.

Introduction

Oral cavity cancer is characterized as an aggressive tumor with a high rate of locoregional spread and initial presentation at advanced stage in the majority of cases, particularly in developing countries [1,2]. Mandibular erosion, extension to posterior soft tissue and perineural invasion have an impact on treatment and prognosis in oral cancer. Information from imaging helps with accurate staging, assessment of resectability and aids in planning multimodal treatment [3].

Management is influenced by mandibular status. Thus, the approach can vary from marginal mandibulectomy (with preservation of function and esthetics) to segmental mandibulectomy. Clinical examination alone is insufficient to predict bone invasion. Cortical, marrow and inferior alveolar canal invasion should be detected by imaging methods such as computed tomography (CT) or magnetic resonance imaging (MRI). Furthermore, the depth and length of erosion, the height of the intact mandible at the site of bone spread and the height of the mandible free of disease are important aspects to be evaluated [3].

The objective of this study was to evaluate the accuracy of magnetic resonance and computed tomography for predicting mandibular invasion in patients with oral cavity cancer.

Methods

Selection criteria

All comparative diagnostic studies that evaluated the accuracy of MRI and CT in patients with oral cancer under suspicion of mandibular invasion were selected. The selection of articles was based on their titles and abstracts. When it was not possible to identify if the study should be included, the complete text was evaluated in detail.

We considered studies that included patients with oral cancer, regardless of the histopathological diagnosis, who presented with suspicion of mandibular bone spread during physical examination.

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The interventions analyzed for evaluating the mandibular invasion were MRI and CT. Initially, there were no restrictions regarding the description of each technology or the employment of contrast.

The histopathological report with description of mandible bone invasion was considered the gold standard.

We excluded studies that evaluated only one diagnostic method, those in which the methods were not compared with the gold standard, those that considered patients without diagnosis of malignancy and those whose data were insufficient for calculating the diagnostic tests.

Identification and selection of the studies

A wide strategy of literature survey was employed in order to perform the systematic review of the available evidence. It included research from the following databases: Medline (through PubMed) and Lilacs up to October 2017.

The survey terms were as follows: (mouth neoplasms OR oral cavity carcinoma OR oral cancer OR head and neck neoplasms) AND (mandible OR mandibular invasion OR bone invasion) AND (tomography) AND (magnetic resonance imaging).

References from the articles selected were also evaluated, in order to select studies not covered by the electronic survey.

Evidence level and methodological quality

The quality of the selected primary studies was analyzed in detail in order to evaluate their evidence strength and the validation of their inclusion in our paper. We employed the criteria of the recommendations QUADAS-2 (Quality Assessment of Studies of Diagnostic Accuracy) [4]. This tool is structured in four key domains, representing the main sources of biases related to (1) patient selection, (2) index test, (3) reference standard, and (4) flow and timing.

Statistical analysis

For all primary studies, the following data were extracted: true-positive (TP), true-negative (TN), false positive (FP) and false negative (FN). The following were also calculated: sensitivity, specificity, negative likelihood ratio (LR−), positive likelihood ratio (LR+), accuracy and diagnostic *Odds Ratio* (dOR), using the bivariate random effect regression model and adopting the confidence interval of 95% ($CI_{95\%}$) as significant. The ROC (Receiver Operator Characteristic) curve was built, and the area under the curve (AUC) was calculated.

Inconsistency among the primary studies was quantified according to the I [2] test. Meta-regression was performed in order to explore the heterogeneity source among the studies. Meta-disc 1.4 software was used for the statistical analyses.

Results

The electronic and manual surveys resulted in 358 studies. After evaluating their titles and abstracts, 340 studies were excluded, since they clearly did not meet the inclusion criteria. Eighteen studies that potentially fitted the inclusion criteria were selected for reading of the complete text. After this stage, seven papers were excluded because two papers included patients with tumors in other primary sites, three papers did not evaluate both tests, one paper included patients who did not undergo both tests, and one used cone beam tomography. Thus, the results of this review were based on data from 11 primary studies [5,7–16] with a total of 477 patients (Fig. 1).

Characteristics of the studies included

The moderate/high risk of bias related to patients' selection was mainly the consequence of the lack of explicit description of the inclusion and exclusion criteria and also due to the exclusion of patients who presented conditions that could interfere with the evaluation of the radiological images. Regarding the index test, the risk of bias was due to the absence of an explicit description of the evaluators' blindness in relation to the result of the gold standard test. Considering flow and timing, there was no interval description of the time between the staging establishment and the surgery in most of the studies, and in some cases, this interval was considered inadequate to some patients. The applicability of the test was considered good in almost all domains. The methodological evaluation of the primary studies is summarized in Table 1.

Results of the diagnostic tests

Univariate meta-regression was used for evaluating the potential sources of heterogeneity. It was based on the period of study (before or after 2000), the study design (retrospective or prospective), the incidence of mandible invasion (< 50% or ≥50%) and the evaluator's blindness in the index tests (yes or no). Significant heterogeneity was not observed (Table 2).

The meta-analysis shows that CT presented sensitivity = 76% ($CI_{95\%}$ 70–82%), specificity = 89% ($CI_{95\%}$ 84–92%), LR+ = 6.00 ($CI_{95\%}$ 2.95–12.20) and LR− = 0.28 ($CI_{95\%}$ 0.17–0.47), whereas MRI presented sensitivity = 78% ($CI_{95\%}$ 72–84%), specificity = 86% ($CI_{95\%}$ 82–90%), LR+ = 5.29 ($CI_{95\%}$ 3.09–9.03) and LR− = 0.23 ($CI_{95\%}$ 0.12–0.42) (Figs. 2 and 3, respectively).

The analysis of accuracy demonstrated that the area under the ROC curve was 82.5% ($CI_{95\%}$: 78.5–86.5%) for CT and 82.3% ($CI_{95\%}$: 78.3–86.4%) for MRI. The curves are practically superimposable, and no superiority was observed between both diagnostic methods regarding mandible invasion detection (Fig. 4). Moreover, there was no difference in dOR at the detection of bone invasion regarding both methods (dOR = 33.4; $CI_{95\%}$ 11.0–101.11 for CT and dOR = 37.3; $CI_{95\%}$ 16.1–86.2).

Discussion

The mandible includes the mandibular alveolar ridge, the lower buccal sulcus, the sublingual sulcus and the retromolar trigone. Tumors of the mandibular region are often correlated to poor prognosis and particularly to a high rate of local failure. This is attributed to frequent invasion of the mandibular bone (12–25%), even at an early stage [5].

Preoperative evaluation of mandibular involvement represents the mainstay of correct therapeutic planning. Various imaging techniques are used for evaluation of bone infiltration; however, each method has its limitations, with a consequent lack of certainty in the diagnosis [5].

Clinical examination has a high sensitivity (82.6%) owing to suggestive but non-pathognomonic signs. Thus, it should be considered a necessary step; however, since it has a relatively low specificity and efficiency (44% and 62%, respectively), it is just preliminary to additional investigation [5].

Bone invasion in the edentulous jaw usually occurs in the atrophic alveolar ridge, which lies in close proximity to the inferior alveolar canal. In dentulous patients, invasion occurs less frequently because the tooth sockets are the main entrance for tumor into the mandible. Extension of tumor inside the mandibular region occurs first through perineural invasion and less commonly through direct growth into the cancellous bone [6].

The final decision regarding the extent of resection is performed in the intraoperative period. In spite of this, preoperative planning for a marginal or a segmental mandibulectomy is impotant [7]. To evaluate tumor spread into the mandibular region, imaging methods may play an important role. Panoramic X-rays, CT, MRI or bone scintigraphy can be used for this purpose [6]. CT and MRI scans are modalities that are routinely used for preoperative staging of oral cancer. Nevertheless, there is some controversy regarding the significance and domain of those two methods for establishing clinical stage [8]. In fact, they have