Review

Performance of different imaging techniques in the diagnosis of head and neck cancer mandibular invasion: A systematic review and meta-analysis

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ARTICLE INFO

ABSTRACT

Background: To assess diagnostic efficacy of imaging techniques for mandibular invasion by head and neck cancer.
Methods: Thirteen databases were searched. Study inclusion, data-extraction and quality assessment were performed independently. STATA 14.0 were mainly used for meta-analysis.
Results: Forty-nine studies were included. For mandibular invasion (cortex and marrow), CBCT, SPECT, CT, MRI, orthopantomography, PET-CT and bone-scintigraphy showed pooled sensitivities of 90%, 97%, 73%, 88%, 75%, 90%, 92%, specificities of 85%, 69% 91%, 90%, 83%, 89%, 79%, AUC of 0.9461, 0.9434, 0.8995, 0.9296, 0.8761, 0.9290, 0.9207, respectively. The combined SROC curves indicated CBCT and SPECT were superior to other techniques. For mandibular medullary invasion (marrow), CT and MRI showed pooled sensitivities of 85% and 93%, specificities of 86% and 84%.
Conclusions: CBCT was top-priority choice for bone invasion diagnosis. SPECT was recommended for exclusion, CT and MRI were suitable for conformation. Further investigations are needed for mandibular medullary involvement.

Introduction

Head and neck cancer is one of the most prevalent malignancies in humans and has an incidence of 4% in males [1]. It has a tendency to invade the mandible because of the anatomical relationships [2]. In clinical practice, the mandibular invasion by head and neck cancer is associated with poor prognosis and has a strong influence on the surgery plan including marginal and segmental mandibulectomy, which inevitably induces cosmetic and functional problems [3,4]. All surgeons must have a sufficient understanding regarding tumor depth and extension, therefore, the preoperative diagnosis is of great importance for such patients.

Among all the preoperative evaluation methods, only the imaging techniques can visualize the mandibular condition in details [5]. We

have previously published several articles assessing the efficacy of computed tomography (CT), magnetic resonance imaging (MRI) and emission computed tomography in the diagnosis of mandibular invasion by head and neck cancer and concluded that all of them possess acceptable diagnostic values [6–8]. Up to now, various other imaging modalities have been used for preoperative diagnosis of mandibular invasion, most of them resulting in a high level of diagnostic efficacy, such as orthopantomography (OPG), cone-beam computed tomography (CBCT), positron emission tomography-computed tomography (PET/CT), single photon emission computed cosmography (SPECT) and bone scintigraphy (BS) [9,10]. However, the accuracy of these imaging modalities is inconstant and the evaluation of the best method to choose for such diagnosis remains controversial [11]. Thus, the current meta-analysis was conducted to assess the diagnostic efficacy of all these

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imaging modalities in case of mandibular invasion by head and neck cancer to provide clear clinical evidences to clinicians.

Materials and methods

As regard the protocol used in the present study, the study inclusion, data extraction and risk of bias assessment were performed by two reviewers independently. Any disagreement was solved by discussion.

Inclusion criteria

Any studies that met the following criteria were eligible for this systematic review: (1) Study types: diagnostic test accuracy studies designed as cohort studies; (2) participants: patients diagnosed with oral cancer or head and neck cancer with preoperative biopsy and mandibulectomy during surgery; (3) index tests: all kinds of imaging techniques including CT, MRI, CBCT, OPG, PET-CT, SPECT, BS and US; (4) standard reference: pathological diagnosis; (5) targeting conditions: mandible invasion by the tumor; (6) outcomes: true positive (TP), false positive (FP), false negative (FN), true negative (TN) or other statistical data that could help in the calculation of outcomes such as sensitivity (SEN), specificity (SPE), positive likelihood ratio ($+LR$) and negative likelihood ratio ($-LR$).

Search strategy

To retrieve all the relevant studies, both electronic search and hand-searching were performed in this systematic review. Bibliographic databases search included MEDLINE (via OVID, 1948 to November 1st, 2017), EMBASE (via OVID, 1980 to November 1st, 2017), Cumulative Index for Nursing and Allied Health Literature (via EBSCO, 1980 to November 1st, 2017), Latin American and Caribbean Health Sciences (via BIREME, 1980 to November 1st 2017), Chinese BioMedical Literature Databases (1978 to November 1st, 2017), China National Knowledge Infrastructure (1994 to November 1st, 2017), VIP database (1989 to November 1st, 2017), and Wanfang database (1998 to November 1st, 2017). Grey literatures were also searched, including Science Paper Online (to November 1st, 2017), System for Information on Grey Literature in Europe (OpenSIGLE 1980 to 2005), and the WHO International Clinical Trials Registry Platform (1948 to November 1st, 2017). The search strategy for the above databases was designed according to Cochrane Handbook for Diagnostic Accuracy Reviews, draft version 0.4, with a combination of MeSH terms and free text words. The MeSH terms used were the following: "head and neck neoplasm", "neoplasm invasiveness", "jaw" and "sensitivity and specificity".

We also hand-searched 21 Chinese related journals and the references of the included studies were further searched to find any eligible studies.

Study selection

Two reviewers analyzed the searched records (titles and abstracts) independently. All recognized records were combined and the full text of these studies was obtained for additional screening. The two reviewers read the full text in detail to make a final judgment based on inclusion criteria. Any discrepancies were solved by discussion.

Quality assessment

Two reviewers assessed the risk of bias and applicability of each study independently, and the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) was the tool used for this work. It included four key domains: (1) patient selection, (2) index test, (3) standard reference and (4) flow and timing. Every domain was assessed in terms of risk of bias, with the first three additionally assessed in terms of concerns regarding applicability. Signaling questions were

included to evaluate the risk of bias. According to the QUADAS-2 instructions, two reviewers first read the full QUADAS-2 tool and then tailored it by either adding or omitting signaling questions. As we did in our previous systematic review [7,8], the review-specific guidance that we developed before was used in the present work to judge the risk of bias. All the studies were classified as high, unclear or low risk of bias.

The signaling questions that remained included in QUADAS-2 for the present review are the following:

(1) Patient selection:
   Was a consecutive or random sample of patients enrolled?
   Was a case–control design avoided?
   Did the study avoid inappropriate exclusions?
(2) Index test:
   Were the index test results interpreted without knowledge of the results of the standard reference?
(3) Standard reference:
   Was the standard reference correctly classifying the target condition?
   Were the standard reference results interpreted without knowledge of the results of the index test?
(4) Flow and timing:
   Was an appropriate interval between index tests and reference standard present?
   Did all patients receive a standard reference?
   Were all patients included in the analysis?

Data extraction

We used a pre-prepared data extraction form [7,8] for a diagnostic accuracy of our systematic review, and pilot-tested on 5 of the included studies. The content of the data extraction form included: Eligibility re-evaluation; basic information of each study (authors, title, publication time, and correspondence); characteristics of the participants (age, gender, inclusion criteria, tumor types and location, types of surgery, number of included patients, and follow-up); study location (country, patients source); index test and standard reference (details of different imaging methods and pathological diagnosis, diagnostic criteria, blinding, consistency of the radiologists); study design (types and duration of each study); and outcomes (TP, FP, FN, and TN, or any other statistical data useful for calculation).

Meta-analysis

Studies were pooled under the condition that no significant clinical or methodological heterogeneity were found. We performed meta-regression to detect slight heterogeneities if the number of included studies exceeded 10. The reporting bias was not assessed in view of the current research progress.

Statistical heterogeneity

I^2 test was used to explore statistical heterogeneity. Any statistical heterogeneity was analyzed when $I^2 > 50\%$ or $P < 0.10$, and fixed-effect model was used for meta-analysis. When $I^2 \leq 50\%$, $P \geq 0.10$, the fixed-effect model was used.

Meta-regression

Log diagnostic odds ratio (logDOR) was considered as the dependent variable of meta-regression. Meta-disc 1.4 (the Unit of Clinical Biostatistics team of the Ramo´ny Cajal Hospital, Madrid, Spain) was used in this process with $P < 0.10$ as statistical significance. Any potential heterogeneity that may affect results was considered as a proof for subgroup analysis.