Original Article

Multimodal magnetic resonance imaging for the diagnosis of parotid gland malignancies: systematic review and meta-analysis

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Background: To systematically evaluate the qualitative diagnostic value of multimodal magnetic resonance imaging (MRI) for parotid gland tumors. However, there is still a lot of controversy in this area, and the results of different studies are not consistent. Therefore, it is necessary to use meta method to analyze the significance of multimodal MRI in the diagnosis of parotid gland tumors.

Methods: This study aimed to assess the diagnostic performance of multimodal MRI for parotid gland malignancies. We performed a search in the databases of the Cochrane Library, PubMed, Web of Science, Embase, Chinese BioMedical Literature (CBM). Quality evaluation and data extraction were performed for the included articles, and meta-analysis was performed on the included studies using Stata 15.0 software.

Results: After screening, a total of 5 relevant documents met the standards and were included. The results of analysis showed that the MRI with diffusion-weighted imaging (MRI-DWI) combined sensitivity and specificity were 0.54 (0.22–0.83) and 0.93 (0.79–0.98). The MRI with dynamic contrast-enhanced (MRI-DCE) combined sensitivity and specificity were 0.81 (0.48–0.95) and 0.95 (0.92–0.97). The pooled area under the curve (AUC) of the MRI-DWI was 0.89 (95% CI: 0.86–0.91) and the pooled area under the curve (AUC) of the MRI-DCE was 0.96 (95% CI: 0.94–0.97).

Discussion: The results of meta-analysis showed that multimodal MRI had good sensitivity, specificity and high sensitivity in the diagnosis of parotid gland carcinoma. However, there is high heterogeneity, which needs to be verified by a large number of clinical studies.

Keywords: Parotid gland tumors (PGTs); multimodal magnetic resonance imaging; imaging analysis; systematic review; meta-analysis

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Introduction

The pathological types of parotid gland tumors (PGTs) are complex, and the clinical manifestations lack specificity (1). Some benign tumors are prone to relapse and malignancy, and some low-grade malignant tumors may have similar clinical characteristics to benign tumors. Some low-grade malignancies may have clinical features similar to those of benign tumors. Imaging modalities, such as MRI and computed tomography, can be used to identify the location and size of PGT. Fine needle biopsy is the primary method for identifying tumor types, but its sensitivity in identifying malignant PGT is low (70–80%) (2,3). Therefore, accurate preoperative diagnosis is of great significance to the

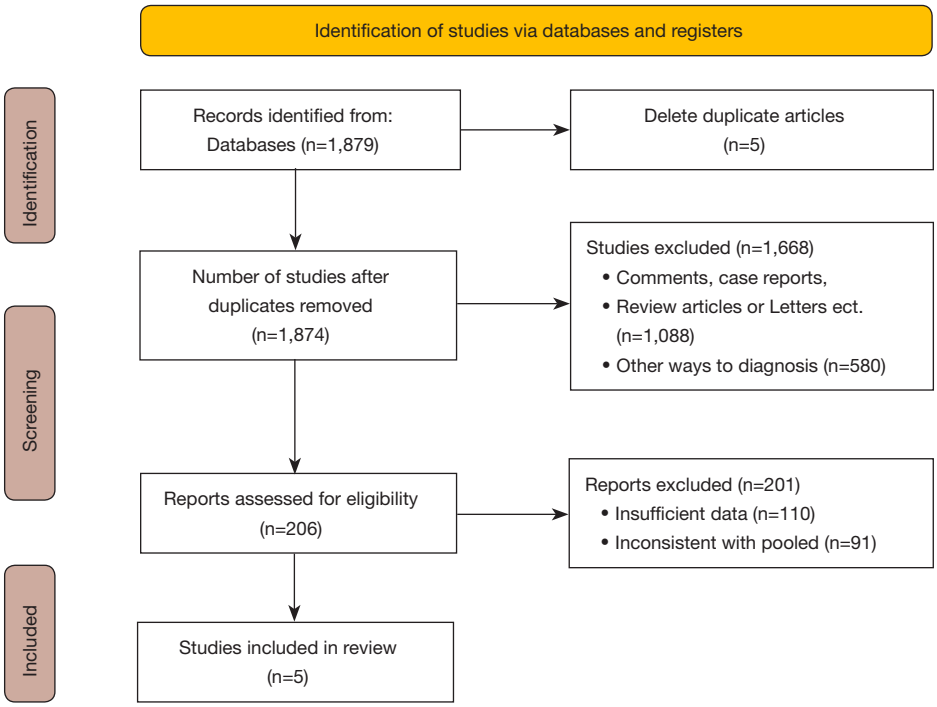

Figure 1 Flow chart of the literature screening.

formulation of a surgical plan (4).

Magnetic resonance imaging (MRI) has good tissue contrast resolution and can clearly display both parotid gland tumor itself and its surrounding tissues (5). At present, MRI has become It is an ideal diagnostic method for parotid gland tumor, including evaluation of tumor scope, local invasion, peripheral nerve diffusion, and distant lymph node metastasis. Apparent diffusion coefficient (ADC) values from diffusion-weighted imaging (DWI) are expected to identify parotid tumors. However, there is still a lot of controversy in this area and the results of different studies are inconsistent. There are large differences in the results, with a sensitivity ranging from 36% to 100% and a specificity ranging from 25% to 97% (6-8). Therefore, it is necessary to use meta method to analyze the significance of MRI multimodal diagnosis in parotid gland tumors. We present the following article based on the PRISMA reporting checklist (available at https://tcr.amegroups.com/article/view/10.21037/tcr-22-695/rc).

Methods

Search strategy

An independent search was conducted by two researchers for all studies comparing the recent outcomes of parotid gland tumors and multimodal MRI published up to 1 October, 2021. The databases searched included the Cochrane Library, PubMed, Web of Science, Embase and Chinese Biomedical Literature (CBM). Additionally, the references of identified articles were manually screened for potentially suitable studies. The search terms included "parotid gland", "tumor", "cancer", "multimodal magnetic resonance imaging", "MRI", "MR", *et al.* Diagnosis of parotid gland tumors by multimodal MRI, and guide the clinical treatment of parotid gland tumors. The flow chart is shown in *Figure 1*.

Inclusion criteria

(I) Included articles had true-positive, false-negative, false-positive, and true-negative data for sensitivity and specificity indicators or indicators for which sensitivity and specificity could be calculated. (II) The age range of enrolled patients was 18-65 years old. (III) Articles published in English were accepted. (IV) Patients without other tumors.

Exclusion criteria

(I) Used animal subjects. (II) Were case reports, review

Table 1 Basic clinical features of the 5 articles included in our study

Author	Year	Country	Group (tumor/control)	Method	Standard
Zhu (9)	2019	China	20/25	MRI-DWI	Operation
Tao (10)	2017	China	47/101	MRI-DWI, MRI-DCE	Operation
Yuan (11)	2016	China	51/156	MRI-DWI, MRI-DCE	Histopathology
Elmokadem (12)	2019	Egypt	16/44	MRI-DWI	Histopathology
Zheng (13)	2018	China	11/34	MRI-DWI, MRI-DCE	Operation

MRI-DWI, MRI with diffusion-weighted imaging; MRI-DCE, MRI with dynamic contrast-enhanced; MRI, magnetic resonance imaging.

articles, commentaries or meeting abstracts. (III) Literature that could not provide valid data for analysis.

Data extraction

All data extraction was completed independently by two evaluators. True positive, false negative, false positive, and true negative values of the ADC were evaluated for the unintentional study. To minimize selection bias, we selected the first reader or method from studies using multiple readers or methods. The first author, publication year, country, tumor/control, method and gold standard were also extracted.

Study quality assessment

Two reviewers independently used the Diagnostic Accuracy Research Quality Assessment Tool (QUADAS-2) to assess the risk of bias for each study. If necessary, the third party will make the final decision. Quality assessment is performed using Stata15 software (The Cochrane Collaboration, London, UK).

Statistical analysis

Diagnostic sensitivity and specificity were calculated using the formulas: sensitivity = true positive/(true positive + false negative); and specificity = true negative/(true negative + false positive). The area under the receiver operating characteristic (ROC) curve was used to evaluate the feasibility of MRI in the diagnosis accuracy of parotid gland tumors. Publication bias was evaluated using Deeks asymmetry funnel plot test, and a P value <0.05 was considered to indicate publication bias. Two-tailed P values of <0.05 were considered statistically significant. All statistical analysis was performed using Stata version 15.0.

Results

Basic characteristics of included studies

In this study, the databases of PubMed, the Cochrane Library, Web of Science, Embase, were searched. Repeated publications and studies were excluded by reading of titles and abstracts. A total of 1,879 relevant articles were retrieved and 5 articles published between 2016 and 2019, involving a total of 505 patients with parotid lesions (including 145 tumor patients and 360 control) (9-13). Different reports of the same clinical study and articles inconsistent with the content of this study were excluded, and references to relevant articles were investigated to prevent literature omission (*Table 1*).

Quality evaluation of the included studies

The 5 included studies (9-13), were of relatively good overall quality (based on QUADAS-2 criteria) in *Figure 2*.

Pooled diagnostic sensitivity and specificity

The MRI-DWI combined sensitivity and specificity were 0.54 (0.22–0.83) and 0.93 (0.79–0.98), respectively, as shown in *Figure 3*. The MRI-DCE combined sensitivity and specificity were 0.81 (0.48–0.95) and 0.95 (0.92–0.97), respectively, as shown in *Figure 4*.

Pooled receiver operating characteristic curves

The pooled area under the curve (AUC) of the MRI-DWI was 0.89 (95% CI: 0.86–0.91) as shown in *Figure 5* and the pooled area under the curve (AUC) of the MRI-DCE was

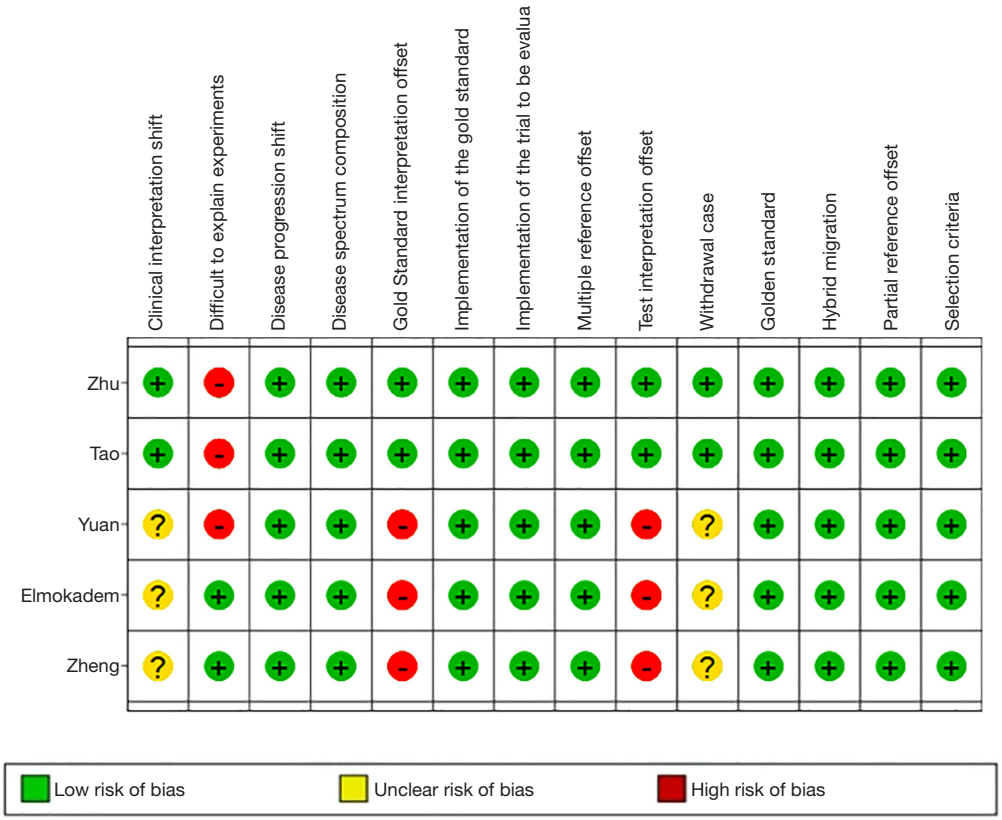

Figure 2 Risk of bias and applicability concerns summary about each domain for each included study. -, low risk of bias; ?, unclear risk of bias; +, high risk of bias.

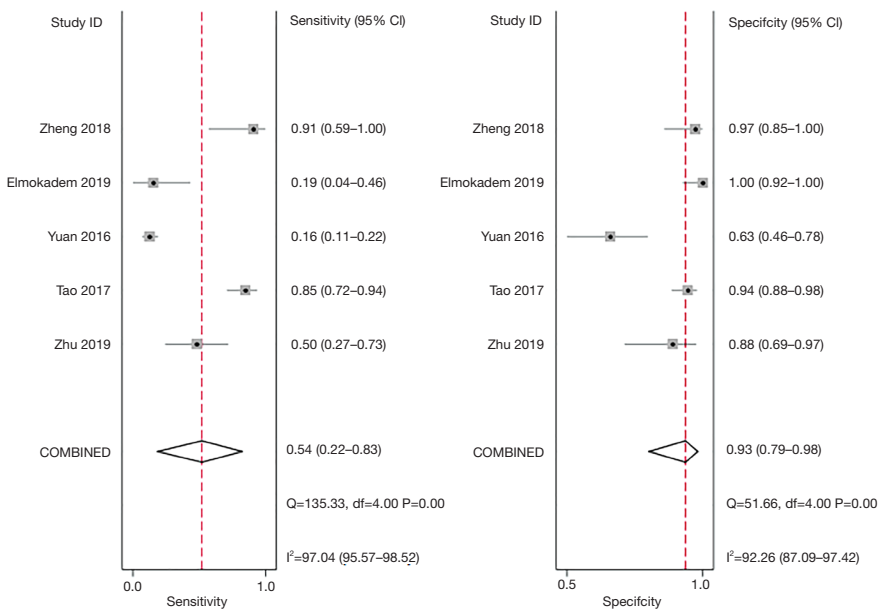

Figure 3 Forest plot: sensitivity and specificity of MRI-DWI. MRI-DWI, MRI with diffusion-weighted imaging; MRI, magnetic resonance imaging.

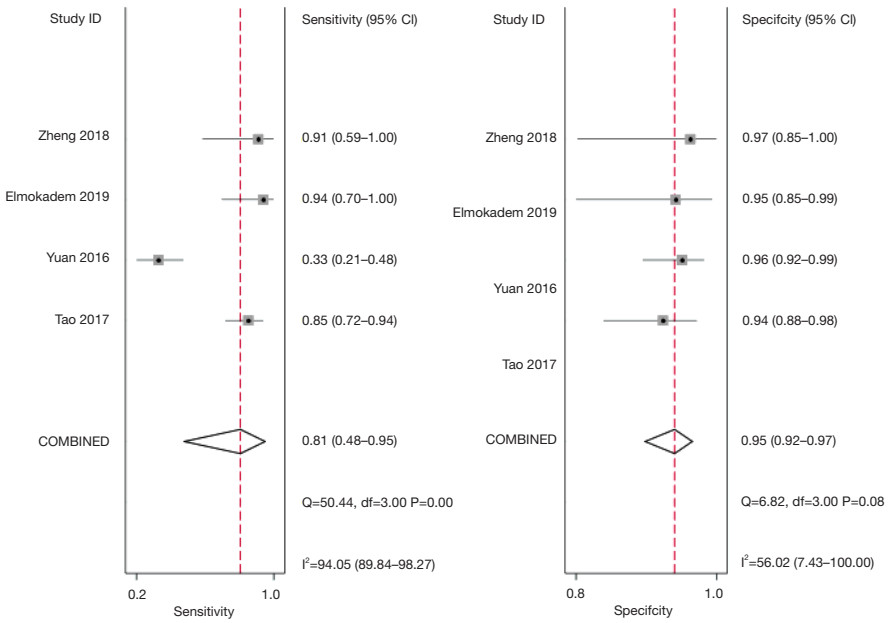

Figure 4 Forest plot: sensitivity and specificity of MRI-DCE. MRI-DCE, MRI with dynamic contrast-enhanced; MRI, magnetic resonance imaging.

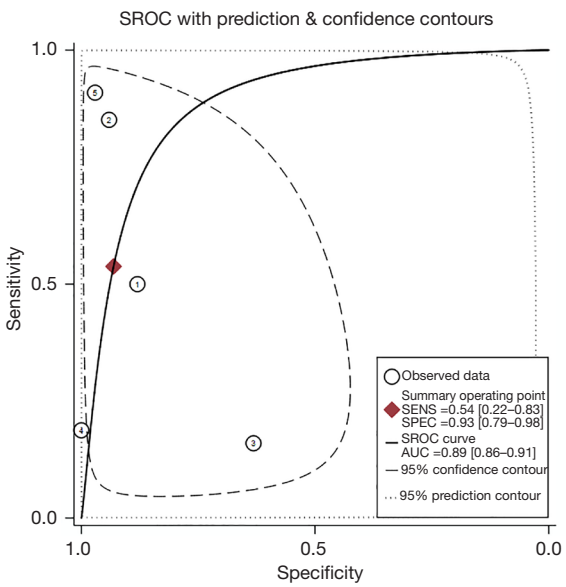

Figure 5 The SROC curve of MRI-DWI diagnosis characteristics. SROC, summary receiver operating characteristic; AUC, area under the curve; MRI-DWI, MRI with diffusion-weighted imaging; MRI, magnetic resonance imaging.

0.96 (95% CI: 0.94–0.97) as shown in *Figure 6*.

Publication analysis

The Deeks' Funnel plot shows that there is no publication bias, and *Figure 7* shows that there is no publication bias in diagnostic studies.

Discussion

Salivary gland neoplasms are relatively rare, accounting for about 5% of all benign and malignant neoplasms, except for those of the skin (13). Among the different anatomical parts of salivary glands, parotid gland tumors have the highest incidence, with various types and complicated pathologic types. In terms of the frequency and location of parotid gland tumors, 80% of salivary gland tumors occur in the parotid gland, 80% are benign, and 80% are located in the superficial lobe. Surgical treatment is the preferred treatment for parotid gland tumors (14). Preoperative diagnosis of benign and malignant parotid

gland tumors is critical to the selection of surgical methods. However, most parotid malignancies have clinical features similar to those of benign tumors, especially in the early stages, where they tend to grow slowly, replace rather than invade adjacent structures, and some malignancies may be mobile (15). Additionally, as a result of tumor cell diffusion and the risk of injury to structures such as the facial nerve, open biopsy is contraindicated in principle for parotid gland tumors. Although fine needle aspiration biopsy (FNA) is less invasive and relatively simple to perform, it carries the risk of tumor cell implantation, and the accuracy of FNA for small or deep tumors is controversial (16).

Therefore, multimodal MRI plays an important role in the preoperative differential diagnosis of parotid gland tumors. Clinicians should include specific diagnostic indicators, and high-accuracy and practical prediction models for benign and malignant diagnosis of parotid gland tumors (17).

At present, there is still a lack of unified guidelines for the assessment of benign and malignant parotid tumors before surgery. Most clinicians can diagnose them solely on personal clinical experience (18). This is more subjective and uncertain in empirical medicine, which may cause misdiagnosis and affect the treatment and prognosis of patients. Therefore, the mathematical prediction model of benign and malignant parotid tumors is being paid increasing attention by clinicians. It involves evidence-based medicine based on empirical medicine and is a new development and new form of clinical research. This prediction model can objectively and accurately judge the nature of parotid tumors (19-21).

The parotid gland is rich in saliva and adipose tissue, and is surrounded by a dense parotid masseter fascia, which is in sharp contrast to the surrounding muscle and bone tissue, enabling multimodal MRI to determine the location of the parotid gland tumor, morphology, boundary, and its relationship to adjacent important blood vessels. Due to its ability to produce MRI scans quickly, with high tissue

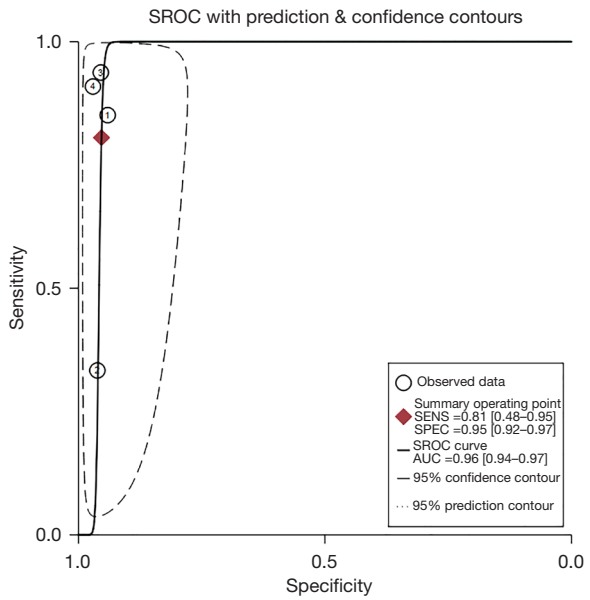

Figure 6 The SROC curve of MRI-DCE diagnosis characteristics. SROC, summary receiver operating characteristic; AUC, area under the curve; MRI-DCE, MRI with dynamic contrast-enhanced; MRI, magnetic resonance imaging.

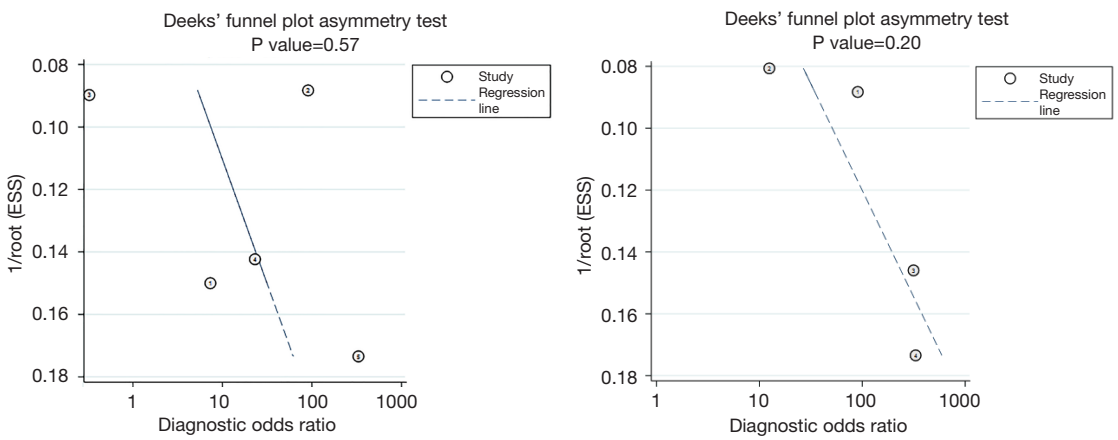

Figure 7 Deeks' funnel plot asymmetry test. ESS: effect sizes.

and spatial resolution, multimodal preoperative MRI has gradually become the preferred means of assessing parotid gland tumor patients. There have been many studies on the analysis of benign and malignant parotid tumors by using multimodal MRI, but we did not locate any previous complete systematic evaluation of benign and malignant parotid tumors combined with multimodal MRI (22).

The systematic evaluation and meta-analysis had some limitations: (I) the inclusion of grey literature was not sufficient; (II) the random effects model was used for meta-analysis of some experimental results, without sensitivity analysis, thus reducing the reliability of the conclusions. There was statistical heterogeneity among the studies, which may be mainly attributed to the varying severity of the disease. In view of the clinical homogeneity of the included study, the random effects model was used for analysis. As the intervention measures and observation indicators of the articles included in this evaluation were different, all of them were low-quality studies, and all of them failed to describe the blind method and allocation hiding method in detail, sensitivity analysis was not performed; (III) the quality of the included literature was not high, a multi-center study had not been implemented, the efficacy indicators were not unified, and the follow-up data were not available, among other detracting features, which will have had a certain impact on the authenticity of the research conclusions.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://tcr.amegroups.com/article/view/10.21037/tcr-22-695/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tcr.amegroups.com/article/view/10.21037/tcr-22-695/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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