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EVALUATE SPECIFICITY AND SENSITIVITY OF CONE BEAM COMPUTED TOMOGRAPHY IN MAXILLOFACIAL SURGERY: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract

Background and aim: in the present study, an attempt was made to determine the diagnostic accuracy of physical examination findings compared to imaging methods for the diagnosis of midfacial and mandibular fractures by consensus of the results and comparison with meta-analyses.

Method: In present systematic review and meta-analysis, information about midfacial and mandibular fractures in all articles published until the end of July 2023 through searching in databases PubMed, Scopus, Science Direct, ISI, Web of Knowledge, Elsevier, Wiley, and Embase and Google Scholar search engine were extracted using keywords and their combinations by two trained researchers independently. Data analysis was done using the fixed effects model in meta-analysis, by STATA (version 17); P-value less than 0.05 was considered significant.

Result: A total of six studies were included in the meta-analysis process. Sensitivity and specificity of physical examination compared to CBCT to diagnosis tooth mobility or avulsion was 14.63% (ES: 95% CI, 14.26% to 15.01%) and 97.47% (ES: 95% CI, 97.10%% to 97.84%), respectively. Sensitivity and specificity of physical examination compared to CBCT to diagnosis malocclusion was 21.58% (ES: 95% CI, 21.32% to 21.84%) and 95.02% (ES: 95% CI, 94.76%% to 95.26%), respectively.

Conclusion: Physical examination findings are not diagnostically accurate of tooth mobility or avulsion and malocclusion and require CBCT.

Keywords: Cone Beam Computed Tomography, Maxillofacial Surgery, Diagnostic accuracy, Maxillofacial fractures, Computed tomography

Introduction

Midfacial trauma is one of the important factors of going to the emergency room(1). Statistical reports show that the epidemiology of midfacial fractures varies depending on the living environment, society and culture of the people(2). Factors such as sports, daily life activities, car accidents, fighting can cause midfacial fractures(3). Studies show different degrees of severity of midface fractures. The anatomy of the midface is known for its complexity(4). Physical examinations are performed to check the severity and identify the location of the fracture(5). However, the fractures of this location are very variable, and accurate identification of fractures such as frontal sinus, maxillary sinus, nasal bone, nasoorbitoethmoid complex, Le Fort type I, II, III and maxillary alveolar tooth complex fractures with physical examination is very complex(6, 7). Therefore, in addition to the findings of the physical examination, other methods such as radiological imaging should be used to properly understand the fracture patterns(8). However, the effective dose of CT and CBCT can be significantly different depending on several factors such as system type, scan range, patient size and scan protocol parameters(9). Therefore, the use of physical examinations to diagnose fractures is commonly used(9). If a physical examination is performed first and then the patients are classified based on the type of midface fractures, the patients who need radiological imaging will be determined and the referral of patients to unnecessary imaging will be avoided; This method also reduces health care costs and exposure to ionizing radiation. Therefore, teaching oral and maxillofacial surgeons physical examination to evaluate maxillofacial trauma patients can lead to early diagnostic management and patients can be correctly diagnosed and treated. Considering the importance of the study and the lack of comprehensive studies in this field, in the present study, an attempt was made to determine the diagnostic accuracy of physical examination findings compared to imaging methods for the diagnosis of midfacial and mandibular fractures by consensus of the results and comparison with meta-analyses.

Method

Search strategy

In present study, in order to obtain scientific documents and evidence related to diagnosis maxillofacial surgery, articles published in international databases such as PubMed, Web of Science, Scopus, Science Direct, Web of Knowledge, EBSCO, Wiley, ISI, Elsevier, Embase and Google Scholar search engine were used. The search process until July 2023 in PubMed database was done using MeSH keywords: ("Fractures, Bone"[Mesh]) AND ("Oral and Maxillofacial Surgeons"[Mesh] OR "Maxillofacial Injuries"[Mesh] OR "Oral Surgical Procedures"[Mesh] OR "Surgery, Oral"[Mesh] OR "Orthognathic Surgery"[Mesh])) AND ("Maxillofacial Injuries/classification"[Mesh] OR "Maxillofacial Injuries/complications"[Mesh] OR "Maxillofacial Injuries/diagnosis"[Mesh] OR "Maxillofacial Injuries/diagnostic imaging"[Mesh] OR "Maxillofacial Injuries/etiology"[Mesh] OR "Maxillofacial Injuries/statistics and numerical data"[Mesh] OR "Maxillofacial Injuries/surgery"[Mesh] OR "Maxillofacial Injuries/therapy"[Mesh])) AND "Cone-Beam Computed Tomography"[Mesh]) AND "Tomography, X-Ray Computed"[Mesh]) AND "Sensitivity and Specificity"[Mesh]. In addition, the reference list of the obtained articles was checked to identify the used articles that were not obtained using the above methods. Databases were searched with high sensitivity. To avoid bias, the search was done by two researchers independently.

Study selection criteria

Inclusion criteria

use of the PICOS (patient/population, intervention, comparison, outcome, and study design) strategy to construct the research question is specified in Table 1; age of patients with midfacial trauma ≥18 years, studies that reported midfacial fractures, studies that reported sensitivity and specificity. studies with incomplete results; in-vitro, in-vivo, animal studies, case reports (The number of patients less than 10) and review articles were excluded.

Table1. PICO strategy.

PICO strategy	Description
P	Population: patients with Midfacial or mandibular fractures
I	Intervention: physical examination
C	Comparison: CBCT and CT
O	Outcome: Diagnostic accuracy
S	Study design: Clinical, randomized controlled trials, cohort studies, Case control, Case report

Data collection

a checklist was designed based on the objectives, and information from the selected articles was entered into the checklist (Table 2).

Risk assessment

Cochrane Collaboration tool to assess risk of bias for randomized controlled trials. Bias is assessed as a judgment (high, low, or unclear)(10). The risk of bias tool covers six domains of bias: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other. The scores of this tool are between 0 and 6, and higher score showed higher quality of study; the scoring of each item is 1 for low risk and 0 for high and unclear risk.

Newcastle-Ottawa Scale (NOS) (11) used to assessed quality of the cohort and cross-sectional studies, case-control and case series studies, This scale measures three dimensions (selection, comparability of cohorts and outcome) with a total of 9 items. In the analysis, any studies with NOS scores of 1-3, 4-6 and 7-9 were defined as low, medium and high quality, respectively.

Data analysis

Meta-analysis was performed using effect size (sensitivity and specificity) with 95% confidence interval. To estimate the heterogeneity of the studies, the index I^2 (<25%: weak heterogeneity, 25-75%: moderate heterogeneity, and more than 75%: high heterogeneity) was used. The results were combined using the fixed effect model (Inverse–variance method) in meta-analysis. The publication bias was checked by Egger test and Beggs funnel plot and data analysis was done using STATA/MP. v17 software. A p-value of less than 0.05 was considered significant.

Result

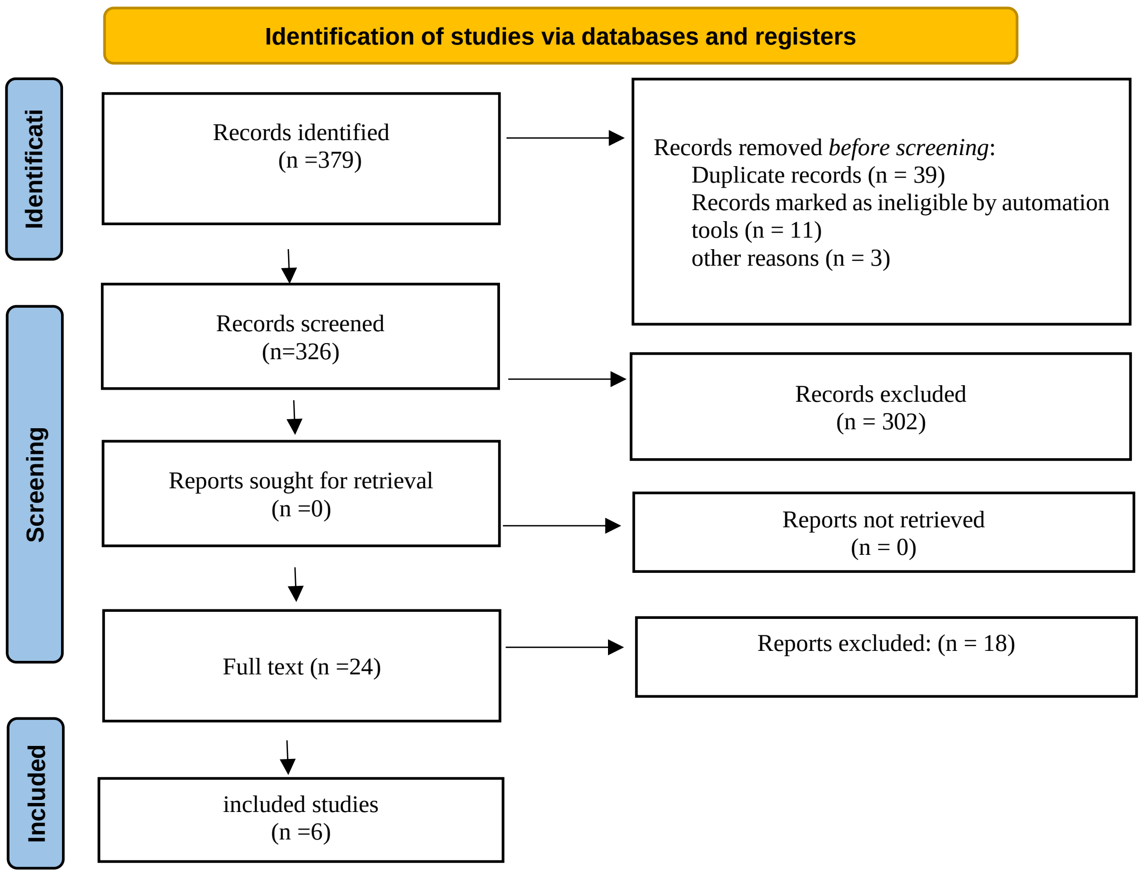

Figure 1. PRISMA 2020 Checklist.

After searching with related keywords, 379 studies were obtained. Endnote.X8 software was used to organize the studies. By using the mentioned software and reviewing the title and abstract of the articles, 39 duplicate studies were eliminated. Then the abstracts of 236 articles were examined by the researchers. 302 studies that did not meet the inclusion criteria or were excluded due to weak or unrelated relevance to the study objective (if after reading the title and abstract, it was not possible to make a decision about the article, the full text was referred to). The full text of 24 articles was carefully reviewed by two independent researchers, and 18 studies were excluded due to the inconsistency of study objectives; Finally, six articles were selected (Figure 1).

Characteristics of patients

4703 patients included in present study. Characteristics and laser parameters reported in Table 2.

Table 2. Characteristics of selected studies.

No.	Study. Years	Study design	Number of Patients	Prevalence of fracture	Mean of age (years)	Fracture outcomes
1	Rozema et al., 2022 (12)	prospective	993	44.3	>18	Midfacial and mandibular fractures
2	Harrington et al., 2018 (13)	retrospective	167	59.3	50	Midfacial and mandibular fractures
3	Huang et al., 2017 (14)	retrospective	1631	13.8	53	Midfacial and mandibular fractures
4	Timashpolksy et al., 2016 (15)	prospective	57	91.2	40	Midfacial and mandibular fractures
5	Sitzman et al., 2015 (16)	retrospective	179	64	31	Midfacial and mandibular fractures
6	Büttner et al., 2014 (17)	retrospective	1676	68	51	Midfacial and mandibular fractures

Diagnostic accuracy of physical examination compared to CBCT

Tooth mobility or avulsion

Sensitivity and specificity of physical examination compared to CBCT to diagnosis tooth mobility or avulsion was 14.63% (ES: 95% CI, 14.26% to 15.01%) and 97.47% (ES: 95% CI, 97.10%% to 97.84%), respectively (Fig.2,3).

Positive and negative predictive value of physical examination compared to CBCT to diagnosis tooth mobility or avulsion was 66.34% (ES: 95% CI, 65.97% to 66.72%) and 66.94% (ES: 95% CI, 66.56%% to 67.31%), respectively (Fig.4,5).

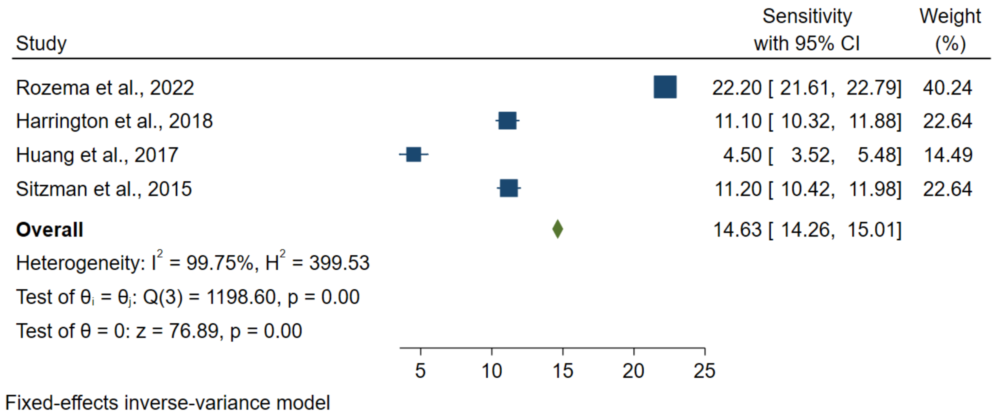

Figure 2. forest plot showed Sensitivity of physical examination compared to CBCT to diagnosis tooth mobility or avulsion

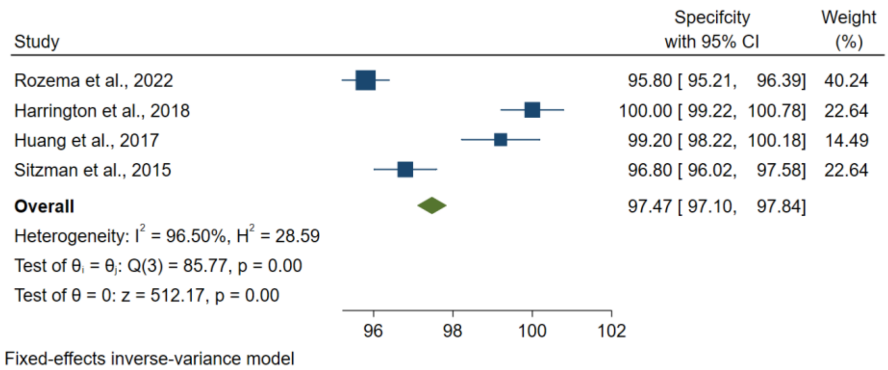

Figure 3. forest plot showed specificity of physical examination compared to CBCT to diagnosis tooth mobility or avulsion

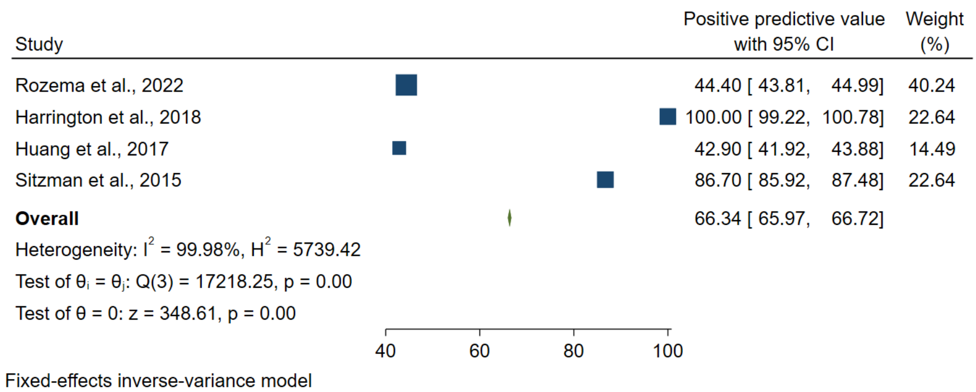

Figure 4. forest plot showed Positive predictive value of physical examination compared to CBCT to diagnosis tooth mobility or avulsion

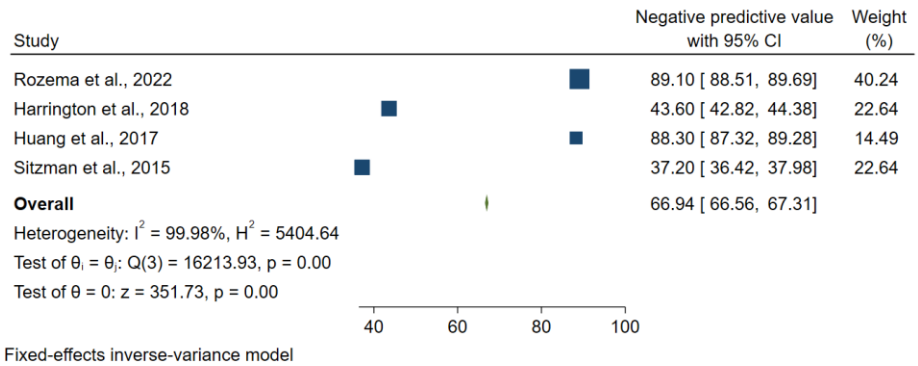

Figure 5. forest plot showed negative predictive value of physical examination compared to CBCT to diagnosis tooth mobility or avulsion

Malocclusion assessment

Sensitivity and specificity of physical examination compared to CBCT to diagnosis malocclusion was 21.58% (ES: 95% CI, 21.32% to 21.84%) and 95.02% (ES: 95% CI, 94.76%% to 95.26%), respectively (Fig.6,7).

Positive and negative predictive value of physical examination compared to CBCT to diagnosis malocclusion was 76.38% (ES: 95% CI, 76.12% to 767.64%) and 55.50% (ES: 95% CI, 55.24%% to 55.76%), respectively (Fig.8,9).

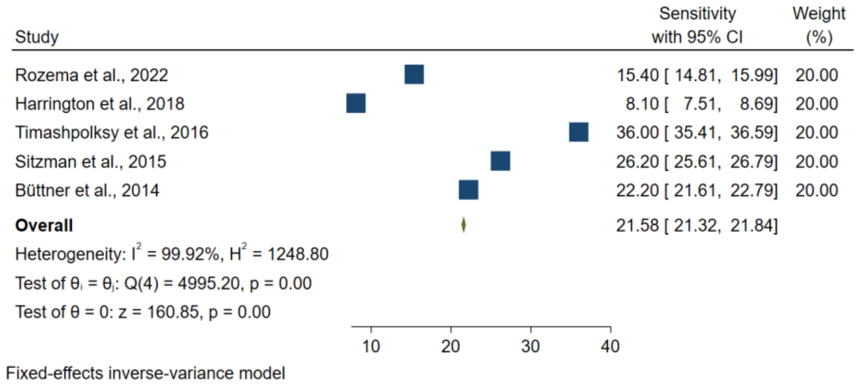

Figure 6. forest plot showed Sensitivity of physical examination compared to CBCT to diagnosis malocclusion

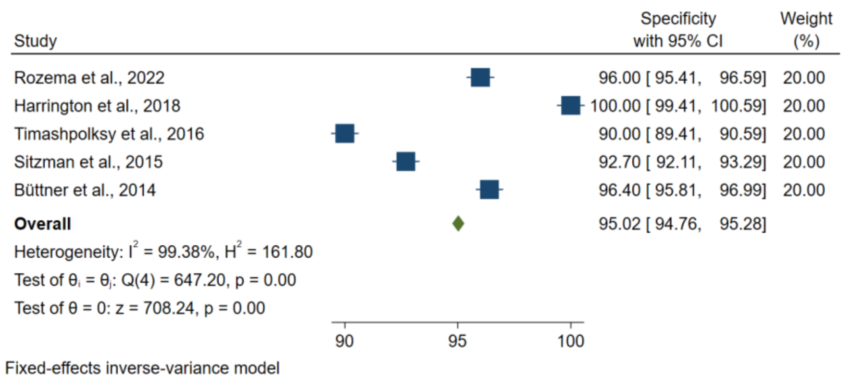

Figure 7. forest plot showed specificity of physical examination compared to CBCT to diagnosis malocclusion

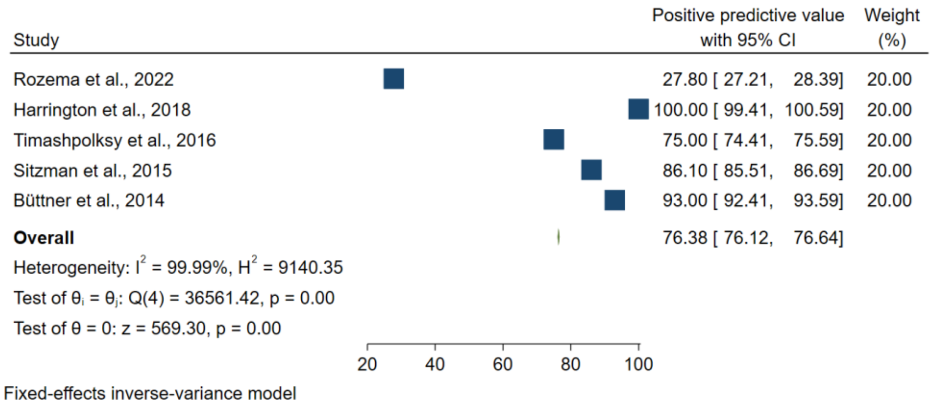

Figure 8. Forest plot showed positive negative predictive value of physical examination compared to CBCT to diagnosis malocclusion

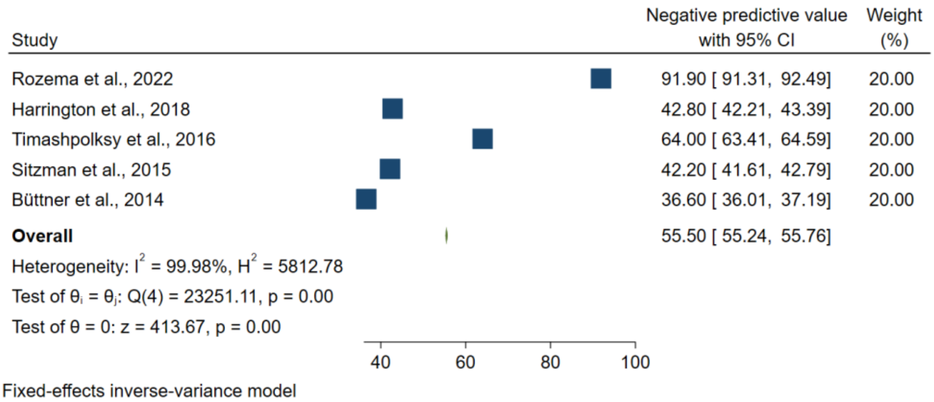

Figure 9. forest plot showed negative predictive value of physical examination compared to CBCT to diagnosis malocclusion

Discussion

The findings of the present study can help maxillofacial surgeons and emergency physicians in correct and optimal diagnosis; Therefore, the present study was conducted with the aim of evaluating specificity and sensitivity of physical examinations compared to Cone Beam Computed Tomography in Maxillofacial Surgery. Based on the present meta-analysis, the diagnostic sensitivity for malocclusion and tooth mobility or avulsion was low, while high specificity was observed. Based on this, there is a possibility of diagnosing a fracture with a physical examination. Also, high PPV was reported based on meta-analysis, so radiological imaging should be considered for these cases. The NPV was also high. Hence, individual findings cannot be identified well and radiological imaging is needed. However, this should be interpreted with caution because of the small number of included studies and the high risk of bias and applicability concerns of most studies.

Studies have published findings consistent with the results of the present study, which show that physical examination has low sensitivity in diagnosis (13, 16, 18). According to the results of CT and CBCT studies they have high diagnostic advantages and it is suggested to use imaging methods in diagnosis(19, 20). CT and CBCT have the major advantage of overcoming the overlapping of structures that inevitably occurs with conventional radiography(19).

In most of the included studies, there was unclear risk of bias for the domains of index test, reference standard, and flow and timing. The present study had limitations, firstly, patient selection and fracture outcomes were not well reported; Second: Geographical and demographic biases were not reported. Third: Few studies were found and more studies need to be done to confirm the evidence.

It is suggested that future studies evaluate the diagnostic accuracy of physical examination findings compared to CBCT, reporting sensitivity and specificity for both. CBCT data should be interpreted by a radiologist and compared with physical findings.

Conclusion

Physical examination findings in clinical decision aids focusing on patients with tooth mobility or avulsion and malocclusion after midfacial or mandibular fractures requiring active treatment are not diagnostically accurate and require CBCT. For appropriate clinical decision making, it is best to use both individual physical examination methods and imaging methods. Few studies have been done in this field, so it is suggested that more studies be done to confirm the evidence.

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