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ORIGINAL

Evaluate specificity and sensitivity of cone beam computed tomography for midfacial fractures: A systematic review and meta-analysis

Evaluar la especificidad y la sensibilidad de la tomografía computarizada de haz cónico para las fracturas del tercio medio facial: una revisión sistemática y un metanálisis

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Abstract

Objectives: The present study aims to evaluate the specificity and sensitivity of cone beam computed tomography compared to physical examination for medial fractures.
Methods: In this study, international databases such as PubMed, Scopus, Science Direct, ISI, Web of Knowledge, and Embase were reviewed to select articles related to the purpose of this study from January 2012 to July 2022. Effect size with 95% confidence interval (CI) with fixed effect modal and inverse-variance done. STATA.V16 software was used for data analysis.
Results: In the initial review, the abstracts of 283 studies were reviewed, two authors reviewed the full text of 32 studies, and finally, eight studies were selected. The sensitivity of the Intra-oral assessment was 17% (ES: 95% CI, -0.34 to 0.74); the subgroup meta-analysis showed Sensitivity to Laceration, and the intraoral assessment was 19% (ES: 95% CI, -1.77 to 2.15); Sensitivity of Tooth avulsion assessment was 9% (ES: 95% CI, -1.04 to 1.22).
Conclusions: Diagnostic sensitivity of individual physical examination was low compared to imaging methods, Based on the findings of the present meta-analysis, which shows that individual physical examination cannot be accurately relied upon to identify intra-oral assessment in mid-face fractures.

Keywords: Cone-Beam Computed Tomography, Sensitivity and Specificity, Tomography, X-Ray Computed.

Resumen

Objetivos: El presente estudio tiene como objetivo evaluar la especificidad y la sensibilidad de la tomografía computarizada de haz cónico en comparación con el examen físico para fracturas mediales.
Métodos: En este estudio se revisaron bases de datos internacionales como PubMed, Scopus, Science Direct, ISI, Web of Knowledge y Embase para seleccionar artículos relacionados con el propósito de este estudio desde enero de 2012 hasta julio de 2022. Tamaño del efecto con 95 % de intervalo de confianza (IC) con modal de efectos fijos y varianza inversa realizada. Para el análisis de datos se utilizó el software STATA.V16.
Resultados: En la revisión inicial, se revisaron los resúmenes de 283 estudios, dos autores revisaron el texto completo de 32 estudios y, finalmente, se seleccionaron ocho estudios. La sensibilidad de la evaluación intraoral fue del 17 % (ES: IC del 95 %, -0,34 a 0,74); el metanálisis del subgrupo mostró Sensibilidad a la laceración y la evaluación intraoral fue del 19 % (ES: IC del 95 %, -1,77 a 2,15); La sensibilidad de la evaluación de la avulsión dental fue del 9 % (ES: IC del 95 %, -1,04 a 1,22).
Conclusiones: la sensibilidad diagnóstica del examen físico individual fue baja en comparación con los métodos de imagen, según los hallazgos del presente metanálisis, que muestra que no se puede confiar con precisión en el examen físico individual para identificar la evaluación intraoral en fracturas de la parte media de la cara.

Palabras clave: tomografía computarizada de haz cónico, sensibilidad y especificidad, tomografía computarizada de rayos X.

Introduction

In the emergency department, most of the referrals are related to traumas, of which mid-facial trauma is one of them that has a high prevalence; According to the available statistics, mid-face fractures can be caused by sports, accidents, daily activities, or fights; Therefore, its prevalence varies according to the geographical region, culture and living environment[1,2]. This type of fracture has different degrees; depending on the type of accident, their severity is different, and the most common one is nose fracture[3]. When a trauma patient enters the emergency room, midface fractures are checked. Middle-face anatomy is complex, so it is important to pay attention to it. This part can be considered similar to a framework that supports and provides functional support for the teeth[4,5]. Studies have reported a wide variety of midface fractures that affect physical examination and are challenging; among these cases, we can refer to fractures of the maxillary alveolar tooth complex, nasal fracture, and frontal sinus[1,6,7]. Identifying fracture patterns is very important because radiological imaging is required for these types of fractures and cannot be detected by physical examination. Among the gold standard methods that have been of great interest in recent decades and are used to diagnose mid-face fractures we can mention cone beam computed tomography (CBCT) and computed tomography (CT)[8-11]. Based on the findings of the studies, the effective dose of both mentioned methods depends on the scan range, system type, and scan protocol parameters[12]; For CBC, a dose of 0.08 to 0.21 mSv is usually considered. The risk of exposure to ionizing radiation is a concern, and there is a need to use less risky methods[12]. If performed with greater accuracy, physical examinations can minimize unnecessary imaging procedures and reduce the risk of exposure to ionizing radiation[13,14]. Therefore, prediction and diagnosis of mid-face trauma using the physical examination method are challenging, and if this method can be done well, it can be considered a good alternative for imaging methods. Considering the importance of the issue and that faster diagnosis by emergency physicians or oral and maxillofacial surgeons can help the patient in treatment, the present study aims to evaluate the specificity and sensitivity of cone beam computed tomography compared to physical examination for medial fractures.

Methods

The present study is a systematic review and meta-analysis based on PRISMA guidelines[15]. In this study, international databases such as PubMed, Scopus, Science Direct, ISI, Web of Knowledge, and Embase were reviewed to select articles related to the purpose of this study from January 2012 to July 2022. Mesh keywords were used for searching in PubMed, and similar keywords were searched in other databases. In the current study, **table I** shows the response to PICO; the Google Scholar search engine was also used.

MeSH terms keywords: ((((((“Wounds and Injuries”[Mesh] OR “injuries” [Subheading]) AND “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].

Table I: PICO strategy.

PICO strategy	Description
P	Population: patients with mid-facial trauma
I	Intervention: physical examination
C	Comparison: CBCT, CT
O	Outcome: Sensitivity and Specificity

Inclusion and exclusion criteria

Randomized controlled clinical trials (RCT) and clinical trial studies, cohort studies, patients with mid-facial trauma, Studies other than RCT and cohorts, other trauma, conflicting data with objective, and studies without full text were excluded from the study.

Reporting and extracting study data

Using a checklist that included the author’s name, year of publication, type of study, number of patients, and the average age of patients, the data of the studies were extracted and reported in **table II**; Also, the data required for meta-analysis including Sensitivity, Specificity, and Diagnostic accuracy were extracted from the studies.

Evaluating the quality of studies

In the current study, randomized control clinical trial studies were included, and the quality of these studies was evaluated using the Cochrane Collaboration’s tool[16]. The scores of this tool are between 0 and 6, and the higher score showed a 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)[17] was used to the 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. Any studies with NOS scores of 1-3, 4-6, and 7-9 were defined as a low, medium, and high quality, respectively.

Table II: Summary of demographic and clinical data of studies selected.

No.	Study. Years	Study design	Number of Patients		Prevalence of fracture	Mean of age (years)
			Male	Female		
1	Sun et al., 2019 (18)	Retrospective	41	6	74.5	40
2	Harrington et al., 2018 (19)	Retrospective	105	62	59.3	50
3	Huang et al., 2017 (20)	Retrospective	918	713	13.8	53
4	Scolozzi et al., 2017 (21)	Retrospective	632	280	77	46
5	Timashpolksy et al., 2016 (22)	Prospective	44	13	91.2	40
6	Sitzman et al., 2015 (23)	Retrospective	132	47	64	31
7	Büttner et al., 2014 (24)	Retrospective	1102	574	68	51
8	Yadav et al., 2012 (25)	Prospective	1544	718	16	38

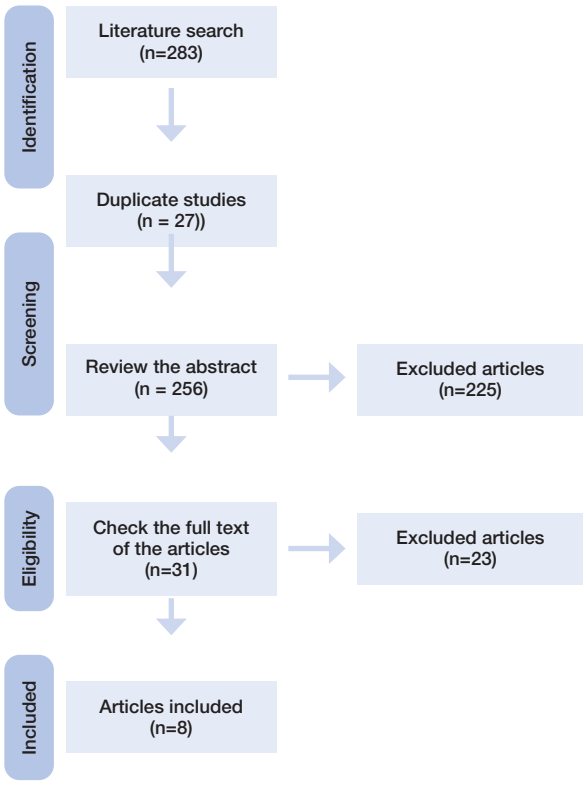
Data analysis

STATA.V16 software was used for data analysis. Estimating Sensitivity and Specificity was done with Effect size with a 95% confidence interval (CI) with a fixed effect modal and inverse-variance method. The level of heterogeneity was evaluated using the I2 index test (I2 < 50% = low levels, 50 < I2 < 75% = moderate and I2 > 75% = high levels).

Result

The search was conducted based on the mentioned keywords, and 283 studies were found in the introduced databases; After entering the studies into the EndNote.x8 software, duplicate studies were removed, and finally, the abstract of 256 studies was reviewed, and the studies that met the inclusion criteria were left out for the full-text review; at this stage, 225 studies were removed. The full text of 31 studies was carefully reviewed, and studies that had incomplete data, very low quality, or did not include the inclusion criteria and matched the exclusion criteria were excluded from the study (23 articles); finally, eight articles were selected, and their data were extracted for meta-analysis (**Figure 1**).

Figure 1: PRISMA flowcharts.



Characteristics

Six retrospective studies and two prospective studies have been included in the present article. The number of male and female patients was 4518 and 2413, respectively; a total of 6931 patients were examined; a summary of the data of the selected studies is reported in **table II**.

Evaluation of diagnostic accuracy of physical examination compared to CBCT and CT

Intra-oral assessment

Sensitivity of Intra-oral assessment was 17% (ES: 95% CI, -0.34 to 0.74) (I2<0%; P=1.00; low heterogeneity). According to **figure 2**, the subgroup meta-analysis showed Sensitivity to Laceration; the intraoral assessment was 19% (ES: 95% CI, -1.77 to 2.15); Sensitivity of Tooth avulsion assessment was 9% (ES: 95% CI, -1.04 to 1.22).

The sensitivity of the Malocclusion assessment was 13% (ES: 95% CI, -1.25 to 1.52). The sensitivity of Functional and palpation assessment was 45% (ES: 95% CI, -1.51 to 2.41). The sensitivity of Facial pain assessment was 18% (ES: 95% CI, -0.70 to 1.06).

Specificity of Intra-oral assessment was 94% (ES: 95% CI, 0.38 to 1.51) (I2<0%; P=1.00; low heterogeneity). According to **figure 3**, the subgroup meta-analysis showed Specificity of Laceration; the intraoral assessment was 95% (ES: 95% CI, -1.01 to 2.91); Specificity of Tooth avulsion assessment was 98% (ES: 95% CI, -0.15 to 2.11). The specificity of the Malocclusion assessment was 97% (ES: 95% CI, -0.42 to 2.36). Specificity of Functional and palpation assessment was 70% (ES: 95% CI, -1.26 to 2.66). The specificity of Facial pain assessment was 95% (ES: 95% CI, -0.07 to 1.83).

Figure 2: The Forest plot showed the Sensitivity of Intra-oral assessment.

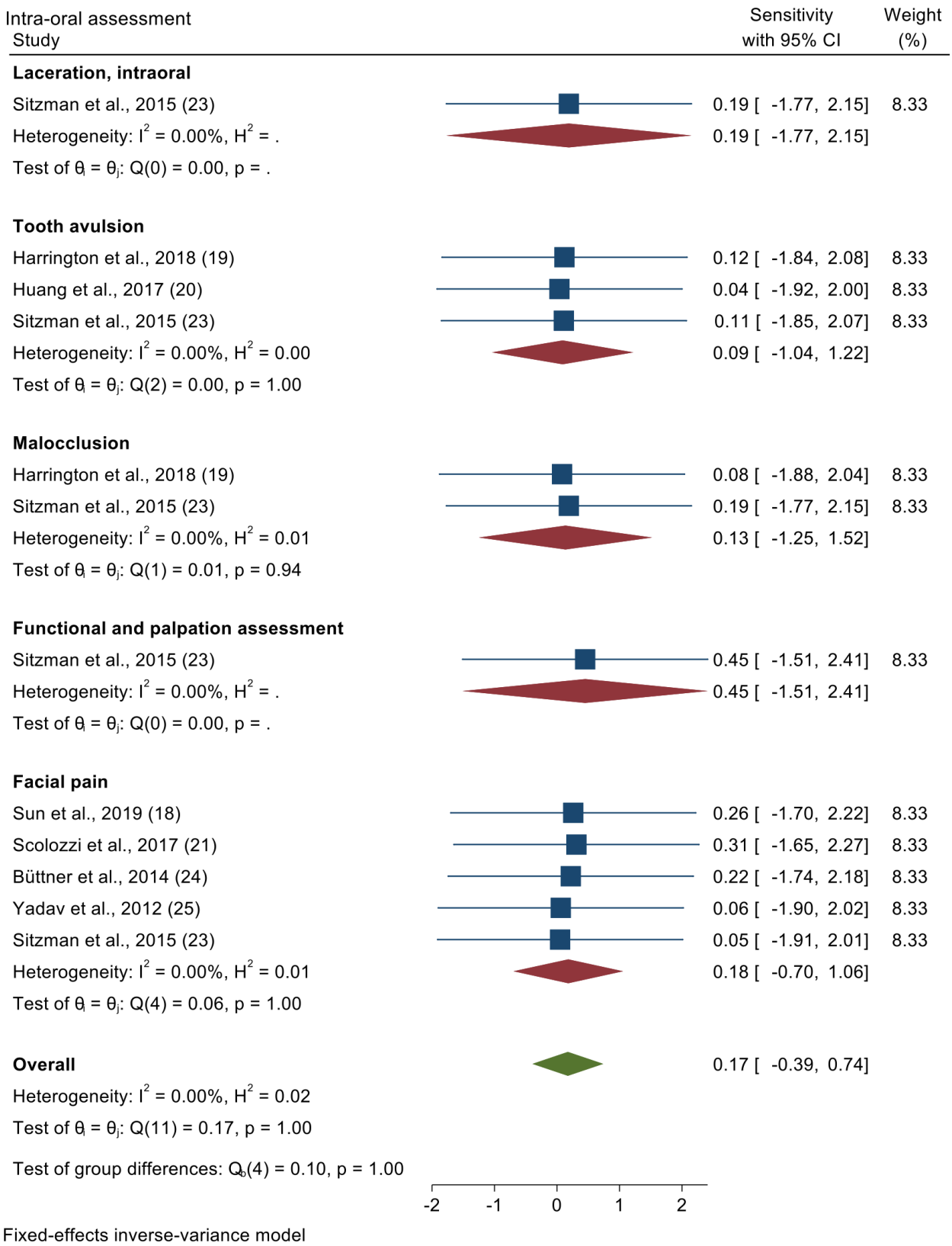
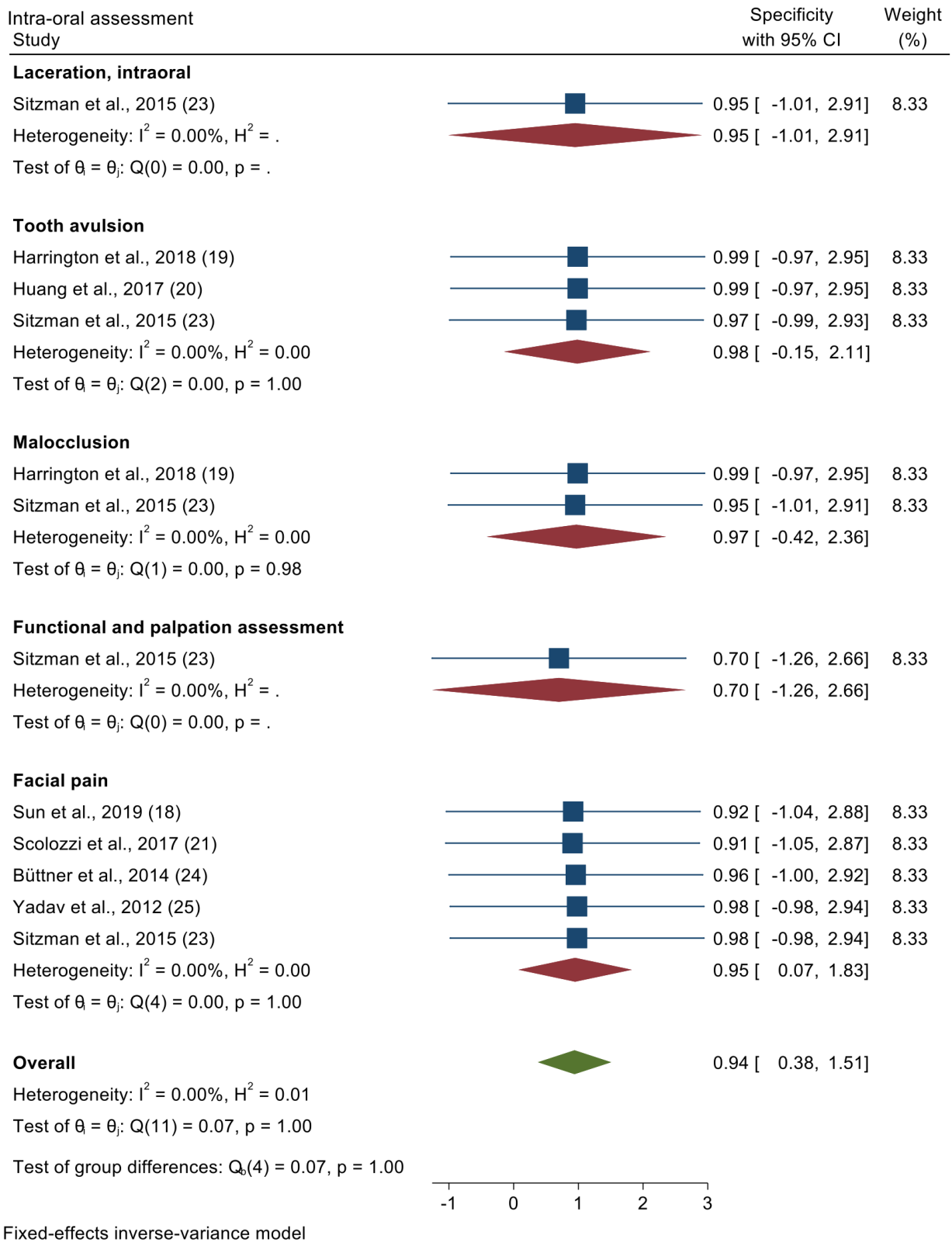


Figure 3: The Forest plot showed the Specificity of Intra-oral assessment.



Discussion

Based on the findings of the present study, comparing the diagnostic sensitivity of physical examination versus imaging methods, the diagnostic sensitivity of intra-oral assessment in mid-face fractures was very low and 17%. Also, by examining the diagnostic feature of physical examination versus imaging methods, the diagnostic sensitivity of intra-oral assessment in mid-face fractures was 94%. Very little heterogeneity was observed between studies, indicating that the findings of the present study provide strong evidence, and high specificity and low sensitivity were reported for the diagnostic accuracy of physical examination related to patient appearance. The studies showed that the diagnostic accuracy for the areas around the mouth, lips, and face using physical examination and CBCT methods is similar to the present findings[23,26,27]. Based on the findings of the studies[19,20,23,27], physical examination can be suitable in diagnosing malocclusion, falling teeth, and intraoral laceration, and its specificity is reported to be around 92 to 98%; in the current study, the specificity was 94%, which is similar to previous findings. Also, the sensitivity in studies has been reported to be around 10 to 21%, which is in line with the findings of the present study.

The findings of the present study conclude that, along with imaging methods, examination through physical examination is suitable for deciding on the treatment of the mid-face fracture. Based on subgroup meta-analysis, it was observed that there is a high diagnostic chance ratio in tooth extraction and malocclusion. In other cases, subgroup meta-analysis showed that physical examination is not a suitable diagnostic method, and it is better to use radiological imaging. Although there was no high heterogeneity between the studies and the findings of the studies were almost close to each other, few studies participated in this meta-analysis, which could be a high risk of bias, and the results should be interpreted with caution. Studies have published findings consistent with the results of the present study, which show that physical examination has low sensitivity in diagnosis[19,21,23]. According to the results of CT and CBCT studies, they have high diagnostic advantages, and it is suggested to use imaging methods in diagnosis[28,29].

It is suggested that future studies be conducted with higher quality and use CBCT as a reference. Also, the interpretation of CT and CBCT results should be done by a radiologist or maxillofacial surgeon to provide stronger evidence. Clinical trial studies were not found to be consistent with the purpose of the present study, and most of the selected studies were retrospective, so it is suggested to conduct prospective multicenter trials. Since the purpose of physical examination is to help speed up clinical decision-making and to minimize the patient's exposure to imaging rays, considering the diagnostic sensitivity of this method, it is suggested that it be used for intra-oral assessment in intermediate fractures if imaging methods are used.

Conclusion

Based on the findings of the present meta-analysis, it was observed that the diagnostic sensitivity of individual physical examination was low compared to imaging methods, which shows that individual physical examination cannot be accurately relied upon to identify intra-oral assessment in mid-face fractures. On the other hand, the high characteristic in the diagnosis of individual physical examination shows that this method is used to distinguish between patients with mid-face fractures and other traumas. Using individual physical examination and imaging methods for appropriate clinical decision-making is better. There were few studies in this field, so it is suggested that more studies be done to confirm the evidence.

Conflict of Interest

The authors declared that there is no conflict of interest.

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