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Objectives: Pediatric oropharyngeal trauma is common. Although most cases resolve uneventfully, there have been reports of internal carotid artery injury leading to devastating neurovascular sequelae. There is significant controversy regarding the utility of CT angiography (CTA) in children with seemingly minor oropharyngeal trauma. The goal of this study was to appraise changes in diagnosis and treatment based on CTA results.

Methods: A comprehensive search of PubMed, Embase, CINAHL, Scopus, the Cochrane Ear, Nose and Throat Disorders Group Trials Register, and the ClinicalTrials.gov database was performed following PRISMA guidelines.

Results: The search yielded 5,078 unique abstracts, of which 8 articles were included. A total of 662 patients were included, with 293 having any CT head/neck imaging, and 255 with CTA. Eleven injuries/abnormalities of the carotid were found on CTAs, comprising edema around the carotid ($n = 8$), potential intimal tear ($n = 1$), carotid spasm ($n = 1$), and carotid compression ($n = 1$). The pooled proportion of imaging findings on CTA that could lead to changes in clinical management was 0.00 (95% CI 0.00–0.43). Angiography was obtained in 10 patients, in 6 cases due to abnormal CTA. Angiography identified 1 patient with vessel spasm and two patients with carotid intima disruption without thrombus. No patient underwent vascular repair or suffered cerebrovascular injury.

Conclusion: Imaging with CTA yielded radiological abnormalities in a few instances. These results do not support the routine use of CTA in screening pediatric oropharyngeal trauma when balanced against the risk of radiation, as it rarely resulted in management changes and was not shown to improve outcomes.

Key Words: CT angiography, oropharyngeal trauma, pediatrics.

Level of Evidence: N/A

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INTRODUCTION

Oropharyngeal trauma in children is common and most cases resolve uneventfully. However, there is significant controversy regarding the utility of imaging in children with seemingly minor oropharyngeal trauma due to the rare, but potentially permanent or fatal neurovascular sequelae that can occur due to injury to the internal carotid artery.[1] Blunt or penetrating oropharyngeal trauma in children typically occurs in young children who fall with an object (e.g., a toothbrush, toy, pen/pencil, straw, or stick) in their mouth.[2] Presentations vary from mild palatal mucosal injuries to severe lacerations, but neither the severity of intraoral injury on physical exam nor the mechanism of injury has been shown to be predictive of the risk of injury to the carotid artery or future neurovascular sequelae.[3] Vascular injury leading to thrombosis, thromboembolism, or vessel wall dissection and subsequent cerebral ischemia and infarction is a rare outcome. However rare, permanent neurologic injury and death have been reported, sometimes after a latent period with no neurological deficit in the hours to days following the initial trauma.[4–8] Internal carotid artery occlusion and cerebral infarction have been reported to occur even beyond 1 week after the initial trauma.[9] Deep space neck infections are also possible with penetrating oropharyngeal injuries.[10,11]

Diagnostic imaging with CT angiography (CTA) has been used to screen for vascular injury at the time of initial presentation. CTA has high sensitivity and specificity for detecting carotid injury but is not an entirely benign diagnostic tool. Some authors have raised concerns regarding pediatric exposure to ionizing radiation and subsequent increased risk of future malignancy, as well as the inability of CTA to definitively rule out vascular injury or the future risk of a propagating thrombus or dissection.[12–17] More invasive diagnostic workup with

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carotid angiography subjects the patient to additional procedural risks, including stroke.

This study aimed to evaluate the utility of diagnostic imaging with CTA in the evaluation of children presenting with oropharyngeal trauma that is not severe enough to be treated similarly to major trauma of neck zone 3, which necessitates more aggressive workup. Clinical guidelines, including the Pediatric Emergency Care Applied Research Network (PECARN) blunt head trauma guidelines,[18] the Canadian Assessment of Tomography for Childhood Head Injury (CATCH) rule,[19] the Children's Head injury ALgorithm for the prediction of Important Clinical Events (CHALICE),[20] and the National Institute of Clinical Excellence (NICE) guidelines[21] for assessment and early management of head injury have been developed to guide clinicians to use CT appropriately in evaluating head trauma. Similarly, the Modified Memphis criteria and the Denver criteria[22–26] have been developed to guide decision-making after blunt cerebrovascular injury (BCVI), but no such guideline exists to direct clinical decision-making for obtaining imaging after pediatric oropharyngeal trauma.

Current recommendations for imaging after oropharyngeal trauma are largely based on expert opinion without a clear understanding of the predictors of neurovascular injury or the current evidence basis for or against obtaining imaging.[1,2] The evidence base in the literature for pediatric oropharyngeal trauma contains multiple accounts of devastating injuries and non-systematic reviews compiling these reports.[3,27,28] In contrast, a number of retrospective series at large centers have reported no neurologic sequelae after oropharyngeal trauma.[29–31] The purpose of this study was to systematically review pediatric patients with oropharyngeal trauma who underwent imaging with CTA compared to those without imaging to determine whether imaging results change management directed towards the identification and management of rare neurovascular sequelae. This will aid decision-making as providers weigh the expected utility of imaging against the risks associated with ionizing radiation. We hypothesized that CTA results would only rarely identify abnormalities that would lead to changes in patient management.

METHODS

A systematic review was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard to evaluate the utility of CTA in the diagnostic workup of pediatric oropharyngeal trauma.[32] Inclusion criteria for the literature search were defined with the PICOS model (population, intervention, control, outcome, study design). Studies were included that assessed pediatric patients (age <18 years) presenting with trauma to the oropharynx who underwent diagnostic assessment with versus without imaging using CTA to evaluate for neurovascular injuries and that reported clinical and/or radiologic outcomes of oropharyngeal trauma. Study designs including meta-analysis, systematic reviews, randomized controlled trials, case–control studies, cohort studies, case series, and case reports were included. Exclusion criteria were the following: non-pediatric patients, non-oropharyngeal trauma, oropharyngeal trauma combined with other severe head injury or multi-system trauma,[22,23,33] not primary research (e.g., editorial, commentary), duplicate articles, and non-English language publication. No restrictions were placed on the length of follow-up time or article publication date. The review methods were established prior to conducting the review, and the protocol was registered on PROSPERO on January 19, 2021 with the following registration number: CRD42021224216.

Information Sources and Search Strategy

A comprehensive search of PubMed, Embase, CINAHL, Scopus, the Cochrane Ear, Nose and Throat Disorders Group Trials Register, and the ClinicalTrials.gov database was performed. The search was performed by a health sciences librarian (K.H.). The search strategy was developed based on variations of keywords including "palate," "oropharynx," "pharynx," "throat," "CT," "computed tomography," "angiography," "trauma," and "injury," as well as related search terms. The search strategy was pilot tested, and the definitive search was performed on January 15, 2021. See Table S1 for full details of the electronic search strategies. The reference lists of included studies were searched to identify any other pertinent studies. References were managed using the RefWorks web-based reference management software package (https://refworks.com/). The search was re-run on March 9, 2022 without language restrictions to identify any new pertinent studies. Unpublished studies were not obtained.

Study Selection

Two reviewers (S.C. and D.C.) independently reviewed the abstracts based on the specified inclusion and exclusion criteria and selected studies for full-text review. The abstract review was performed using Rayyan. The two reviewers (S.C. and D.C.) then independently reviewed all full-text articles to confirm the inclusion criteria were met. Reviewers were blinded to each other's assessments, and any disagreements were resolved through consensus moderated by the senior author (D.J.).

Data Extraction

Data from each included study were extracted by at least two reviewers (S.C., D.C., and P.V.) who were blinded to the others' reported data. The following data were extracted from all included studies: number of patients studied, number of patients imaged with CTA, number of patients who underwent conventional angiography, demographic data (age, sex, race, and ethnicity), mechanism of injury, clinical setting, follow-up time, number of patients who develop injuries due to oropharyngeal trauma (infection, injury to the carotid artery, other vascular injuries, and cerebrovascular injury), neurologic abnormalities at the time of presentation, and delayed neurologic abnormalities (defined as occurring after initial presentation and attributed to the oropharyngeal trauma). Any disagreements in the extracted data were resolved through discussion moderated by the senior author.

Risk of Bias Appraisal

Studies were assessed for the risk of bias at the study level according to the Cochrane Collaboration's ROBINS-I tool (Risk Of Bias In Nonrandomized Studies - of Interventions).[34] Results across seven domains were summarized as "low risk of bias," "moderate risk of bias," "serious risk of bias," "critical risk of bias," or else "no information" if there was insufficient information to make a judgment.

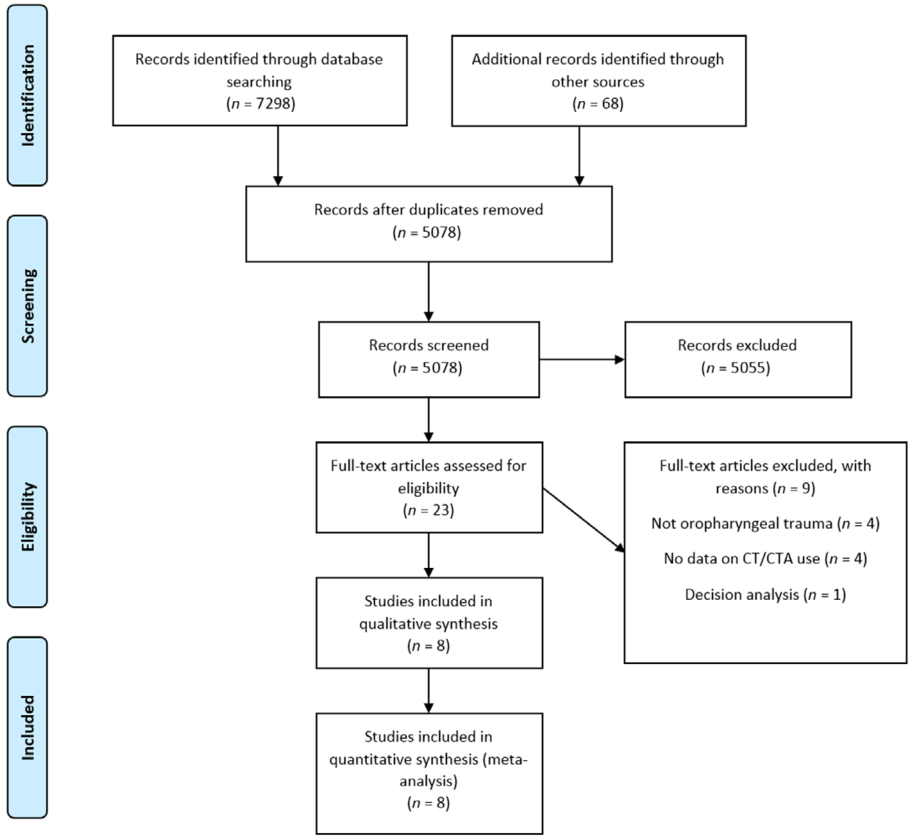

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

Studies were also classified according to the Centre for Evidence-Based Research (CEBM) at the University of Oxford.[35] Each included study was independently assessed with these instruments. Disagreements were resolved with consensus after discussion and independent review by the senior author. The risk of bias was not used to exclude studies from further analysis.

Data Synthesis and Statistical Analysis

Descriptive statistics were calculated from the data extracted from the included articles and summarized in the included tables. Studies that reported the use of CTA specifically or any CT protocol in the evaluation of pediatric oropharyngeal trauma and outcomes data related to management decisions were included in the pooled analysis. Random effects models were used to estimate the pooled proportion of events in the included studies, defined as positive imaging findings that could be used to change clinical management. Between-study heterogeneity was estimated using the I^2 statistic. Forest plots were generated for positive imaging findings on CT or CTA. Statistical analysis was performed in R version 4.03 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Study Characteristics

The initial query identified 6827 citations, with 4707 potentially eligible articles remaining after removing duplicates. An additional 68 articles were identified through screening the reference lists of reviewed articles. The final re-run of the search identified 303 additional unique articles. Screening abstracts yielded 23 studies, which were selected for full-text review. Eight articles meeting inclusion criteria were included in the analysis. A PRISMA Flow Diagram of the search is given in Figure 1. The included studies totaled 662 patients. All 8 included studies were retrospective cohort studies. No randomized controlled trials or prospective cohorts were identified. Details of the included studies are shown in Table I.

Five out of 8 studies reported rates of CTA use (Table II). There were 293 patients who underwent imaging with any CT protocol and 255 patients whose imaging was specified as CTA. The number of patients who underwent CTA for evaluation of oropharyngeal trauma in the included studies ranged from 0% to 100%.[36,37] Indications for carotid angiography included free air near the carotid ($n = 2$), bruit on neck exam ($n = 2$), hematoma adjacent to the carotid ($n = 2$), carotid spasm ($n = 1$), history of tonsil injury and profuse bleeding ($n = 1$), and carotid artery exposure with arterial compression ($n = 1$).

Table III shows the clinical outcomes after oropharyngeal trauma. In 2 cases, angiography showed disruption of the carotid intima without evidence of a thrombus.[29] These 2 patients were treated with aspirin to

TABLE I.
Details of Included Studies.

Author	Title	Year	Study design	Number of patients	Males	Females	Ages	Mechanism/causes of injury (*n*)	Follow-up: number or average duration
Choi	Neck CT angiography examinations for pediatric oropharyngeal trauma: diagnostic yield and proposal of a new targeted technique.	2020	Retrospective cohort	97	NR	NR	Mean (SD): 5.1 (3.3) years Range: 11 months to 17 years	Toy (19), toothbrush (18), straw (11), pen/pencil (5), hanger (5), utensil (3), other (36)	NR
Matsusue	Impalement injuries of the oral cavity in children.	2011	Retrospective cohort	144	93	51	Median (IQR): 2 years (1 to 3 years) Range: 7 months to 10 years	Toothbrush (30), cylindrical toy (27), chopsticks (19), stick (18), pen/pencil (9), spoon (6), can/bottle (5), sanitary ware (5), ruler (3), hanger (3), straw (3), other (16)	68 (47%) up to 10 days, 37 (26%) longer than 10 days, 39 (27%) did not follow-up
Hennelly	Incidence of morbidity from penetrating palate trauma.	2010	Retrospective cohort	205	131	74	Median (IQR): 40 months (19–64 months)	Stick (35), tool/household item (33), kitchen utensil (22), toy (21), musical instrument (21), writing object (16), straw (16), popsicle stick (9), toothbrush (8), hygiene item (5), ruler (4), flagpole (4), not described (11)	median: 3.4 days
Soose	Evaluation and management of pediatric oropharyngeal trauma.	2006	Retrospective cohort	107	73	34	Mean (SD): 46 (34) months Median: 36 months Range: 4 months to 15 years	Pen/pencil (13), musical instrument (13), pipe or tube (13), toy (12), stick (12), kitchen utensil (10), toothbrush (4), straw (4), comb (3), flagstick (3), lollipop (3), curtain rod (2), unwitnessed (5), other (10)	NR
Brietzke	Pediatric oropharyngeal trauma: what is the role of CT scan?	2005	Retrospective cohort, systematic review	23	9	14	Mean: 4.3 years Median: 3.5 years Range: 10 months to 13 years	Toothbrush (4), toys (4), popsicle stick (2), straw (2), twigs (2), ruler (1), spoon (1), pen (1), comb (1)	12/23 (52%)
Ratcliff	Evaluation of pediatric lateral oropharyngeal trauma	2003	Retrospective cohort	48	29	19	Mean: 42 months Median: 33 months Range: 2.4 months to 11.6 years	Pen/pencil (9), stick (6), toy (6), toothbrush (5), fork/spoon (4), ruler (3), candy cane (2), hairclip (1), chopstick (1), snorkel (1), coke bottle (1), flagpole (1), flute (1), glass (1), harmonica (1), antenna (1), vacuum attachment (1), apple (1), coat hanger (1), comb (1)	10/48 (21%)
Schoem	Management of oropharyngeal trauma in children.	1997	Retrospective cohort	26	22	4	Mean: 3.4 years Range: 5 months to 14 years	Wooden stick (8), toothbrush (5), unknown (3), pen (2), plastic arrow (1), baton (1), ruler (1), plastic sword (1), wooden hammer (1), plastic straw (1), gunshot wound (1), hand/fist (1)	NR
Kosaki	Penetrating injuries to the oropharynx.	1992	Retrospective cohort	12	6	6	range: 6 months to 6 years	Toothbrush (4), chopsticks (3), toy (2), fish bone (1), ruler (1), pencil (1), skewer (1)	NR

IQR = interquartile range; NR = not reported.

TABLE II.
Diagnostic and Therapeutic Interventions.

	Imaging				Medical management			Operative management		
Author	CT*	CTA	Angiography†	Indication for angiography (n)	Antibiotic treatment	Antiplatelet or anticoagulant treatment	Hospital admission	Wound exploration, hemostasis, or laceration repair	Foreign body removal	Vascular surgery
Choi	97/97 (100%)	97/97 (100%)	0 (0%)	N/A	NR	NR	NR	1/97 (1%)	1/97 (1%)	0 (0%)
Matsusue	16/144 (11%)	NR	0 (0%)	N/A	80/98 (82%) for outpatients. NR for inpatients.	NR	12/144 (8%)	5/144 (3%)	NR	0 (0%)
Hennelly	90/205 (44%)	88/205 (43%)	3/205 (1%)	Air around carotid (1), neck bruit (1), unknown/no prior CTA (1)	67/116 (58%)	0	101/205 (49%)	8/205 (4%)	0 (0%)	0 (0%)
Soose	52/107 (49%)	52/107 (49%)	1/107 (1%)	Hematoma anterior to carotid artery (1)	77/107 (72%)	NR	44/107 (41%)	16/107 (15%)	1/107 (1%)	0 (0%)
Brietzke	18/23 (78%)	18/23 (78%)	3/23 (13%)	Carotid bruit on exam (1), air near carotid sheath (1), tonsil injury with profuse bleeding (1)	23/23 (100%)	NR	21/23 (91%)	4/23 (17%)	1 (4%)	0 (0%)
Ratcliff	14/48 (29%)	NR	3/48 (6%)	Carotid spasm (1), carotid sheath hematoma (1), carotid artery exposure with arterial compression (1)	NR	2/48 (4%)‡	12/48 (25%)	3/48 (6.3%)	1/48 (2%)	0 (0%)
Schoem	5/26 (19%)	NR	0 (0%)	N/A	24/26 (92%)	NR	25/26 (96%)	6/26 (23%)	3/26 (12%)	0 (0%)
Kosaki	1/12 (8%)	0/12 (0%)	0 (0%)	N/A	12/12 (100%)	NR	3/12 (25%)	1/12 (8%)	0 (0%)	0 (0%)

CT = computed tomography; CTA = computed tomography angiography; N/A = not applicable; NR = not reported.
*Includes contrasted or noncontrasted CT protocols.
†Any operative angiography including conventional angiography and digital subtraction angiography.
‡Both patients were treated with aspirin for carotid intima disruption.

TABLE III.
Outcomes and Complications.

Author	Neurological deficit at presentation	Abnormality/injury to the carotid artery on CT/CTA	Abnormality/injury to the carotid artery on angiography	Cerebrovascular injury	Infection
Choi	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2/97 (2%), phlegmonous change ($n = 2$)
Matsusue	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1/144 (1%), sublingual abscess ($n = 1$)
Hennelly	0 (0%)	9/90 (10%), potential intimal tear ($n = 1$), edema around the carotid ($n = 8$)	0 (0%)	0 (0%)	3/205 (1%), location not reported
Soose	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Brietzke	0 (0%)	0 (0%)	1/3 (33%) vessel spasm ($n = 1$)	0 (0%)	1/23 (4%), retropharyngeal phlegmon ($n = 1$)
Ratcliff	0 (0%)	3/48 (6%), carotid spasm ($n = 1$), carotid sheath hematoma ($n = 1$), carotid artery exposure with arterial compression ($n = 1$)	2/3 (67%) disruption of carotid intima without thrombus ($n = 2$)	0 (0%)	1/48 (2%), retropharyngeal abscess ($n = 1$)
Schoem	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Kosaki	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1/12 (8%), retropharyngeal abscess ($n = 1$)

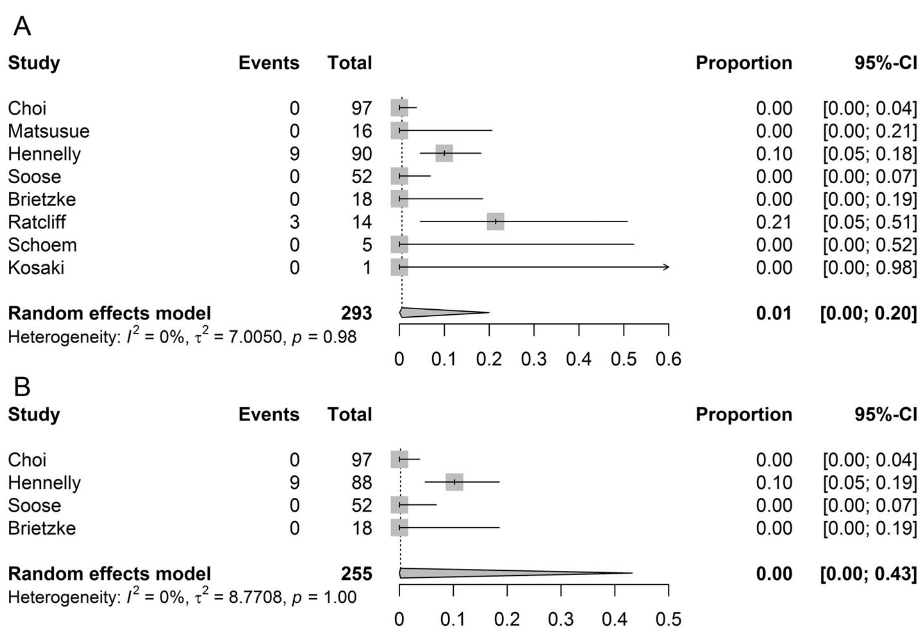

Fig. 2. Forest plot of imaging findings that could lead to changes in management. "Events" are defined as CT or CTA studies with positive findings that can be used to change clinical management. "Total" refers to the number of patients with CT or CTA results in the study. (A) Forest plot of positive imaging findings among studies that include patients with either CT or CTA results. (B) Forest plot of positive imaging findings, limited to include only studies that specified that all imaging studies were CTA.

prevent neurovascular sequelae. Patients were admitted to the hospital for observation between 4% and 100% of cases based on the assessment of the treating physician or institutional protocol.[38–40] No patients were reported to have cerebrovascular injury or undergo vascular surgical treatment after oropharyngeal trauma. Four out of 8 studies reported rates of patient follow-up after discharge from the emergency department or inpatient stay.

Changes in Management

Changes in patient management based on the results of imaging were assessed in 3 domains: additional diagnostic tests obtained, changes in medical management, and surgical management due to imaging results. Angiography was obtained in 3.4% of patients imaged with CT or CTA ($n = 10$). Six patients underwent angiography after positive findings were noted on imaging. The reasons given for undergoing angiography for the other

4 patients were bruit on physical exam ($n = 2$), profuse bleeding ($n = 1$), or no explanation given ($n = 1$).

Antibiotic treatment was reported in 6 out of 8 studies. Medical management with aspirin or anticoagulants was reported in only 2 patients. No patients required endovascular interventions such as stent placement or thrombectomy.

Due to the low numbers of positive imaging findings and the incomplete data regarding the impetus for changes in clinical management, pooled analysis was used to calculate the overall proportion of patients with positive imaging findings in either CT or CTA. Figure 2A shows the pooled proportion of 0.01 (95% CI 0.00–0.08) in the analysis of all patients imaged with any CT protocol. In the analysis limited to imaging specified as CTA, the pooled proportion was 0.00 (95% CI 0.00–0.43) (Fig. 2B). The heterogeneity across studies was evaluated by calculating the I^2 statistic and was found to be 0% in both analyses. A funnel plot was constructed and is shown in Figure 3.

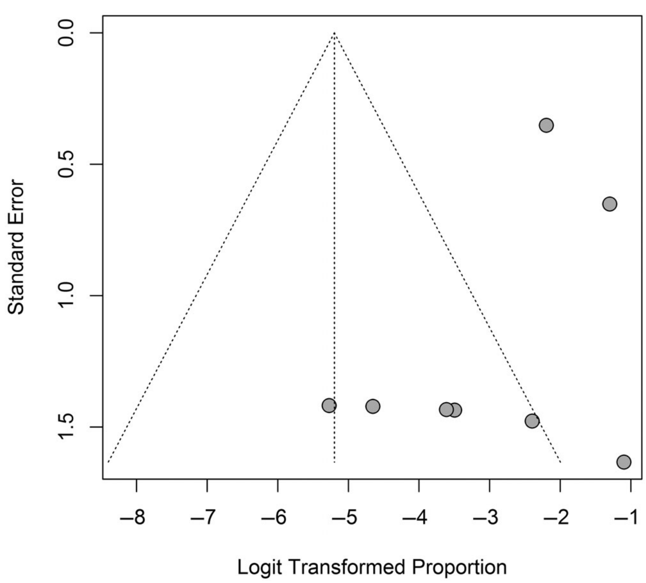

Fig. 3. Funnel plot assessing publication bias.

Risk of Bias and Level of Evidence

Among the included studies, the risk of bias as assessed with the Cochrane ROBINS-I tool was high for pre-intervention bias (bias due to confounding and bias in the selection of participants for the study). All of the included non-randomized studies were judged to have at least a moderate risk of the study results differing systematically from the results expected from a randomized trial conducted on the same participant group (Table IV).

Post-intervention bias was highest in the domain of missing data due to incomplete reporting or loss of follow-up after CTA led to high rates of post-intervention bias across studies. Follow-up time was not reported in four studies.[30,36,37,41] In other studies, follow-up was limited to an average of 3–4 days after discharge from the emergency department or hospital admission,[31,42] or only a minority of patients were seen for follow-up in clinic.[29] Measurement of outcomes and selection of the reported results was judged to be at low risk of bias due to the unlikelihood that measurement or reporting of these results was influenced by knowledge of the intervention received by study participants and involved negligible assessor judgment.

Studies were appraised according to the Oxford Centre for Evidence-based Medicine Levels of Evidence. Due to their analyses being based on retrospective cohorts, all were appraised as being at level 4.

DISCUSSION

This review summarized the changes in the management of pediatric patients with oropharyngeal trauma who underwent imaging with CTA compared to those without imaging to determine whether obtaining imaging affected patient management decisions. Our study found that imaging findings only rarely led to changes in clinical management. The overall paucity of relevant studies

TABLE IV.
Level of Evidence and Risk of Bias Assessment.

			Pre-intervention bias		At-intervention bias	Post-intervention bias			
Authors	Year	Oxford level of evidence	Confounding	Selection of participants	Classification of interventions	Deviations from intended interventions	Missing data	Measurement of outcomes	Selection of the reported results
Choi	2020	4	Serious	Moderate	Low	Low	Serious	Low	Low
Matsusue	2011	4	Serious	Moderate	Low	Low	Moderate	Low	Low
Hennelly	2010	4	Serious	Serious	Low	Low	Moderate	Low	Low
Soose	2006	4	Serious	Moderate	Low	Low	Serious	Low	Low
Brietzke	2005	4	Serious	Moderate	Low	Low	Moderate	Low	Low
Ratcliff	2003	4	Serious	Moderate	Low	Low	Moderate	Low	Low
Schoem	1997	4	Serious	Serious	Low	Low	Moderate	Low	Low
Kosaki	1992	4	Serious	Serious	Low	Low	Serious	Low	Low

and the heterogeneity of patients, however, limits the ability to identify in which circumstances CTA is indicated in the workup of pediatric oropharyngeal trauma. This review shows that there is insufficient published data to recommend obtaining CTA in all pediatric oropharyngeal trauma cases. CTA, however, may be considered on a case-by-case basis to guide further diagnostic workup or treatment decisions.

In contrast to the notable case reports that have described devastating neurologic injury or mortality in children after oropharyngeal trauma, the studies included in this review did not report any cerebrovascular injuries or mortalities after oropharyngeal trauma. This incongruence within the literature underscores the need for guidance regarding the utility of imaging studies to evaluate vascular injury after oropharyngeal trauma. Unlike some presentations of head and neck trauma, in which there are validated guidelines to suggest the appropriateness of obtaining imaging to screen for injury after head trauma[18–21] or to evaluate for blunt cerebrovascular injury (BCVI) after neck trauma,[22–26,33] no imaging guidelines exist for pediatric oropharyngeal trauma. The primary goal of this review was to investigate the rates of vascular injury after pediatric oropharyngeal trauma as detected by imaging studies and to determine the changes in management that occurred because of the imaging results.

Overall, imaging with CTA yielded pertinent radiological abnormalities in only 4.3% across the included studies. Among patients with evidence of vascular injury noted on CTA, changes in management included further diagnostic studies, pharmacologic treatments, or operative interventions. The most commonly reported diagnostic modality used after positive CT findings was angiography. Six patients (2.0% of patients examined with CT or CTA) underwent angiography after positive findings were noted on imaging.

Only Ratcliff et al. reported medical treatment using anticoagulation or antiplatelet medications.[29] In this study, two patients were treated with aspirin for carotid intima disruption. The literature on patients with blunt carotid or vertebral artery injuries has shown that treatment with anticoagulant or antiplatelet therapy reduces neurologic morbidity and mortality.[14,15] By extension, anticoagulation or antiplatelet therapy may be beneficial in patients with carotid artery injury caused by oropharyngeal trauma.

Operative indications after trauma included wound exploration, obtaining hemostasis, laceration repair, and foreign body removal. No accounts were given in the included studies regarding how CT results influenced the decision to pursue surgery. Patients may benefit from the operative intervention in the absence of imaging findings if there is evidence or high suspicion of a retained foreign body, significant bleeding, or large lacerations. No study reported vascular surgical interventions for primary repair, interposition grafting, stenting, or ligation of blood vessels injured due to oropharyngeal trauma.

One significant drawback to screening patients with CTA after oropharyngeal trauma is the inability to definitively rule out future cerebrovascular ischemia. Cerebral infarction has been reported despite treatment with aspirin after a diagnosis of carotid dissection was made with CTA and subsequent carotid angiography after oropharyngeal trauma.[43] Incidence of such catastrophic events is low but cannot be estimated based on the published literature.

Another considerable drawback to screening with CTA is the associated exposure to ionizing radiation. Children have long-term cancer risks that can be 2–3 times higher compared to adults after exposure to imaging radiation due to higher sensitivity and a longer lifetime for the effects to manifest.[37] The risk of lethal malignancy due to radiation may be as high as 1 in 1000 after a single CT scan.[44,45] CTA protocols designed for purposes other than oropharyngeal trauma may increase patients' exposure to radiation beyond what is needed for diagnostic purposes. Protocols designed to reduce the area of imaging may decrease but do not remove the risks of radiation.[37] A sensitivity analysis as part of a decision analysis study recommended not routinely obtaining a CTA in this clinical situation until the risk of stroke exceeds 2.3% and the risk of radiation-induced malignancy is under 0.24%, while no study has shown that the risk of stroke after oropharyngeal trauma is this high.[12]

Inpatient observation after oropharyngeal trauma has been advocated by some to allow for close neurological monitoring to detect delayed presentations of neurovascular injuries. Some earlier authors have advocated for routine inpatient observation for 48 h or more after injury based on a review of the published cases of proven or suspected internal carotid artery occlusion caused by blunt intraoral trauma.[3,8] Others have advocated for continued observation after discharge by parents or caretakers for pertinent signs and symptoms including fever, drooling, irritability, decreased level of consciousness, unilateral weakness, headache, vision changes, or neck pain/swelling/restriction of head turning.[39–42,46–48] The financial cost of universal inpatient observation after oropharyngeal trauma together with the lack of correlation between wound severity on physical exam and the risk of delayed neurovascular complications challenge the need for routine hospitalization for patients with reliable caretakers.

This review was limited in that it included only non-randomized retrospective studies due to the rarity of cerebrovascular injury after oropharyngeal trauma. The present analysis did not evaluate the indications for treatments to prevent neurovascular sequelae, which treatments to use, the efficacy of these treatments, or the cost effectiveness of these treatments. The risk of selection bias is also high due to wide variation in both institutional policy and individual provider practice patterns when deciding whether to pursue CTA. For example, studies that restricted inclusion to patients seen by specialists such as oral and maxillofacial surgery[48] or otolaryngology,[36,41] may have been more likely to include patients who underwent imaging. This differential rate of intervention was seen in Soose et al., where 55% of patients seen by an otolaryngologist underwent CTA, compared to 7% of patients without an otolaryngology consultation.[30]

CONCLUSIONS

Imaging with CTA yielded radiological abnormalities in 4.3%, with 0.8% treated with antiplatelet or anticoagulant medications. No patients developed neurovascular sequelae due to oropharyngeal trauma. The routine diagnostic evaluation of pediatric oropharyngeal trauma with CTA is not supported by the published literature because imaging results rarely led to changes in patient management and have not been shown to improve outcomes. The best management paradigm for the use of advanced imaging remains to be determined in neurologically intact children after oropharyngeal trauma.

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