PEDIATRIC OROPHARYNGEAL trauma is largely underreported and underestimated. Many traumatic oropharyngeal injuries are unwitnessed, and, even among those witnessed by a parent or guardian, most of the patients involved do not present to a physician or hospital unless there are associated symptoms such as bleeding, dysphagia, or pain. Although most cases heal without any long-term sequelae, prior reports have linked seemingly innocuous oropharyngeal injuries to occult internal carotid artery (ICA) damage with delayed onset of disastrous complications, such as aphasia, hemiplegia, and even death, in otherwise normal and healthy children.1

Debate exists regarding which imaging studies, if any, are warranted to screen for occult ICA injury in pediatric patients with oropharyngeal trauma.2,3 The recommended imaging studies in most institutions range from computed tomography (CT) to lateral neck radiography to no screening test.2,3 Furthermore, even within a single institution that recommends diagnostic imaging, there is considerable variability regarding which patients actually undergo imaging.2,3 Because of the unknown incidence of the rare complication of neurologic devastation following such injuries, it is unclear if patients with oropharyngeal trauma should be routinely screened for ICA injury. In this article, we analyze our experience at Children’s Hospital of Pittsburgh, Pittsburgh, Pa, for patterns and associations in medical decision making that would suggest a logical approach regarding radiologic workup, hospital admission criteria, surgical and/or medical therapy, and follow-up in children with oropharyngeal injuries.
METHODS

Charts were retrospectively reviewed for all inpatients and outpatients with a diagnosis suggestive of oropharyngeal injury (International Classification of Diseases, Ninth Revision [ICD-9], codes 873.60, 873.65, 873.70, and 873.75) at Children’s Hospital of Pittsburgh over a 6-year period, from 1998 to 2004 (n=107). Patients with an impalement-type injury to the soft palate, tonsillar region, or posterolateral pharyngeal wall were included in the study. Patients with other mechanisms of trauma to the oropharynx, such as gunshot wounds, motor vehicle crashes, and posttonsillectomy hemorrhage, were excluded.

Records were evaluated for the following clinical data points: age, sex, date of presentation, bleeding (at injury and at presentation), time from injury to presentation, mechanism (object) of injury, wound severity, site of injury, presence of foreign body, otolaryngologic evaluation, presence of neurologic symptoms, screening radiology tests and results, surgical therapy and indications, hospital admission and duration, antibiotic therapy, complications, and follow-up. The severity of injury was divided into 3 categories to facilitate analysis: grade 1, abrasion or ecchymosis without mucosal disruption; grade 2, puncture wound or simple laceration (≤1 cm), and grade 3, laceration larger than 1 cm or any laceration with an oronasopharyngeal fistula or large mucosal flap.

The data were subsequently analyzed to determine whether any clinical factors indicated which patients were more likely to undergo the following interventions: (1) CT angiography, (2) surgical therapy in the operating room, (3) hospital admission, and (4) antibiotic administration. The relationship between the patients’ clinical factors and the presence of positive radiographic findings and/or clinical complications was also analyzed. Variables were compared using the Pearson χ² test, with a P value of less than .05 suggesting statistical significance. The results of the study were used to construct a protocol for the evaluation and management of pediatric oropharyngeal trauma at Children’s Hospital of Pittsburgh.

RESULTS

A total of 107 patients with traumatic oropharyngeal injuries presented to Children’s Hospital of Pittsburgh over a 6-year period (1998-2004). Demographic data and clinical findings at presentation are listed in Table 1. The median time interval from injury to presentation, which was documented in 73 charts, was 3 hours (range, 1-96 hours). The mechanism of injury almost exclusively involved children falling with an object in their mouth or having an object pushed in their mouth by another individual. One injury was the result of a finger sweep by a parent during a choking episode. The objects of injury varied considerably (Table 2). There was no association between the type or material of the object and any of the 4 interventions, positive radiographic findings, or clinical complications.

The majority of patients were initially evaluated in the emergency department; however, some were seen either initially or exclusively in a pediatrician’s outpatient office. An otolaryngologist was consulted in 93 (87%) of the cases. On examination, no patient had a documented change in mental status or a focal neurologic deficit. Most injuries involved the soft palate and occurred with essentially equal laterality (Table 1).

The injuries were divided into 3 categories of severity, with the majority being grade 2 (Table 3). Two patients presented with an embedded foreign body: one was a small piece of lead from a pencil tip that was curetted from the soft palate in the office; the other was a tooth-
brush injury that penetrated the right anterior tonsillar pillar, with the entire head of the toothbrush lodged lateral to the tonsil (Figure). The toothbrush was removed without complication in the operating room with the patient under general anesthesia.

Treatment included at least 1 radiographic screening test in 56 patients (52%), 52 (49%) of whom underwent CTA. Eight (15%) of the 52 patients also underwent previously ordered lateral neck radiography and/or chest radiography, while CTA was the only imaging study in 44 patients (85%). Although none of the 52 patients who underwent CTA had evidence of vascular injury, 16 (31%) had positive radiographic findings, such as free air, hematoma, and/or parapharyngeal edema. One patient had a 2-cm hematoma just anterior to the right carotid artery that was suggestive of vascular injury. This patient subsequently underwent formal angiography, the results of which were negative for vascular disruption.

Sixteen (15%) of the 107 patients were taken to the operating room, primarily for wound closure but also for hemostasis, examination under anesthesia, and foreign body removal. One of our patients was an 8-year-old boy who was emergently transferred to our institution with a 1-day history of fever, drooling, labored breathing, voice changes, and a presumed diagnosis of epiglottitis. On laryngoscopy in the operating room, the epiglottis was normal; however, the patient was found to have a grade 2 laceration of the right soft palate. Most patients were treated as outpatients; however, 44 (41%) were admitted to the hospital for observation. Antibiotics were administered to most patients regardless of admission status, most commonly ampicillin–sulbactam for inpatients and amoxicillin–clavulanate potassium for outpatients.

Of the 93 patients who were seen by an otolaryngologist, only 22 (23%) were seen in our office for outpatient follow-up a median of 10 days after their initial presentation. Only 1 patient in the study developed a complication of any kind (including neurologic). The patient was a 3-year-old boy with hemophilia who sustained a grade 3 midline laceration from a plastic toy. He was treated with factor VIII replacement therapy, followed by outpatient oral aminocaproic acid (Amicar) therapy, without surgical wound closure. He returned to the emergency department 9 days later with acute hemorrhage from the wound, which resolved after more factor VIII replacement therapy.

We subsequently analyzed our patient population for statistically significant relationships between the previously mentioned clinical factors and the 4 interventions (CTA, surgical therapy, hospital admission, and antibiotic administration), as well as the presence of positive CTA findings and clinical complications. Although a number of clinical factors influenced the treatment of these patients, none of the clinical factors were predictive of the presence of positive radiographic findings or clinical complications.

Of all the clinical factors examined, 4 correlated with an increased likelihood of the patient undergoing CTA: lateral injury (vs midline), soft palate injury (vs other locations), increasing wound severity, and otolaryngology consultation. Computed tomographic angiography was ordered in 50 (60%) of 83 patients with lateral lesions, as opposed to 1 (6%) of 17 patients with midline lesions (P < .001). Similarly, 50 (52%) of 96 patients with soft palate lesions underwent CTA, while none of the 9 patients with an injury to the hard/soft palate junction underwent CTA (P = .004). With regard to wound severity, none of the 8 patients with grade 1 injuries underwent CTA, whereas 33 (49%) of 68 patients with grade 2 injuries and 19 (61%) of 31 patients with grade 3 injuries underwent CTA (P = .008). Finally, of the 93 patients who were seen by an otolaryngologist, 51 (55%) underwent CTA, as opposed to only 1 (7%) of 14 patients without an otolaryngology consultation (P = .001).

Despite the above clinical correlations with ordering CTA, none of the factors, including wound severity, was sta-
Catastrophic, neurologic sequelae from seemingly innocuous oropharyngeal injuries are well documented in earlier case reports. The proposed mechanism of injury involves compression of the carotid artery between the penetrating object and the transverse process of an upper cervical vertebra. The resultant shearing effect causes an intimal tear in the vessel, with subsequent thrombus formation and distal propagation of the thrombus into the cerebral vasculature. The “lucid interval” (duration of normal neurologic status before the onset of symptoms) is believed to correlate with the time necessary for formation and propagation of the thrombus, reportedly ranging from 3 to 60 hours after injury. If ICA intimal injury could be detected before the onset of neurologic signs and symptoms, anticoagulation therapy could be initiated to help prevent neurologic sequelae.

A review of 4 recent large series of pediatric oropharyngeal trauma cases, with a total of 228 patients, showed that a lack of consistency exists in the decision-making process with regard to radiographic screening, surgical and medical therapy, and hospital admission not only between institutions but also among physicians within a single institution. For example, the recommended screening radiologic test ranges from none to lateral neck radiography to contrast-enhanced CT. Such discrepancies are likely attributable, at least in part, to the unknown, extremely low incidence of patients with neurologic complications available for statistical analysis. As in the previous 4 series, none of the patients described herein developed neurologic sequelae.

In this review, we add to the literature 107 cases of oropharyngeal trauma involving patients who presented to the Children’s Hospital of Pittsburgh in the 6-year period from 1998 to 2004. The average annual incidence of oropharyngeal trauma at our institution over that period was approximately 18 patients per year. The age and sex distributions closely paralleled those in the other reports: a median age of 3 years, a mean age closer to 4 years, and a male-female ratio of approximately 2:1. Although young age has been previously cited as a criterion for admission, age did not correlate with rates of admission in our study, nor did it correlate with any of the other aspects of management. Prior studies have shown that left-sided lesions occur about twice as often as those on the right, possibly because of the predominant right-handedness of the general population. In contrast, we found no significant difference between right-sided (45%) and left-sided (38%) injuries.

Prior studies have reported nonneurologic complications such as bleeding, retropharyngeal abscess, facial cellulitis, velopharyngeal insufficiency, and pneumomediastinum. Our patient population included only 1 such complication: bleeding. However, of the 93 patients who were evaluated by an otolaryngologist, only 21 (23%) returned to our otolaryngology clinic for outpatient follow-up, with a median time of 10 days. This low rate is similar to the 21% follow-up rate reported by Ratcliff et al. The main reasons that we would recommend a follow-up appointment are to inspect the wound after it has healed, to assess for dysphagia and velopharyngeal insufficiency, and to assess for delayed-onset neurologic symptoms. For patients with grade 1 and 2 injuries with no operative repair, it is reasonable for this follow-up visit to occur with their pediatrician.

Laterality and location influenced the radiologic workup, which is expected given the proximity of the carotid artery to the lateral soft palate. It is less clear why ordering CTA should be influenced by the severity of the wound on physical examination. In a review of 16 reported cases of soft palate injury with neurologic sequelae, Hengerer et al concluded that “even the most innocent appearing injury may develop devastating complications,” suggesting that wound severity does not correlate with the risk of carotid injury and subsequent neurologic complications. To evaluate this assertion in our patient population, we devised a grading system for wound severity.

We found that patients with higher grades of wound severity were statistically more likely to undergo CTA, to go to the operating room, and to be admitted to the hospital; however, these patients were not more likely to have positive findings on CTA or to have an adverse clinical outcome. Most of the correlations appear to be justifiable; eg, larger and more complicated wounds more frequently require surgical closure with the patient...
under general anesthesia and may be associated with more severe symptoms, such as increased pain and dysphagia, all of which may have an impact on hospital admission. Nevertheless, it remains unclear why the patients with more severe wounds were preferentially imaged.

Because any patient with lateral oropharyngeal injury, regardless of wound severity, is potentially at risk for ICA thrombus formation and the development of neurologic sequelae, we conclude that, except for the rare case of an embedded foreign body, the severity or appearance of the wound should not necessarily influence the decision to image. Among the 335 total patients with oropharyngeal trauma in this and other recent large series, 71 patients underwent either CT or CTA. Among these 71 cases, 2 CT scans showed evidence of intimal disruption of the ICA, a finding that was confirmed by follow-up traditional contrast angiography. Thus, the incidence of ICA injury in children with oropharyngeal trauma can be estimated at 2.8% of those imaged with CT or CTA (2/71), and 0.6% (2/335) overall. The incidence of neurologic sequelae in all 335 patients was 0, but the 2 patients with angiography-confirmed CT evidence of ICA intimal injury were treated with aspirin. We recommend that an institution or physician should either (1) image all patients who are at risk for carotid injury, which follows a more defensive and cautionary philosophy based on the few catastrophic case reports, or (2) image no patients, which is reasonable as well since, in all 5 large reviews (now totaling 335 patients), there were no cases of neurologic complications. All treating physicians and institutions will have to make their own decision as to whether the low incidence of carotid artery injury and the even lower incidence of neurologic sequelae are worth the cost of obtaining imaging in patients with lateral oropharyngeal trauma. One goal of the present study was to try to identify which patients with oropharyngeal trauma might be more at risk of ICA injury, but we were unable to identify any predisposing factors.

If imaging is obtained, CTA seems to be a reasonable option, as it provides a quick, convenient, and relatively inexpensive method, with low associated morbidity, of promptly diagnosing a carotid injury so that, if necessary, timely hospitalization, follow-up angiography, neurology consultation, and anticoagulation can be implemented. Regardless of whether or not an imaging study is obtained, patients and their parents should be counseled to return if any neurologic symptoms develop.

In our hospital, a standard contrast CT scan of the neck is approximately $300, whereas CTA of the neck is approximately $400. The duration of cervical CTA is approximately 15 minutes, and approximately 50% of the children require sedation. General anesthesia is not used. Most of the patients who receive sedation are younger than 5 years. Some of our study patients also underwent lateral neck or chest radiography, which is a manifestation of the retrospective nature of this study, in which multiple physicians, with different opinions regarding management, were caring for these patients.

The sensitivity of CTA for detection of ICA injury in the setting of oropharyngeal trauma is not known. However, the sensitivity of CTA for the detection of ICA injury when compared with contrast angiography has been calculated to be 68% for blunt cerebrovascular trauma and 90% for penetrating neck trauma.

Most wounds do not require surgical intervention and closure. In our study, 12 (11%) of 107 wounds were surgically closed in the operating room, a rate that is similar to those reported by Schoem et al (7%) and Ratcliffe et al (6%). Four other patients in our series went to the operating room for other reasons, including hemostasis, airway concerns, and foreign body removal. The amount of time that has elapsed between injury and presentation is not typically a factor that influences the decision to operate, because most of the wounds heal spontaneously, regardless of when they are seen. We recommend reserving the operating room for wounds with avulsed tissue or an obvious nasopharyngeal-oropharyngeal fistula (grade 3 injuries), as well as for foreign body removal, active hemorrhage, airway concerns, or exploration when awake examination is not possible.

Because complications are so rare and because of the lucid interval of 3 to 60 hours, prior studies have suggested that hospital admission is not cost-effective and merely provides a false sense of security to both parents and physicians. We found that patients who had higher wound severity grades, underwent CTA, or went to the operating room were statistically more likely to be admitted.

The main purpose of CTA is to find evidence of intimal vascular injury before any neurologic symptoms develop and not necessarily to get patients discharged sooner. The higher admission rate for patients who underwent CTA is likely because CTA happened to be ordered for wounds of greater severity, with more associated pain and dysphagia and delayed resumption of adequate oral intake. Hospital admission was also recommended in cases involving an unreliable home situation or in cases in which surgical exploration was planned for the following day. Most children who underwent CTA typically returned to the emergency department, where discharge to home was considered, if feasible. Most patients can be treated as outpatients and are instructed to return for outpatient evaluation in 1 to 2 weeks, or sooner at the first sign of neurologic changes or infection. The admission rates from some of the other large series are difficult to calculate because only inpatients were included in those studies.

Prophylactic antibiotics were administered to 70 (72%) of all 107 patients in our study, which is somewhat lower than the 87% to 92% reported in previous studies. However, on closer look, of the 180 patients in the other 3 studies that reported antibiotic use, 178 were inpatients. Of our 44 inpatients, 39 (89%) received antibiotics (most commonly ampicillin-sulbactam), which is consistent with the numbers reported in previous studies. Moreover, 70 (69%) of all 107 patients received a prescription for outpatient oral antibiotics on leaving the hospital or the emergency department. In an effort to standardize our management, we now recommend prophylactic antibiotic therapy for any patient with mucosal penetration (grade 2 or 3), regardless of admission status.
CONCLUSIONS

Previously published case reports involving children who developed neurologic complications after seemingly innocuous oropharyngeal trauma have led us to conclude that any patient with a lateral soft palate or peritonsillar injury, regardless of wound severity, is potentially at risk for ICA injury. Still, the incidence of ICA injury is rare (0.6% in 5 large series, including this one) and the incidence of neurologic sequelae is low enough (0% incidence in 335 patients in 5 large recent series) that routine imaging cannot be emphatically recommended. Still, it remains our preference, when consulted, to request imaging for lateral oropharyngeal trauma, regardless of wound severity. In the present study, we were unable to identify any specific clinical factors that might lead to higher suspicion of vascular injury in patients with oropharyngeal trauma; therefore, we base the decision to obtain imaging on a balance of cost and risk tolerance. When imaging is performed, CTA seems to be a reasonable choice.

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REFERENCES