Archives of Academic Emergency Medicine. 2024; 12(1): e45

REVIEW ARTICLE

Life-threatening Carotid Complications Caused by Extraluminal Migration of Ingested Foreign Bodies; a Case Report and Narrative Review of Literature

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Received: February 2024; Accepted: March 2024; Published online: 5 May 2024

Abstract: Carotid complications resulting from extra-luminal migration of ingested foreign bodies (FB) are rare but potentially life-threatening. Previous data on the topic predominantly comprises isolated case reports, leaving a gap in comprehensive evidence necessary to guide clinical decision-making. In this article, we offer a narrative review alongside a novel case report, aimed at providing a broad, evidence-based perspective on the topic to guide clinical practice. The search strategy employed keywords related to carotid artery complications from ingested FB across the following electronic databases: PubMed, Scopus, Google Scholar, and Cochrane Central.

Screening involved standardized data extraction by two independent reviewers, with a focus on abstracts meeting inclusion criteria and excluding non-English literature and non-relevant studies from further analysis. Moreover, we present a novel case report on the topic that was successfully managed using a unique surgical approach.

Overall, a total of sixteen case reports were finally included, data on clinical presentations, diagnostic strategies and findings, surgical management and outcome were extracted, tabulated, and discussed.

In carotid complications from extra-luminal migration of ingested FB, high clinical suspicion is crucial due to potentially mild symptoms and negative first-level examinations. Computed tomography (CT) scan plays a pivotal role for accurate diagnosis and surgical planning, along with neck ultrasound to detect complications. Tailored surgical strategies based on the severity of carotid involvement, including venous patch grafts in severe vessels involvement, are crucial for optimal patient outcomes. As a novelty, in our case report, carotid shunt was successfully employed instead of prolonged carotid clamping to reduce the risk of associated neurological sequelae. It could be concluded that diagnosis and managing carotid complications from extra-luminal migration of ingested FB remains challenging and a multidisciplinary approach is warranted.

Keywords: Anastomosis, surgical; Foreign bodies; Carotid arteries; Eating; Lacerations

Cite this article as: Soloperto R, Festa G, Beatrice M, et al. Life-threatening Carotid Complications Caused by Extraluminal Migration of Ingested Foreign Bodies; a Case Report and Narrative Review of Literature. Arch Acad Emerg Med. 2024; 12(1): e45. https://doi.org/10.22037/aaem.v12i1.2306.

1. Introduction

Foreign body (FB) ingestion is accidental in 95% of cases and is usually related to food, as fish, chicken bones, or toothpicks. Most of these accidents occur in children (1), and, when they occur in adults, they usually occur in older adults, individuals with underlying psychiatric (2) or neurological illnesses, alcohol-intoxicated patients, or prisoners (3, 4). Often, FB ingestion occurs because of batteries or alleged drug-containing balloons in patients with previous intentional self-harm history (5).

Common presenting symptoms include persistent FB sensation, odynophagia, and/or sharp pricking pain during swallowing. While most (80-90%) ingested foreign bodies pass without the need for intervention (5, 6), some patients need

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immediate medical treatment but recover well without any pathological sequelae. Endoscopic management is required in 10-20% of patients, and surgical intervention is required in less than 1% of patients (7, 8).

Nevertheless, a few patients present with complications when conservative management or a late presentation delays definitive care. In a previous study by Liu et al., female sex and non-emergent endoscopy after 6 hours were significantly associated with a higher overall complications rate (6). For major complications, older age, time interval >24 hours, and sharper objects were associated with major complications.

The detection of FB impaction or missing FBs is usually delayed because nothing has been detected via visual inspection or laryngoscopy.

Among missed FBs, radiolucent fish bones tend to be missed in lateral neck radiographs (9), thus presenting a few days later as emergencies with symptoms and signs of complications such as neck abscess (10, 11) or subcutaneous emphysema (12). Therefore, fish bone ingestion is one of the most common scenarios involving FBs found in the ED (13, 14). In addition to their slender shape and sharp points that facilitate embedment, fish bones are small and can easily be missed during eating (12, 15). Fish bone ingestion is much more common in people between forty and sixty years of age and is associated with rapid eating (13). Fish bone ingestion is also more common in Asia, the Mediterranean region, and other coastal regions where eating whole fish, bones included, is common (14).

Carotid complications arising from FB ingestion are rare but can be especially severe. We therefore sought to comprehensively explore the diagnosis and management of carotid complications resulting from the ingestion of FBs. Through presentation of a novel case report and a critical narrative review on current research and up-to-date evidence-based data, our goal is to raise awareness about the diagnosis and management of this condition in order to offer clinical insights useful to clinical practice.

2. Case presentation

A 22-year-old Caucasian man presented with a three-week history of persistent odynophagia associated with dysphagia and a pricking sensation in the right anterior neck. He did not report any antecedent events, and there were no obstructive symptoms such as dyspnea or noisy breathing at the presentation. The patient had been given a course of oral antibiotics and corticosteroids by his general practitioner without success.

On physical examination, there was neither soft tissue swelling nor latero-cervical or submandibular lymphadenopathy. Intraoral examination was normal, with no signs of hyperemia, tonsillar turgor, overt openings, or pus.

Examination by Ear-Nose-Throat (ENT) specialist was negative, and both flexible fiberoptic nasopharyngoscopy/laryngoscopy and esophagoscopy, performed under light sedation, were normal: pooling of saliva in both pyriform fossae, no medialization of the lateral pharyngeal wall, no bulging at the posterior wall, and no evidence of a FB in the oropharynx, hypopharynx, larynx, or esophagus.

2.1. Imaging

Due to persistent symptoms, ultrasound of the right supraoptic vessels was performed to exclude vascular pathologies (e.g., carotid dissection), resulting in a linear, hyperechoic FB coursing from the right thyroid lobe and running obliquely, with the tip of the FB abutting the right common carotid artery (Figure 1A). Immediately superior to the FB entry point, turbulent forward and backward flow caused a characteristic “yin-yang” sign on color flow and a "to and fro" pattern on pulsed Doppler, indicating a pulsating pseudoaneurysm (Figure 1B and C).

Contrast-enhanced computed tomography (CECT) scan revealed the presence of a 3 cm thick, sharp-ended FB opacity embedded within the right latero-cervical soft tissue, with its pointed, sharp tip located in the lumen of the right common carotid artery 5 cm from the bifurcation and the other tip proximal to the right thyroid cartilage (Figure 2 A and B). A 1.5-cm pseudo-aneurysm was confirmed at the carotid artery entry point of the migrated FB (Figure 2 c). Furthermore, medially, there was a 3 cm hematoma in the adjacent soft tissues contiguous with the right thyroid lobe, with no evidence of active bleeding.

2.2. Treatment

A multidisciplinary team meeting, involving radiologists, vascular surgeons, emergency physicians, and anesthesiologists, was arranged for optimal surgical planning, with the aim of mitigating both the risk of infectious complications and the risk of permanent neurological sequelae resulting from intra-procedural carotid dissection or distal embolization. In this context, different surgical and anesthesiologic approach were considered. From a surgical point of view, due to extended cranio-caudal laceration of the right common carotid artery (CCA) wall all around the fish bone, termino-terminal anastomosis between the proximal and distal artery walls was not feasible. The consideration of employing a double-layer saphenous vein patch on the affected right common carotid artery wall was dismissed due to the breach diameter exceeding 2 mm. Additionally, the patient had presented more than 20 days post-event, resulting in severe and extensive perilesional inflammation and adhesions. The placement of a patch on such a fragile wall was deemed precarious, potentially establishing a locus of hemodynamic minoris resistentiae and thereby increasing the risk of future complications, such as pathological carotid aneurysm or sudden rupture. Thus, a graft to entirely replace the altered stretch of the right CCA was chosen, as reported in previous cases (16-18). Since FB is by definition contaminated, autologous grafts were preferred over allosteric materials, unlike in

previous cases (18), to minimize infection risk. The calibers of suitable vessels were evaluated peri-operatively via ultrasound. The use of the femoral artery, which would have been ideal due to its caliber and characteristics, was excluded because permanent prosthetic reconstruction would have been needed. The use of the saphenous vein, in contrast with previous case (17), was excluded because it was too small (3 mm vs 8 mm for the CCA). Therefore, the superficial left femoral vein was chosen, despite the risk of transient venous impairment in the leg.

The patient was placed in supine position with neck hyperextension and was rotated onto the left side by Ĩ0°. An incision was made over the right lateral neck, and the area was carefully isolated after lateralizing the sterno-mastoid muscle and anteriorizing the internal jugular vein. A superficial left femoral vein patch was obtained via a longitudinal inguinal incision, with the vein's collaterals dissected, tied, and sutured. Healthy segments of the common and internal right carotid arteries were isolated, then, during clamping for less than one minute, a Pruitt-Inahara F3® Carotid Shunt (19) was successfully positioned (Figure 3A). A 3-cm long fish bone (Figure 3B) with complete piercing of the right common carotid artery was successfully removed, hemostasis achieved, and the lacerated segment of the common carotid artery removed. The femoral graft was inserted, and a termino-terminal anastomosis was fashioned, using Prolene 6/0 suture for both sides.

The major novelty of our case report distinguishing it from previous data (16, 17, 20-26) was the choice not to proceed with prolonged intraoperative carotid clamping. Due to the expected complexity of the procedure, the young age of the patient with otherwise healthy carotid, and the estimated long duration of surgery, to minimize the risks of acute and prolonged reductions in cerebral flow, an alternative technique to proximal–distal carotid clamping consisting in Pruitt-Inahara F3® Carotid Shunt (19) was used. This system allowed us to ensure cerebral flow during carotid surgery by shunting arterial blood to the common and internal carotid vessels, reducing the risk of associated harmful neurological sequelae. In addition, to ensure continuous cerebral function monitoring under general anaesthesia, near-infrared spectroscopy (NIRS)-based cerebral oximetry with the INVOS™ 5100C Regional Oximeter (27) (Covidien, USA) was preferred to intraoperative wakening, using non-invasive continuous cerebral regional oximetry (rSO2) integrated with the cerebral bispectral index (BIS™, Medtronic, Inc, Minneapolis, MN) (28) as a guide.

2.3. Outcomes

Surgery was successful without any immediate postoperative complications apart from slight edema of the left lower limb in the absence of deep vein thrombosis. There were no neurological deficits or paralysis of the cranial nerves, and postoperative Doppler ultrasound revealed a normal velocity in both the common and internal right carotid arteries.

The patient was given intravenous antibiotics (ceftriaxone 2 g) and was discharged after 4 days, during which he received constant clinical and ultrasound follow-up. He was discharged with short-term full anticoagulation therapy (subcutaneous heparin 100 UI/kg twice daily) for one month, together with elastic compression of the left lower limb in consideration of the iatrogenic high-risk pro-thrombotic state, followed by aspirin 100 mg, orally. The patient was followed up in the clinic for three months after discharge. There were no long-term complications after the procedure, and the left lower limb gradually returned to normal without any vascular or functional impairments.

3. Literature Review

While foreign body ingestion into the upper gastrointestinal tract is relatively common (29), complications involving the carotid artery are rare but potentially life-threatening (30-34). Despite previous studies (35, 36) offering valuable insights into the broader spectrum of foreign body ingestions and their complications, they were conducted during an era with different diagnostic capabilities, which may not completely align with today's diagnostic and therapeutic standards. Furthermore, their comprehensiveness is limited by a lack of specific focus on carotid artery complications arising from extra-luminally migrated ingested foreign bodies, for which existing literature is exclusively composed of isolated case reports.

To overcome this literature gap, this narrative review aims to critically synthetize the existing evidence-based knowledge specifically surrounding carotid complications arising from ingested FBs, with the purpose to extend the understanding of the diagnostic complexities and therapeutic strategies involved in managing this rare clinical scenario. With this purpose, our aim is to address the following questions:

1. What are the demographic characteristics of patients presenting with carotid complications resulting from FB ingestion?
2. What diagnostic modalities are employed to identify carotid complications arising from extraluminal migration of accidentally ingested FBs?
3. What is the comparative diagnostic sensitivity of different examinations in identifying carotid complications associated with FB extraluminal migration?
4. What are the clinical outcomes and complications associated with various management strategies for carotid complications resulting from FB ingestion?

3.1. Methods

3.1.1. Search strategy

In this narrative review, two authors searched for related articles using the keywords of "carotid artery", "carotid complications", "pseudoaneurism", "foreign body", "ingested body", fishbone", "ingested" and "migrated". The search strategy for Pubmed was as follows:

((carotid artery) OR (carotid complications) OR (pseudoa-

neurysm)) AND ((foreign body) OR (ingested body) OR (fishbone)) AND ((ingested) OR (migrated))

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3.1.2. Databases accessed

By setting language limitations, focusing on English-language publications, a search was performed in the following electronic databases:

PubMed/Medline, Scopus, Google Scholar, and Cochrane Central database. No specific date of the last search was mentioned as the search was conducted until the time of manuscript preparation (December 2023).

3.1.3. Screening and data extraction

Data extraction was performed using standardized forms, piloted prior to use, with extraction conducted independently and in duplicate by two reviewers, with discrepancies resolved through consensus or consultation with a third reviewer, when necessary. The eligibility criteria for this review encompassed all studies primarily focusing on carotid complications arising from extraluminal migration of foreign bodies, with no age limits specified for the study population, and including descriptions of diagnostic and therapeutic approaches. No limit was set for the duration of follow-up in the selected studies, given the acute nature of this condition and its rarity. Abstracts from pertinent articles were obtained. If the study pointed to the carotid complications arising from extraluminal migration of ingested foreign body, the paper underwent complete final assessment, in accordance with eligibility criteria. In addition, bibliography and citations to the selected studies were evaluated and relevant articles not previously found were also included, in order to augment the search results. Full-text not being accessible, non-relevance to the subject, studies not reporting managing strategy, conference presentations, gray literature, letters to editor, and languages other than English were considered as exclusion criteria. Variables sought during data extraction included: participant demographics, diagnostic modalities employed and results, treatment strategies, and clinical outcomes. Assumptions and simplifications were minimized through careful consideration of the available data and consensus among reviewers.

3.2. Findings

A total of 154 studies were screened through titles and abstracts, 22 of which were deemed eligible. Following the full-text review, 16 studies fully met the inclusion criteria and were therefore analysed in detail. Reasons for exclusion included irrelevant study focus, inadequate data reporting, missing information, and duplication. Data extraction included: demographic characteristics, clinical presentation, diagnostic strategies and findings, treatment strategies, and outcomes.

3.2.1. Demographics and presentation symptoms

The data extracted from each study are presented in Table 1 (16-18, 20-26, 37-42). Sixteen case reports met our inclusion criteria. The mean age of patients was 37.9 ± 22.4 years, with a minimum age of 8 and a maximum age of 71 years. Bilateral neck swelling was a recurrent theme (16-18, 20-26, 37-42), which was of variable duration and intensity (38, 39, 41). Dysphagia ranged from mild discomfort to severe pain, correlating with the FB type and location (18, 37, 40). Odynophagia, often accompanied by a FB sensation, was common (23, 25). Systemic signs included fever and hematemesis (17, 26, 42), while painless pulsatile masses, suggestive of an aneurysmal or pseudo-aneurismal component, added diagnostic complexity (16, 23).

3.2.2. Diagnostic approaches

Endoscopic examinations were performed in ten (62.5%) patients: in five (50%) patients the examinations were negative (16, 23, 24, 38, 39), with non-specific features of inflammation (22, 25, 37) or trauma (20, 25, 42) reported in the remaining patients. No endoscopic examination visualized a foreign body. X-ray was performed in 12 (75%) patients (neck X-ray: 11; chest X-ray: 1) and was diagnostic in seven (43.8%) patients (17, 20, 24, 25, 38, 40, 41), negative in one (8.3%) patient (16) and reported non-specific signs (without direct visualization of the FB) in four (33.3%) patients (18, 22, 26, 37). CT was performed in 14 (87.5%) patients. A neck CT scan was positive and diagnostic (with direct visualization of the FB) in every patient. Complications related to extraluminal FB migration were found in ten (62.5%) patients: abscess (22, 23, 39, 41), carotid aneurysm/pseudoaneurysm (16, 18, 21, 40, 41), other signs of traumatic vessel involvement (24, 25), and arteriovenous (17) or carotid-esophageal (17, 42) fistulae. Neck ultrasound was performed in seven (43.8%) patients; ultrasound examination was positive in four (57.1%) patients and was reported as non-specific (no direct visualization of the FB) in three (18.8%) patients. Nevertheless, neck ultrasound detected FB-related complications, such as pseudoaneurysm (18, 40, 42), hematoma (37), neck vessel traumatic injury (24, 37), abscess (28), and AV fistula (17) in every patient. Notably, in three patients (26, 37, 42), neck ultrasonography successfully identified complications related to the FB that the neck CT scan had failed to detect.

3.2.3. Surgical treatment

Every patient underwent urgent surgical exploration to locate and extract the FBs. Various incisions were strategically chosen based on radiological localization and clinical assessment, allowing access to the affected anatomical sites. While emergent cervicotomy was essential in certain cases to directly access vascular structures to mitigate life-threatening hemorrhage (23), others require lateral cervical incisions to optimize exposure while minimizing collateral tissue damage, thereby ensuring meticulous dissection and precise vascular repair (39). In cases where FBs penetrated vascular structures, the choice of suture material was critical, with non-absorbable options such as fine monofilament sutures (e.g., 4/0 or 5/0 Prolene) preferred to ensure robust vascular reconstruction (22, 41) or patch grafting, such as with saphenous vein grafts, when vascular integrity needed to be restored (16-18).

Notably, hemorrhage control approaches were variable, with some cases mandating arterial clamping both proximal and distal to the injury site to facilitate safe exploration and meticulous repair of the damaged vessels, thereby safeguarding optimal vascular integrity (21, 25).

Complications such as pseudoaneurysms or abscess formation were often managed through comprehensive excision and drainage, necessitating meticulous end-to-end anastomosis to restore vascular continuity and ensure optimal perfusion, thereby mitigating the risk of postoperative complications and improving patient outcomes (16, 37). Moreover, comprehensive debridement was performed to remove devitalized tissue, and abscesses were drained to facilitate resolution and promote tissue healing (38, 40). Concurrently, in patients with oropharyngeal or esophageal injury, adjunctive measures such as tracheostomy or gastrostomy were judiciously employed to maintain airway patency and provide enteral nutrition during postoperative convalescence, thereby enhancing patient recovery trajectories (17).

3.2.4 Postoperative care and outcomes

Postoperative care involved intensive monitoring and targeted interventions to mitigate potential complications. Close surveillance for hemorrhage, infection, or neurological sequelae was essential for early recognition and management. Meticulous wound care protocols were implemented to promote optimal healing, while tailored rehabilitation strategies facilitated recovery and minimized long-term sequelae (38, 41).

Duration of follow up was reported in 11/16 studies, mean of reported follow up was 39 days (from a minimum of 2 days to a maximum of 90 days). Overall outcome was favorable in all cases, with most related symptoms resolving rapidly after surgery and with satisfactory results on imaging at follow up examinations. Nevertheless, a patient presented with complications such as transient hemiparesis or dysphagia, underscoring the importance of vigilant postoperative monitoring and supportive care to address potential sequelae and optimize patient outcomes (38).

4. Discussion

Late presentation to the emergency department with an accidentally ingested FB is more frequently associated with complications, ranging from mild mucosal ulceration to severe retropharyngeal and deep neck abscess with airway compromise, mediastinitis, retention in the thyroid gland (14, 43), and vascular dissection, due to a higher risk of FB migration and related infection (35). The majority of penetrating foreign bodies of the upper aerodigestive tract occur in the pediatric age group (36), thought previous clinical data showed that migrated foreign bodies can occur in any adult age group with no sex predilection (35), with a reported prevalence in Chinese population (35).

Extraluminal FB migration is thought to occur due to the FB being propelled through the oropharyngeal mucosa by a combination of vigorous tongue movements, constrictor peristalsis, and neck movements, thereby migrating the FB across the parapharyngeal space and carotid sheath to trap within the bulky muscle. The type of FB migration is conditioned by its shape, sharpness, direction, and orientation (35), while the duration since ingestion and the symptoms of an impacted foreign body does not always correlate with the probability of migration (35), carotid artery injuries (aneurysms or rupture) are an exception and are always delayed and occur secondary to infection (36). Although extraluminal migration is a rare complication, it must be promptly recognized because it can be life-threatening (36). In patients with suggestive symptoms of an impacted FB, a thorough medical history and physical examination followed by accurate endoscopic and radiological examination are crucial to prevent harmful misdiagnosis. Although oral examination and bedside endoscopy, followed by laryngoscopy and rigid esophagoscopy, play pivotal roles in the early management of accidentally ingested FBs (25), in late presentations, when the FB is migrated into surrounding extraluminal structures, both physical and endoscopic findings are negative (35). Specifically, a migrated FB should be suspected if symptoms persist in the neck without difficulty swallowing, or in the presence of blood-stained saliva or pooling of saliva in the hypopharynx on endoscopic examination (25), without other pathological findings.

In this review 10/16 (62.5%) patients underwent endoscopic examination, 50% of examinations were completely negative (16, 23, 24, 38, 39), and, for the other 50%, only non-specific signs of inflammation (22, 25, 37) or trauma (22, 25, 42) were reported. In all cases, FB was not directly visualized. In these situations, when symptoms persist or when there is a suggestive history despite negative endoscopic findings, suspicion of an extraluminally-migrated FB should be raised and imaging is strongly recommended (37), with a plain lateral neck X-ray as a first-line examination. According to previous data (35), a foreign body is assumed to have migrated in the event of a positive lateral neck radiograph and a negative endoscopy. Nevertheless, due to low sensitivity of x-ray (15), negative findings cannot be used to rule out this diagnosis, as not all ingested FBs (such as some fish bones) are radiopaque (44).

In our review, X-ray was performed in 12 patients (75%), revealing a diagnostic sensitivity of 43.8% for detecting FBs (17, 20, 24, 25, 38, 40, 41), consistent with a previous report in which plain radiography had a diagnostic sensitivity of 39% for FBs (45). According to our data, neck radiography was completely negative in 1/16 (8.3%) patients (16), and non-specific signs (missing direct visualization of the FB) were reported in four (33.3%) patients (18, 22, 37, 38). Moreover, 2D-radiography images failed to provide precise information about the anatomical site of impact.

If the radiograph provides definitive evidence of a foreign body or if the patient has a negative neck radiograph with a high clinical suspicion, a CT scan should be arranged for further evaluation. As previously reported (45-48), CT is supe-

rior to plain radiography for discriminating ingested foreign bodies. In our review, CT was performed in 14 (87.5%) patients, revealing diagnostic results (with direct visualization of the FB) in all cases; additionally, CT successfully identified FB-related complications in 62.5% of patients including abscess (22, 23, 39, 41), carotid aneurysm/pseudoaneurysm (16, 18, 21, 40, 41), other signs of vessel traumatic involvement (24, 25), and arteriovenous (17) or carotid-esophageal (17, 42) fistulae. Even if CT scanning may not be suitable for screening patients with suspected FB ingestion, due to radiation exposure and costs, it remains the most sensitive diagnostic tool when other investigations are negative despite persistent symptoms. Moreover, considering that a CT is the primary tool for investigation, as it gives information on the size, type, location, and orientation of the foreign body and, more importantly, on the relationship of the foreign body to other vital structures, such as the carotid sheath, hyoid bone, cricoid cartilage, and thyroid gland (35), it plays a pivotal role in surgical planning. Thus, CT scan could be considered as the first choice - avoiding neck x-ray - in cases that a positive history of ingested foreign body is provided and symptoms are persistent despite negative endoscopic exams, in combination with bedside point of care ultrasound (POCUS) of neck.

Notably, neck ultrasonography may be a useful adjunct to CT for dynamically evaluating vascular flow, especially when vascular complications are suspected. In our review, neck ultrasounds, performed in seven (43.8%) patients, had a diagnostic sensitivity of 57.1%, while in the remaining 18.8% patients it revealed non-specific signs (absence of direct visualization of FB). Moreover, neck ultrasound detected FB-related complications such as pseudoaneurysm (18, 40, 42), hematoma (37), neck vessel traumatic injury (24, 37), abscess (26), and arteriovenous (AV) fistula (18) in every patient examined with the modality. According to our data, neck ultrasounds successfully detected FB-related complications with greater sensitivity than CT (26, 37, 42).

In the presence of complications, early diagnosis and proper planning of prompt surgical exploration can help prevent life-threatening consequences. In particular, when complications arise from extraluminal migration of accidentally ingested FBs involving the large arteries of the neck, surgical exploration under general anesthesia remains the most common management strategy. Specifically, when carotid complications occur, as reported previously (16, 20-26, 37), surgical management under general anesthesia is usually conservative: in most instances (20-23, 25, 37), removal of the embedded FB by open surgery through cervicotomy (23) or lateral cervical incisions (39) followed by hemostasis and end-to-end anastomosis of the involved arterial segment were sufficient (21, 38, 39, 41, 42). In these cases, nonabsorbable options such as fine monofilament sutures (e.g., 4/0 or 5/0 Prolene) were usually preferred to ensure robust vascular reconstruction (22, 41).

In this review, in all cases with reported outcome, the overall results were largely positive and marked by symptom resolution and adequate wound healing in the majority of patients, with only one patient experiencing complications such as transient hemiparesis or dysphagia (38), emphasizing the need for vigilant postoperative surveillance for potential neurological associated sequelae.

4.1. Limitations

The general limitations of this study included the heterogeneity of the methods adopted in the reviewed studies for reporting the variables of interest and the lack of access to all the related documents published worldwide.

The discussion of limitations at the outcome level highlights several crucial considerations regarding the interpretation and external validity of our findings. Firstly, the retrospective nature of case reports introduces inherent biases, including selection bias and incomplete data collection. Secondly, the heterogeneity in surgical approaches and postoperative care protocols among included case reports complicates the assessment of the most effective management strategies, as institutional practices and surgeon preferences might cause variations in surgical techniques, along with different resources across different countries.

Thirdly, the small sample size and lack of control groups in case reports compromise the statistical power and ability to assess the relative efficacy of interventions.

Fourthly, incomplete and non-standardized follow-up and reporting of long-term outcomes limit the understanding of functional outcomes, and quality of life measures beyond the short-term postoperative period. On this point, validated scales for assessing postoperative complications or functional status at long-term would be required.

Fifthly, publication bias towards favorable outcomes and selective reporting of outcomes may overestimate success rates and skew understanding of risks associated with surgical management.

Regarding the limitations at the review level, incomplete retrieval of identified research, reporting bias, and variability in reporting of case reports due to not always adhering to CARE Guidelines (51), contribute to limitations in the quality and generalizability of findings. To overcome all these limitations in studying carotid complications from ingested foreign bodies, future research should focus on standardized protocols, larger sample sizes, studies with long-term follow up, and comparative effectiveness analyses. Collaborative efforts across institutions and international registries are essential to gather comprehensive data, enabling robust analyses and generalizable conclusions regarding patient outcomes and management strategies.

5. Conclusions

The diagnosis and management of carotid complications resulting from extraluminal migration of ingested foreign bodies are challenging and require a multidisciplinary approach. Due to mild symptoms and negative first-level ex-

aminations, clinical suspicion remains crucial to avoid missing life-threatening diagnoses. While endoscopic examination has severe limitations, radiological assessment, particularly CT scan, is essential for accurate diagnosis and surgical planning, supplemented by ultrasound to detect complications. Multidisciplinary decision-making for planning a tailored surgical approach based on the severity of carotid involvement is mandatory. In severe cases requiring extensive vessel repair, venous patch grafts potentially offer a safe alternative to carotid termino-terminal anastomosis, while Pruitt-Inahara F3® Carotid Shunt could be considered as alternative to carotid prolonged clamping when the estimated surgery time is lengthy.

6. Declarations

6.1. Acknowledgments

We would like to thank Nextgenediting (www.nextgenediting.com) for English language editing.

6.2. Conflict of interest

The authors declare that they have no competing interests.

6.3. Funding and support

This research received no external funding.

6.4. Authors' contribution

RS designed the study. RS, GF, MB, NO and CFM contributed to the article search and data extraction. RS performed data analyses, interpretation of data and manuscript writing. NO and CFM provided interpretation of data, radiological images and analysis, and contributes with RS to writing their legends. PC and DR reviewed the article independently and made minor revision. AT reviewed the article independently and made major revisions. All the authors read and provided final approval for the version to submitted and contributed substantially to its revision. The Authors certify that neither the submitted manuscript, including related data, figures, and tables, nor another one with substantially similar content under their authorship has been published in any language or being considered for publication elsewhere.

6.5. Data availability

All data generated or analyzed during this study are included in this published article. Extra data about the novel case report are available from the corresponding author on request.

6.6. Consent for publication

Written informed consent was obtained from the patient. The patient has consented to the submission of the case report for submission to the journal.

6.7. Using artificial intelligence chatbots

The use of ChatGPT-4 has been limited to enhancing the syntax and spelling in the English language within the manuscript.

6.8. List of abbreviations

AV: Arteriovenous
BIS™: Bispectral index
BP: Blood pressure
CCA: Common carotid artery
CECT; Contrast-enhanced computed tomography
CT: Computed tomography
ENT; Ear, nose, and throat
ETCO2: End-tidal carbon dioxide
FB; Foreign body
NIRS: Near-infrared spectroscopy
PDS: polyester poly(p-dioxanone)
PE: Physical examination
PRBCs: Packed red blood cells
PTFE: Polytetrafluoroethylene
rSO2; Regional oxygen saturation

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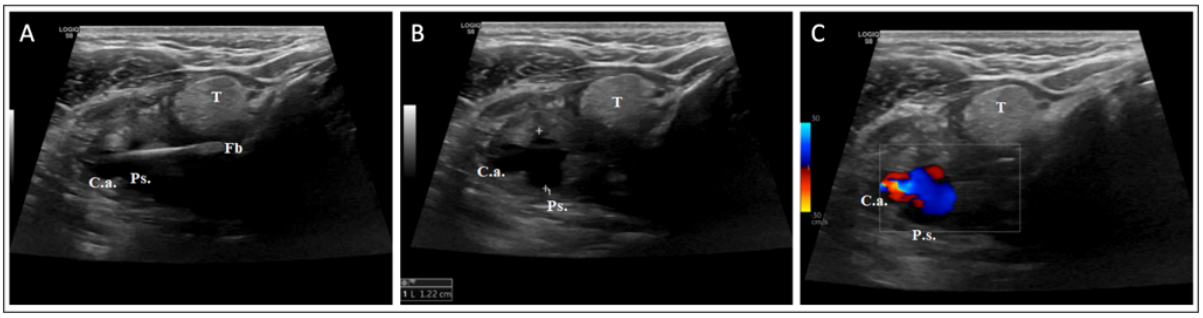

Figure 1: Neck B-mode ultrasound. (A) Paraxial view using a high-resolution multifrequency linear probe (bandwidth3-12 MHz). The fish bone passes from the soft tissue posterior to the right lobe of the thyroid to the common carotid artery, where it forms a pseudoaneurysm at the site of entry. A foreign body is seen as a hyper-echoic linear structure within the common carotid artery. Ultrasound machine: Logiq S-8, General Electric, Milwaukee. (B and C) Axial ultrasound view in B-mode (B) and B-mode color Doppler (C) showing a pseudoaneurysm on the medial side of the right common carotid artery. T: thyroid gland; Fb: foreign body; Ps: pseudoaneurysm; C.a.: common carotid artery.

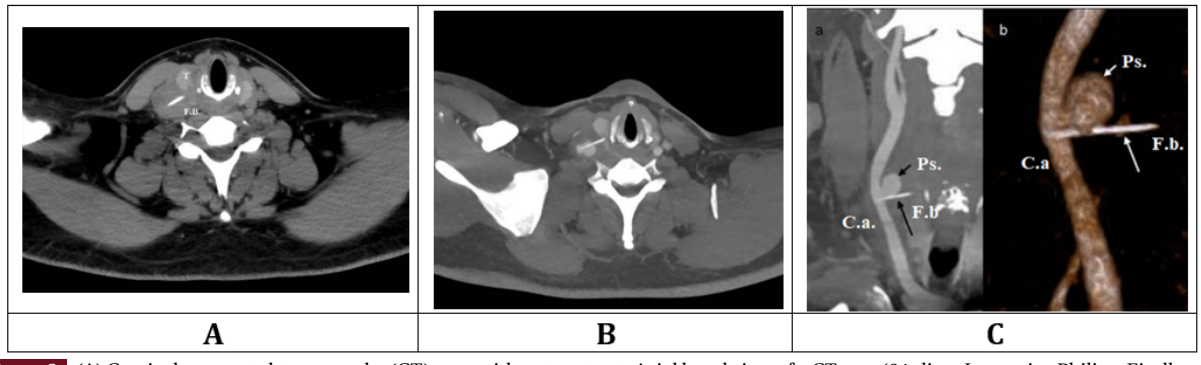

Figure 2: (A) Cervical computed tomography (CT) scan without contrast. Axial basal view of a CTscan (64 slices Ingenuity, Philips, Eindhoven, Netherlands) before administration of contrast medium. A 3-cm hyperdense fishbone can be observed on the right side, migrated into the soft tissues and right neck vascular bundles. Without administration of iodinate contrast medium, it was not possible to assess which vessel had been involved. Abbreviations: T: Thyroid gland; F.b.: foreign body. (B) Contrast-enhanced computed tomography: arterial and vascular phase. Axial view of a contrast-enhanced CT scan (64 slices Ingenuity, Philips, Eindhoven, Netherlands) in the arterial and vascular phases; maximum intensity projection (MIP) technique with 10 cm thickness. A 3-cm hyperdense fishbone can be observed with the lateral extremity in the common carotid artery, the medial extremity in the neck soft tissue (behind the right thyroid lobe), and the pseudoaneurysm on the medial side of the carotid artery at the point at which the fishbone enters the vessel. (C) Contrast-enhanced CT scan in the coronal plane in the arterial phase. Contrast-enhanced CT scan in the arterial, vascular phase (CT64 slices; Ingenuity, Philips) after intravenous injection of 80 ml of the nonionic soluble water Iopamiro 370 mg/ml (Bracco, Milan, Italy). A 3-cm hyperdense fish bone can be observed with the lateral extremity in the common carotid artery and the medial extremity in the neck soft tissue. A pseudoaneurysm on the medial side of the carotid artery at the point of fish bone entrance is observed. (A) A coronal view of the right carotid artery was obtained using the MIP technique with a thickness of 10 mm. (B) On the right side, the same CT arterial vascular phase scan was performed using the volume rendering (VR) technique to create a three-dimensional representation of the data. The carotid artery pseudoaneurysm and the fish bone with its medial extremity within the artery are well depicted. Fb: foreign body; Ps.: pseudoaneurysm; C.a.: common carotid artery.

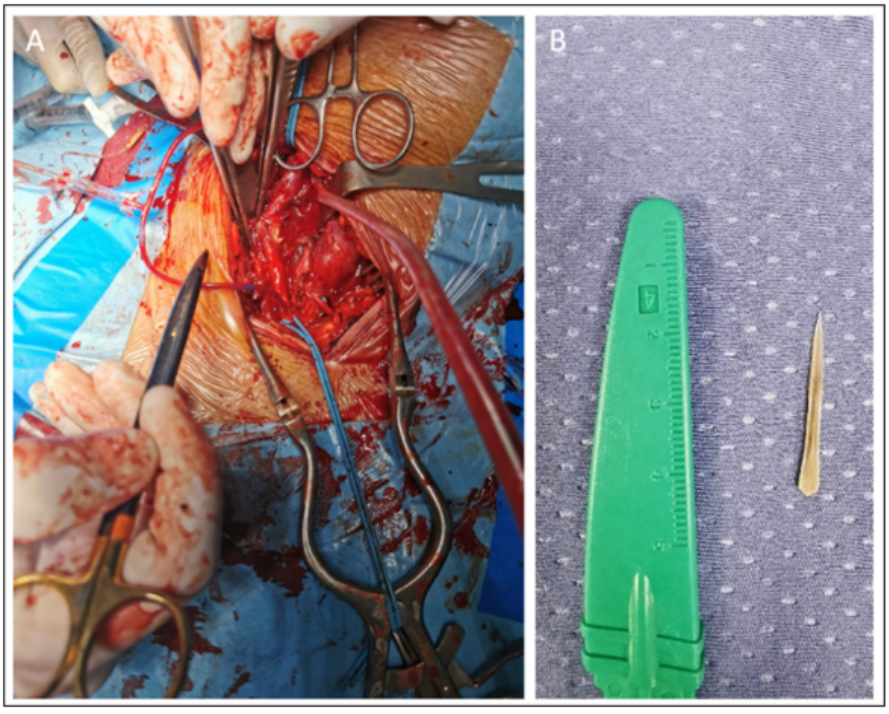

Figure 3: Intraoperative view of the neck dissection. (A) The Pruitt-Inahara F3® Carotid Shunt and the tract of the common carotid artery are visible. (B) Surgically removed accidentally ingested fish bone.

Table 1: Review of the literature on carotid complications from ingested foreign bodies

Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Lee et al. 2023 (32) Case report, 60-year-old female	Increasing right neck swelling, tenderness and heating sensation, beginning two weeks earlier. PE: Diffuse right neck swelling	Laryngoscopic examination: mucosal swelling of the right aryepiglottic fold.	Air-tracheogram: thickening of the soft tissue of the posterior pharynx. Contrast-enhanced neck CT: abscess medial to the sternocleidomastoid muscle and posterolateral to the thyroid gland; suspected FB-like material (linear-shaped, high density) near the right common carotid artery.	General anesthesia: surgical neck exploration through an external neck approach, along with incision and drainage. Massive irrigation, necrotic tissue debridement, and CuraVac insertion performed, but the severe inflammation and adhesions prevented the detection of the FB. The patient was subsequently administered intravenous antibiotics for 8 days, followed by surgical neck exploration. After dissection of the sternocleidomastoid muscle, a fishbone, approximately 3 cm in size, was detected and completely removed.
Correa et al. 2016 (20) Case report, 9-year-old female	History of a fish bone ingested three days earlier, with FB sensation and dysphagia. PE: Unremarkable	Upper gastrointestinal endoscopy: the FB was not visualized; however, a hematoma was seen in the right portion of the hypopharynx.	Cervical X-ray: a fish bone and an increase in the retropharyngeal space were identified.	Cervical exploration was performed through a right cervicotomy approach. Despite open exploration, the FB was difficult to visualize, so endoscopy and X-ray evaluation were required during the procedure. Thanks to this approach, an opening in the hypopharynx was found, and then the fish bone was identified entering the vascular lumen, through the anterior wall of the right common carotid artery. The carotid artery was dissected and repaired distal and proximal to the lesion and completely surrounded without finding an aneurism or perforation of the posterior wall. The fish bone was extracted, and vascular 5/0 Prolene was used to repair the carotid artery with interrupted sutures. The necrotic anterior wall tissue of the hypopharynx was removed, and 4/0 PDS was used to close the digestive side, also with interrupted sutures. Tissucol was used to reinforce the sutures, and the posterior portion of the digastric muscle was dissected in the middle portion and interposed between the suture lines. On follow up visit at day 8 following hospital release, patient was asymptomatic without dysphagia, tolerating oral intake, without pain, and no trill or masses on physical evaluation.
Johari et al. 2016 (37) Case series, 20-year-old male	Odynophagia and pricking sensation in the right anterior neck four days after ingesting FB while eating. PE: no fever, no neck swelling and no obstructive symptoms.	Laryngoscopy: no evidence of FB in the oropharynx, hypopharynx, or larynx. Direct laryngoscopy and rigid esophagoscopy under general anesthesia: edematous posterior pharyngeal wall but no FB seen.	Neck radiograph: a radiopaque FB shadow at C5 vertebral body level. Neck CT: thin sharp-ended FB opacity embedded within the soft tissue of the right neck just below the vocal cord region (level C5/C6). Neck ultrasonography study: a linear FB seen coursing from the right thyroid lobe and running obliquely, piercing the right common carotid artery with the tip of the FB abutting the internal jugular vein. Small hematoma in between the right thyroid lobe and the right common carotid artery.	Patient underwent right neck exploration, and the removed fish bone measured 2.5 cm, with transluminal piercing of the right common carotid artery.Patient underwent right neck exploration, and the removed fish bone measured 2.5 cm, with transluminal piercing of the right common carotid artery.

Table 1: Review of the literature on carotid complications from ingested foreign bodies (continue)

Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Jean Roger et al. 2015 (21) Case report, 8-year-old male	Left-sided neck swelling observed 3 weeks earlier,which gradually increased in size. PE: Painless pulsatile left-lateral cervical mass with a smooth outline, mild edema of the left hemiface, and a normal temperature. A systolic murmur was present suggestive of aneurysm.	Not performed or not reported.	Contrast-enhanced Contrast-enhanced CT scan of the neck: a 42 mm × 55 mm × 28 mm (H×W×AP) saccular dilatation of the left common carotid artery 20 mm proximal to the bifurcation. There was a mass effect on adjacent structures, notably the esophagus and trachea, without significant stenosis. On reformatted images, a 45 mm long linear hyperdensity was seen inside the aneurysm.	Emergency surgical operation (requiring oro-tracheal intubation due to inspiration dyspnea) performed through a left posterior cleidomastoid incision, followed by clamping of the ipsilateral common, internal, and external carotid arteries. The aneurysmal sac was resected, and a fish bone was found inside that had perforated the common carotid wall. An end-to-end anastomosis was carried out using Prolene 5/0, and cerebral blood flow was reestablished. On day 2 after surgery there was complete regression of the dyspnea and one year later the patient was completely asymptomatic.
Karim et al. 2015 (16) Case report, 28-year-old male	Four-day history of difficulty swallowing, followed by pain and swelling of the right side of the neck. Unable to swallow even liquids due to pain. History of small fish bone impaction on the same side 2 weeks before. PE: 7.5 cm × 6 cm soft tender swelling over the right side of the neck, not moving with swallowing or tongue protrusion.	Indirect laryngoscopy: the impacted bone was not detected. X-ray: the impacted bone was not detected.	CT scan of the neck and angiography: a 3.6 cm × 2.2 cm × 3 cm pseudoaneurysm arising from medial wall of the right common carotid artery (CCA) with an impacted FB likely to be a fish bone.	Urgent exploration under general anesthesia with endotracheal intubation with the use of two units of packed red blood cells (PRBCs), fluid pump and fluid warmer in hand. Arterial line inserted under local anesthesia for continuous blood pressure (BP) monitoring before induction of anesthesia. As soon as pseudoaneurysm was reached, a sudden spurt of blood led to approximately 1000 ml blood loss before it could be stopped using surgeon's finger to occlude CCA and, subsequently, the CCA was repaired with grafting. Patient's BP dropped immediately with the blood loss, which was managed with pumping warm crystalloid followed by two units of PRBCs. Patient was extubated in the deep plane of anesthesia to prevent coughing over the tube and shifted to intensive care unit for observation. No neurological deficit was found in the postoperative period, and he was discharged home in good health on 5th postoperative day.
Susibalan et al. 2015 (24) Case report, 21-year-old male	One-day history of a fish bone stuck in his throat. He could feel the FB located on the right side of his neck, corresponding to the level of the hyoid bone. He also complained of odynophagia but was still able to take fluid. PE: unremarkable.	Even with the use of a rigid 70° scope, no FB was detected. Direct laryngoscopy and esophagoscopy under general anesthesia: intraoperatively, no FB seen in the oropharynx or the supraglottic region. The hypopharynx was clear. Esophagoscopy was also negative. There was no localized pus, sloughing, or a foul-smelling collection.	Plain radiograph of the neck: vague opacity suggestive of a fish bone at the C5 level. No FB in the larynx or in the visualized trachea. Ultrasound scan of the neck: a possible FB near the right common carotid artery. The FB appeared to have pierced through the artery. Urgent CT scan of the neck: a fish bone that appeared to have pierced the carotid artery; no fluid collection or hematoma present.	Emergency neck exploration was carried out under general anesthesia. A skin incision was made two finger breadths below the right angle of mandible extending from the level of hyoid to the anterior border of the right sternocleidomastoid. The skin was opened up in layers and the sternocleidomastoid identified and retracted upward. The right common carotid artery was carefully skeletonized, and the tip of the fish bone was seen piercing the artery at the mid third of its length. Finger palpation allowed rapid identification of the involved region and the identification and removal of the FB with minimal tissue destruction. The fish bone was removed without any complications. The pierced site sealed itself and there was no tear or laceration seen in the artery wall. No repair of the artery was needed. A surgical drainage tube was inserted and the skin was closed. A Ryle's tube was inserted for commencement of feeding. The patient did well post operatively and feeding was commenced via Ryle's tube. The drain was removed two days after operation and he started on oral feeding on the following day. There was no complication and he was discharged well on 4th day after the operation. After two weeks as outpatient, he showed no complication.

Table 1: Review of the literature on carotid complications from ingested foreign bodies (continue)

Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Maués Filho et al. 2022 (23) Case report, 27-year-old female	Hematemesis, fever, and odynophagia that had started 20 days previously after accidental fish bone ingestion; reported dyspnea and dysphagia. PE: superficial palpation of the cervical region resulted in pain and phlogistic signs were identified at the site.	Upper gastrointestinal endoscopy: no source of bleeding.	Non-contrast CT scan of the neck: poorly defined right paraoesophageal collection with significant soft tissue edema compressing the right thyroid lobe and the esophagus to the left, which extended to the right sternocleidomastoid muscle. An image of an elongated FB inside the aforementioned collection measured 2.8 × 0.3 cm.	Urgent surgical intervention, in which she underwent an exploratory cervicotomy. An extensive inflammatory process was identified in the right cervical region with abscess and active bleeding in the topography of the right carotid artery. A transfixing lesion of the right common carotid artery by a serrated foreign body was observed, in addition to a transfixing lesion on the right side of the esophagus wall. After systemic heparinization with 1 ml of unfractionated heparin, proximal and distal clamping of the right common carotid artery was performed with removal of the FB, debridement of the peri-arterial inflammatory tissue, followed by suturing with 6.0 Prolene by separate stitches. Esophageal suturing was performed with Caprofyl 4.0 with separate stitches and interposition of posterior digastric muscle belly flap. There was good evolution during hospitalization with progression from enteral diet to liquefied oral diet with good tolerance. On return to the general surgery outpatient clinic about 3 months after surgery, the report was of regular intake of solid foods without any complaints. There was no return visit to the vascular surgery outpatient clinic for Doppler.
Tang et al. 2009 (25) Case report, 66-year-old male	A history of accidental fish bone ingestion the day before while having lunch. He felt the fish bone had become stuck in his throat and complained of dysphagia, odynophagia, and hoarseness of voice. He attempted to remove the fish bone by self-induced vomiting and eating some rice. However, the fish bone remained in his throat and the pain was worsening. PE: mild tenderness in right lateral upper neck	Flexible fiberoptic endoscopy of the laryngopharynx showed an inflamed right arytenoid with pooling of saliva in the pyriform fossa. The right vocal cord showed reduced movement compared with the left vocal cord. However, the airway was adequate and no fish bone was found. An urgent direct rigid endoscopy showed a small puncture wound in the right lateral wall of the pharynx 16 cm from the incisors adjacent to the right arytenoid. However, no fish bone was found.	A plain lateral X-ray of the neck showed the fish bone at the level of C5–C6. An urgent plain CT scan of the neck was performed. It showed a fish bone measuring 2.7 cm lying obliquely posterior to the right arytenoid with surrounding soft tissue edema and highly suspicious of penetrating both the common carotid artery and internal jugular vein.	An emergency exploration of the neck was performed through an incision in a skin crease on the right side of the neck. After isolating the right sternocleidomastoid muscle and retracting it laterally, the right carotid sheath was identified. A fish bone with serrated edges similar to that of a stingray bone was noted to have punctured and penetrated the common carotid artery and the internal jugular vein intraluminally as well as horizontally at the level of thyroid cartilage. Arterial clamps were used above and below the puncture; the fish bone was removed from the lateral end of the artery and vein, as the serrations on the fish bone might have caused grievous damage to the great vessels if it was removed from the point of entry. The common carotid artery and internal jugular vein were repaired with 4/0 Prolene (monofilament polypropylene). Despite an uncomplicated surgery, the hoarseness of the voice appeared worsening on the first postoperative day. Repeated flexible fiberoptic endoscope revealed immobile right vocal cord in paramedian position on the first postoperative day. He had right vocal cord palsy, otherwise he was well. He requested to be discharged on the third postoperative day. He was last seen 6 weeks after the operation and his voice returned to normal without dysphagia, odynophagia or swelling of the neck. Repeated flexible fiberoptic endoscope revealed bilateral symmetry mobile vocal cords.
Lahiri et al. 2011 (17) Case report, 45-year-old female	She presented with gradually increasing swelling in the right side of his neck, following injury by a penetrating metallic splinter two months previously. She had no other complaints. PE: Local examination revealed a 3×2 cm firm, pulsatile swelling in the right side of his neck at the level of the thyroid cartilage. The swelling had a palpable thrill.	Not performed or not reported.	An X-ray of the neck showed an opaque foreign body in the right side of his neck. A Doppler ultrasound of the neck suggested that there was an AV fistula involving the right common carotid and the internal jugular vein and the foreign body was close to the carotid artery.	Surgical exploration was undertaken under general anesthesia. The AV fistula was dissected out and after taking proximal and distal control, it was excised. Next an attempt was made to localize the foreign body under C-arm guidance: it was localized to the undersurface of the carotid artery at the level of the thyroid cartilage. An arteriotomy was performed and the splinter was removed from a saccular aneurysm in the posterior wall of the common carotid artery. The aneurysm was repaired and the arteriotomy closed with a saphenous vein patch graft. The incision was closed over a drain. Postoperative recovery was uneventful, and the patient is doing well, without any neurological deficit or other complication.

Table 1: Review of the literature on carotid complications from ingested foreign bodies (continue)

Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Thuduvage 2021 (26) Case report, 50-year-old female	Right-sided neck pain for two days. She gave a history of suspected fish bone in the throat a few days before, with symptoms subsiding over time without any investigations or treatments. She had severe odynophagia initially, which later resolved. PE: mild swelling over the right lateral neck and tenderness over the right lateral neck.	Not performed or not reported.	X-ray of the lateral neck showed a suspicions opacity over the esophageal shadow area. Ultrasound scan indicated likely parapharyngeal infection of the right side of the neck. A CT scan was arranged, which revealed a sharp fish bone that had migrated to the right side of the lateral neck remarkably close to the right carotid artery.	Neck exploration was planned under general anesthesia. The patient was positioned supine with a neck extension and rotated to the left side. An incision was made over the right lateral neck at the site of maximum swelling under CT guidance. The area was carefully explored after lateralizing the sternomastoid muscle. A fish bone was found under the sternomastoid muscle lateral to the esophagus. The fish bone was removed, and hemostasis was achieved. The patient was followed up in the clinic for 3 months after discharge. The patient did not have any immediate postoperative complications or long-term complications after the procedure.
Xu 2023 (42) Case report and literature review, 58-year-old female	Hematemesis and hemorrhagic shock. One week prior, she had visited a local hospital with throat pain and foreign body sensation after the accidental ingestion of a chicken bone. She was discharged with persistent dysphagia and throat pain after an emergent laryngoscopy examination did not reveal any foreign bodies. PE: at presentation during the second hospitalization, her clinical condition deteriorated, with low blood pressure, tachycardia, and lethargy. Her body temperature was 40.5°C, she looked pale and lethargic. The neck had no mass and the skin was intact.	An emergent endoscopic examination revealed two lamellar mucosal lesions in the upper esophagus. There was also blood in the gastric lumen.	A contrast enhanced computed tomography (CT) scan of the neck showed a patchy enhanced shadow extending from the right cervical root to the right CCA, with surrounding free air bubbles. The shadow was close to the esophageal entrance. Ultrasonography examination revealed a 33 × 27 mm cystic CCA pseudoaneurysm with partial thrombosis. An emergency carotid arteriography revealed a carotid-esophageal fistula. The patient was diagnosed with an upper gastrointestinal hemorrhage, hemorrhagic shock, right CCA pseudoaneurysm, possible right carotid-esophageal fistula, and aspiration pneumonia.	The initial management necessitated the stabilization of hemorrhagic shock through blood and platelet transfusions, the administration of tranexamic acid, and dopamine infusion. Then, under general anesthesia, the patient received a right CCA balloon occlusion, right CCA pseudoaneurysm excision, right CCA repair with end-to-end anastomosis, and debridement and drainage. The fistula in the upper esophagus was also repaired. During the operation, she received a total of 800 ml red blood cells and 400 ml plasma transfusions. Postoperatively, the patient was admitted to the surgical intensive care unit. Her vital signs gradually returned to normal limits and dopamine infusions were stopped. No major complications occurred after surgery. Contrast enhanced CT scans reported normal appearance to the right CCA. The patient was discharged from the hospital and followed up in clinic.

Table 1: Review of the literature on carotid complications from ingested foreign bodies (continue)

Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Fontes et al. 2019 (39) Case report, 71-year-old female	She presented with mild discomfort associated with a pricking sensation when swallowing, odynophagia, and a mass on the left side of her neck. Examination of the neck revealed a painful, reddish, warm, and edematous mass.	Direct rigid endoscopy (DRE) did not reveal perforation of the esophagus or detect the foreign body.	Plain and contrasted computed tomography (CT) scans revealed the presence of a foreign body in the left parapharyngeal/perihyoid region associated with an abscess, characterized by soft tissue infiltration and dissection through the cervical muscles.	Urgent exploratory surgery of the neck was performed via lateral cervical incision. To access the esophagus, the sternocleidomastoid muscle was temporally diverted. The fish bone was removed and the area extensively washed with saline 0.9%. Perforation of the esophagus and a traumatic PA of the left common carotid artery were detected. After arterial clamping of the proximal and distal ends of the vascular lesion, the PA was excised and the common carotid artery was repaired with an end-to-end anastomosis with no need of additional intervention on the internal and external carotid arteries. The esophageal perforation was sutured and adjacent tissue was used to buttress the primary repair. The sternocleidomastoid muscle was dissected at its proximal insertions and used as a flap to protect the common carotid artery. Six Penrose drains were placed in the left paraesophageal area, and the surgical wound was sutured. A tracheostomy procedure and a Whipple gastrostomy were performed to nourish the patient and to prevent possible suture dehiscence. A contrasted esophagus CT and a CT angiography of the left common carotid artery were performed 37 days after the surgery at a follow up consult, resulting normal. There was no evidence of fistulation and the patient presented satisfactory progress with no sequela.
Mathur et al. 2010 (40) Case report, 15-year-old male	Presented as an emergency with a 15-day history of painful swallowing, gradually increasing in intensity. Previously treated for tonsillitis, he had noticed a right-sided swelling of the lower neck which had progressively increased in size, associated with fever, without any chills or rigors. On direct questioning, the patient gave a history of accidental foreign body ingestion during eating, approximately 15 days ago. PE: a diffuse, globular, 5 x 5 cm mass occupying the right muscular and carotid triangles. The overlying skin was slightly erythematous. On palpation, the local skin temperature was found to be slightly raised, and the swelling was noted to be firm, smooth, and tender with ill-defined margins. There were few transmitted pulsations. Reducibility and trans-illumination were absent. The trachea was shifted to the left.	Not performed or not reported.	Plain X-ray of the neck showed a linear, radiopaque shadow. Computed tomography scanning of the neck with intravenous contrast revealed a 3x2.9 cm, contrast-filled space with an anterior, curvilinear, hypodense area in the right carotid space at the level of the C6 to T1 vertebrae, which also contained a linear, hyperdense foreign body. Doppler ultrasonography of the neck showed a 3x3 cm pseudoaneurysm of the right CCA, containing a 2.5 cm long metallic foreign body, touching the wall of the artery. The neck of the aneurysm measured 2.9 mm in diameter.	The patient was prepared for surgery under antibiotic cover. An oblique skin incision was made in the lower neck on the right. Dissection was performed with the aim of securing the right common carotid artery both below and above the aneurysm. There was little space in the neck below the aneurysm; during dissection of this region, the aneurysm was ruptured but bleeding was stopped via direct finger pressure. The dissection was thus shifted superior to the level of the aneurysm, and the common carotid artery was secured from above. The dissection was then extended below the aneurysm. There were severe adhesions between the common carotid artery and the internal jugular vein. An approximately 5 mm, linear tear was discovered in the common carotid artery wall, approximately 1 cm above the clavicle, and one end of a 3.0-cm, thin, linear, metallic wire was found piercing the artery wall. This foreign body was removed and the carotid repaired with 6-0 polypropylene sutures. The wound was sutured in layers after placing a negative pressure drain. The patient's postoperative recovery was uneventful. There was no evidence of any neurovascular compromise after 10 days of follow up.

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Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Sanapv 2014 (18) Case report, 50-year-old female	She presented with sudden onset pulsatile and gradually increasing swelling in the right lower neck for 2 months. The swelling was painless, nontender and gradually increasing in size. PE: visible swelling noted on right lower neck relatively soft on palpation. No redness over the region. The patient revealed a history of accidentally swallowing a sewing needle along with food approximately 3 months back and of having odynophagia for a few days. The pain abated to mild discomfort for the next 15-20 days and was relieved by eating plenty of bananas and drinking large quantities of water.	Not performed or not reported.	Neck radiographs revealed soft tissue swelling on the right side with displacement of tracheal shadow toward the left. A vertically oriented linear radiopaque metallic foreign body was noted overlying the left pedicles of T1 and T2 vertebral bodies. Ultrasonography with Color Doppler revealed partially thrombosed large pseudoaneurysm involving the right CCA. The right CCA was narrowed in caliber just distal to the pseudoaneurysm due to mass effect. The pseudoaneurysm sac was connecting with right CCA. CT angiography confirmed the diagnosis of a pseudoaneurysm measuring approximate 6 x 7 cm involving the proximal right CCA. This pseudoaneurysm was displacing the trachea and thyroid gland toward the left. The metallic foreign body was seen within the thrombosed medial portion of pseudoaneurysm. The sewing needle was oriented vertically closely abutting the esophageal wall, without obvious signs of esophageal perforation.	The patient was operated upon, and the sewing needle was removed along with aneurysmectomy followed by polytetrafluoroethylene (PTFE) graft repair. No active management of the distal part of CCA was done and it got re-established to its original size after treating the pseudoaneurysm. Postoperatively, it was difficult to analyze the true nature of arterial wall due to graft. Surgical correction was preferred to remove the sewing needle as other options like endovascular procedures were not useful to assess associated complications like leak; moreover, it was not possible to assess perivascular and peri-esophageal soft tissue by endovascular procedure.
Behesthirouy 2014 (38) Case report, 65-year-old female	The patient presented to the ED after experiencing severe and pulsatile hematemesis following lunch. This event occurred after three-weeks complaint of persistent dysphagia and pain in the left side of the neck, which initially manifested after consuming a small amount of bread. At that point, she perceived the sensation of a retained foreign body in her throat, prompting consultation with an otorhinolaryngologist. The direct pharyngoscopy conducted during the consultation revealed mild local erythema but no conclusive evidence of a foreign body. PE: Her vital signs at the presentation were stable with mild tachycardia. Head and neck examination revealed mild bulging of the left side of the neck with tenderness. After radiological exams, severe hematemesis occurred causing hemorrhagic shock.	Upper gastrointestinal endoscopy was negative except for a small amount of old blood in the stomach.	Neck antero-posterior and lateral radiographs revealed a transverse-lying tiny steal wire in the left side of the neck. A neck computed tomography showed a metal foreign body in the left side of the neck, protruding from the esophagus near the carotid artery wall, with air around it. Under general anesthesia, rigid esophagoscopy revealed a very small ulcer but no frank bleeding at the left pharyngoesophageal junction.	A standard anterior left sternocleidomastoid incision was performed at an acceptable distance from the upper neck bulging to control the large neck blood vessels, but sudden bleeding obscured the surgical field. The bleeding was controlled by finger packing, and the incision was extended to an upper sternotomy to control the proximal carotid without stopping the bleeding from the distal carotid stump. All tissues were severely inflamed, and distal control was very difficult and associated with severe arterial bleeding, requiring massive transfusion. After removing all blood clots and necrotic tissues, the distal stump was controlled before the carotid bifurcation. Because of severe infected inflammation, no reconstruction was possible, and both proximal and distal ends were ligated. A tiny steal wire was found protruding from the lateral wall of the esophagus and penetrating the completely disrupted carotid artery. The jugular vein was inflamed but intact, and the tiny hole in the laryngal-esophageal junction needed no repair. A Penrose drain was inserted, and the incision was repaired after irrigation. The patient was transferred to the intensive care unit and full-dose heparin was started for prevention of cerebrovascular thrombotic accident, but right-sided hemiparesis occurred, associated with dysphasia. The drain was removed after 7 days, intravenous broad-spectrum antibiotics were continued for 2 weeks, and she was discharged. Three months later, she was stable with no signs of wound infection. Most of the hemiparesis improved on physiotherapy, mild dysphasia persisted.

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Investigators and study	Clinical presentation and physical examination	Endoscopic examinations	Radiological and ultrasound examinations	Surgical management and outcome
Suharto 2018 (41) Case report, 14–year–old male	The patient, affected by cognitive disabilities, presented with a painful reddish lump on his right lateral neck for 6 days. Lump was found days after swallowing a fish bone, one week before admission. He had difficulty in communicating and was unable to express his complain. Antibiotic and analgesic were previously administered, with no improvement. PE: fever and tachypnoea. Fluctuate red painful lump found on his right lateral neck sized of 7x5x4 cm. On laboratory exam it showed a leucocytosis. ENT assessment found no pathology on oral exam.	Not performed or not reported.	Chest x–ray showed no abnormality found. Antero–posterior projection of lateral neck x–ray showed a radio–opaque linear shaped shadow on the right lateral neck at the level of C5–6th vertebra. CT scan showed right common carotid artery dilated at the level of C3–4th vertebra, just beneath the carotid bifurcation. Irregular lesion border with air visualized surround was noted. A linear shaped foreign body of bone like density found at the level of C4 in lateral right side, inferior to the dilatation. These findings were suggestive of carotid pseudoaneurysm due to migrated fish bone with a posterior mediastinal abscess.	Intra operatively, the fish bone was found penetrated esophageal wall and passing through the right common carotid artery and the right internal jugular vein; accompanied with an abscess in loose connecting tissue in cervical region. The fish bone along with 2 cm of the common carotid artery and the internal jugular vein were resected. Abscess was drained, and all identified necrotic tissues were removed. There was no mediastinitis. Stump of right internal jugular vein and right common carotid artery were ligated distally and proximally. Esophageal perforation, 1 cm in diameter, was left open for healing by secondary intention. On follow up, the fistula spontaneously closed after 56 days post operation, and he was discharged for outpatient management.

ED: Emergency Department; PE: Physical Examination; CT: Computed Tomography; FB: Foreign Body; CCA: Common Carotid Artery; PRBCs: Packed Red Blood Cells; BP: Blood Pressure; ETCO2: End-Tidal Carbon Dioxide; AV: Arteriovenous; PTFE: Polytetra fluoroethylene; PDS: Polyester Poly(p-dioxanone); PA: pseudoaneurysm. Blue color was used for follow up time and outcome.