fortune Journals

Case Report

ARCHIVES OF INTERNAL MEDICINE RESEARCH

ISSN: 2688-5654

The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature

Omar A. Bamalan[1*], Abdulaziz A. Bazuhair[1], Omar Y. AlKhlaiwy[1], Ahmad S. Bubshait[1], Eman A. Almohawes[2], Khaldoon A. Alkhums[1]

Abstract

Bowel perforation secondary to Fishbone (FB) ingestion is a common clinical entity, however factors related to FB-induced bowel perforation were rarely studied. Understanding the clinical presentation, management and biomechanics of FB-induced bowel perforation. A case report of a 63-year-old female presented to our centre with a FB-induced bowel perforation and a systematic review using the Cochrane Central Register of Controlled Trials, PubMed, MEDLINE and Web of Science databases from inception to March 2026. The inclusion criteria approved all cases with a diagnosis of FB-induced bowel perforation or related complication (e.g., intra-abdominal collection). The case was examined, investigated and operated on laparoscopically, extracting the FB and primarily repairing the ileal wall, then was discharged in a stable condition. Furthermore, the systematic review yielded a total of 174 studies, of which 30 studies were included for the qualitative and quantitative analysis. An individual's mere ingestion of a FB poses an increased risk of perforation, if the tip of the FB directly contacts the wall tissues, regardless of the tissue thickness, site or curvature, despite anatomical and health factors being pivotal in determining outcomes in post-perforation sequalae (e.g., Sepsis).

Keywords: Biomechanics, Bowel, Fishbone, Perforation

Introduction

The accidental ingestion of Fishbones is a clinical entity with a spectrum of clinical presentations and sequelae (i.e., asymptomatic to septic with peritonitis) [1,2]. In addition, small bowel perforation secondary to ingestion has been reported in several sites of relative narrowing (e.g., ileocecal junction, duodenojejunal junction), different tissue thickness (e.g., stomach, duodenum) and differing patient factors (e.g., multimorbid elders with polypharmacy) [3]. Therefore, in this case report and systematic review we focus on the biomechanics of small bowel perforation secondary to fishbone ingestion.

Methods

The patient was consented for photographs use and using the clinical details for research purposes under the Helsinki doctrine, in Security Forces Hospital in Dammam, Saudi Arabia. In addition, the formulated research question is: "In patients with fishbone ingestion, what are the factors, mechanics of bowel perforation, migration and impalement in different sites?" The guidelines of Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) were implemented in this review, with a PROSPERO ID: [CRD420251026514].

Affiliation:

[1]General Surgery Department, Security Forces Hospital, PO Box 9003, Dammam 31413, Saudi Arabia

[2]Medical Imaging Department, Security Forces Hospital, PO Box 9003, Dammam 31413, Saudi Arabia

***Corresponding author:**
Dr Omar A. Bamalan, General Surgery Department, Security Forces Hospital, PO Box 9003, Dammam 31413, Saudi Arabia.

Citation: Omar A. Bamalan, Abdulaziz A. Bazuhair, Omar Y. AlKhlaiwy, Ahmad S. Bubshait, Eman A. Almohawes, Khaldoon A. Alkhums. The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature. Archives of Internal Medicine Research. 9 (2026): 309-316.

Received: August 20, 2026
Accepted: August 27, 2026
Published: September 02, 2026

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

Search Strategy and Eligibility

A search of the literature was done using the Cochrane Central Register of Controlled Trials (OvidSP), PubMed, MEDLINE (ProQuest) and Web of Science (Clarivate) databases. The available publications from inception until March 2026 were included in the review, with an inclusion criterion of studies that discuss patients with small bowel perforation secondary to fishbones, who underwent conservative or surgical management, worldwide. The included study designs are randomized studies and others (e.g., observational studies, case-control studies, case reports). This review will consider only the articles that have been conducted on human subjects and published in any language. On the other hand, the exclusion criteria encompass studies that discuss small bowel perforation secondary to foreign bodies other than fishbones (e.g., nails, glass), involvement of non-human subjects, and poor-quality studies (i.e. unclear diagnostics, and/or outcomes). After the search was done, All relevant studies were imported into and examined for duplicates using the Microsoft Excel software, then two reviewers (OB and OA) examined the titles and abstracts for possible included studies, and if any variances between the two reviewers' discussion in regards to a study, a discussion with a third reviewer (AB) is warranted.

Data Extraction

Microsoft Excel software was used, and articles were retrieved from the databases if they met the inclusion criteria. Furthermore, excluded articles were reviewed to ensure that no relevant articles were missed in the during the first screening process. Detailed items required for data extraction were gathered and organized in tables for each included study (e.g., clinical presentation, patient demographics, FB ingestion to presentations, etc.).

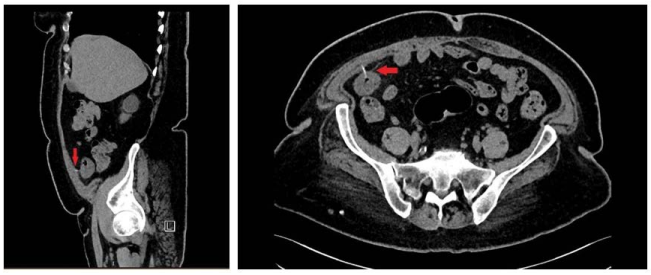
Study Quality Assessment

The Joanna Briggs Institute appraisal tools for different studies were used to assess the quality of included study and address the possible biases within (e.g., study methods and conclusions), and set an objective assessment of results' reliability.

Case presentation

This is a 63 year old female, with a past medical history of Diabetes mellitus type 2 and Hypertension and a past surgical history of an ovarian cystectomy a few years ago, presented to the Emergency department (ED) with a 2 days history of generalized abdominal pain that started suddenly, post eating her regular meal, stabbing in nature, 9/10 in severity, partially improved on analgesics, aggravating by eating or drinking with no other bleed, obstructive or septic symptomology. The patient reported that on the day prior to her pain she had a seafood meal (fried fish) and probably swallowed a few, small fish bones.

Upon examination, the patient was notably in pain, vitally stable and afebrile, while her abdomen had a diffuse tenderness at the right upper and lower quadrants, no rigidity, no guarding with intact hernial orifices. Furthermore, the patient's labs upon presentation showed elevated inflammatory marker with normal renal, pancreatic and hepatic markers. The surgical team opted for a computed tomography (CT) with intravenous contrast imaging (Figure 1a and 1b) which showed a linear bone density most likely fish bone penetrating the terminal ileum lumen and extending into right transversus abdominus and internal oblique muscles with minimal surrounding fat stranding, no free air or free fluid seen. Therefore, the patient was shifted for an emergent Laparoscopic exploration and intra-operatively, a fishbone was noted demonstrating what was described on the CT, in which it was retrieved and the defect primarily repaired (Figure 2a and 2b). Post-operatively, the patient was well, tolerating her diet and was discharged. In the outpatient clinic, a few weeks post-operatively, the patient was doing well with no complaints, ED visits or re-admission.



Figures 1: (a) A sagittal view and (b) an axial view, of the abdominal CT showcasing the fishbone (red arrowed).

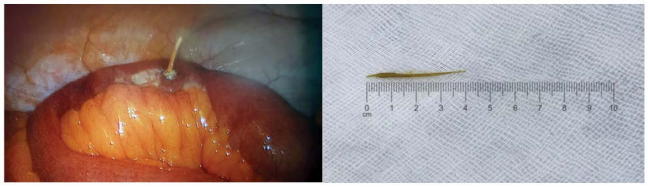


Figure 2: (a) A Laparoscopic view of the Fishbone penetrating the Terminal ileum. (b) An extracted 4 cm Fishbone.

Systematic Review Results

Study Selection

A total of 174 studies were found, 57 duplicates were removed and after a three-step filtration process, 30 studies were included after the application of the inclusion and exclusion criteria quantitative and qualitative appraisal [Table 1 and Figure 3].

Citation: Omar A. Bamalan, Abdulaziz A. Bazuhair, Omar Y. AlKhlaiwy, Ahmad S. Bubshait, Eman A. Almohawes, Khaldoon A. Alkhums. The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature. Archives of Internal Medicine Research. 9 (2026): 309-316.

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

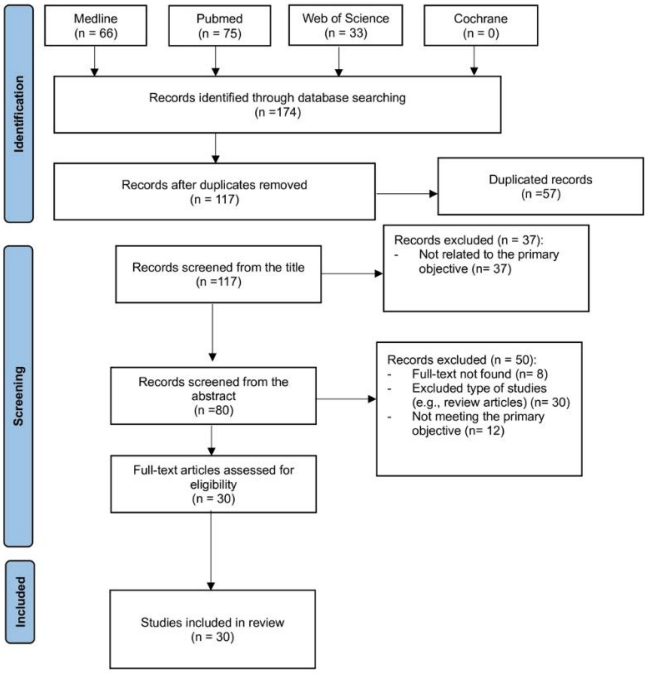


Figure 3: PRISMA Figure.

Demographics and Background

The resultant included international studies including the majority from Spain [13, 17], China [19, 28-30, 32], United Kingdom [15, 23, 26], Turkey [8, 22, 31] and Japan [5, 23, 25], with a sample size of 87 participants. The number of Male patients was 57 (65.5 %) and Female patients 30 (34.5 %) with a Male-to-female ratio of 2:1. The mean age of included cases was 52.7 ± 3.8 years of age [Range 5 – 83] with 2 patients being below 18 years of age (a 5 years old Male and a 10 years old Female) [12, 32] [Table 1].

The patients past medical and surgical histories included 3 patients with ischemic heart disease requiring angioplasty [17, 24, 29], 3 hypertensive [14, 17, 28] and 2 hypothyroid patients [14, 15]. On the other hand, a patient underwent partial gastrectomy for gastric cancer at the age of 60 [13] and a Roux-en Y gastric bypass (RYGBP) in another patient [15]. However, most of the included studies did not record the patients' background.

Diagnostics

Clinically, the chief complaint was abdominal pain of varying sites while identification of fish type and duration since ingestion was limited, in 12 studies the duration from ingestion of fish to diagnosis was 7.7 ± 2.5 days, with 5 studies being able to identify the fish type (Codfish, Rockfish, Sea bass, Tilapia and Salmon) [4-6,9,12,14,17,22,24,27,30,31]. Radiologically, the most commonly utilized imaging modality was abdominal computed tomography (A-CT) then abdominal ultrasound (A-US) and rarely a magnetic resonances imaging (MRI) was indicated or done. Furthermore, the site of impaction was mainly the ileum in 12 studies [16,4,8,10-12, 17, 23,24,26,27,31], Duodenum in 6 studies [18,20-22, 29, 30] and Colon in 5 studies (3 in the rectosigmoid, 1 in the right-colon and 1 in the cecum) [4,5,13,16,32]. In addition, there were unusual sites of impaction noted, such as the appendix [7, 28], Omental mass [25], urachal cyst [33] and Meckel's diverticulum [10, 27]. Nonetheless, there was a statistically insignificant ($P > 0.05$) correlation between fishbone length to site, days till presentation and age.

Management

There was a spectrum of presentations and imaging results, accordingly the management was individually tailored with three main categories. Firstly, conservative care (i.e., intravenous antibiotics, percutaneous aspiration of abscess, intensive care with follow up imaging) in which 8 patients underwent it. Secondly, endoscopic exploration and retrieval where 9 patients had symptoms alleviation with no noted complications. Lastly, surgical (open or laparoscopic) exploration and extraction was opted in 70 patients with various employed techniques (e.g., retrieval and primary repair, resection and anastomosis, etc.). There were no noted major post-operative complications or functional affection.

Bias assessment

The quality of the included studies was assessed using Joanna Briggs Institute critical appraisal checklists were utilized, to evaluate for bias categories (information bias, selection bias, confounding), study design and statistical analysis. In addition, depending upon the checklists output, the category is labelled as high, intermediate or low risk of bias. The details of the assessment of bias are provided in (Supplementary Tables 1-3).

Discussion

Foreign body ingestion represents a significant clinical issue, with fishbone ingestion being one of the most frequently encountered scenarios, posing a substantial risk of bowel perforation [34]. We encountered a case of a fishbone penetrating the lumen of the terminal ileum and impaling into the abdominal wall. This prompted us to conduct a systematic review of literature on fishbone-related intestinal perforations and derive factors related to its biomechanics.

Perforation sites and patient characteristics

The systematic review identified multiple studies discussing perforations found in different anatomical sites, we revealed that the most frequent perforation sites are the ileum, followed by the duodenum and stomach. In addition, uncommon sites were found (e.g., Roux-en-Y gastric bypass entero-enterostomy site, Meckel's diverticulum) affected by fishbones ranging from 1 to 4.5 cm in length. Notably, our findings did not reveal any correlation between the size of the fishbone and the site of Perforation.

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

The mean age and standard deviation for each anatomical site was calculated as follows: Stomach (59.7 ± 12.5 years), Duodenum (53.6 ± 15.7 years), Jejunum (50.5 ± 8.5 years), Ileum (45.7 ± 22.5 years) and Sigmoid (80 ± 3 years), while abdominal pain was the most frequent symptom. The majority of cases were males noted across all sites, especially in the ileum, representing 60.6%, initially presenting with symptoms lasting for a mean of 2 days, with noted outliers (e.g., extending up to 10 months [13]). The analysis of the outliers yielded no unique characteristics reported to account for the chronic nature of the condition.

Management

Immediate intervention was required in cases of duodenal perforation presenting with septic shock, however the rest were hemodynamically stable. In managing these cases, our data showed that endoscopic retrieval was feasible in hemodynamically stable patient with perforations in the stomach, duodenum, and one reported case involving the sigmoid colon with no noted complications and fishbone sizes ranging from 1.8 to 4 cm. Furthermore, most reported cases were managed via a laparoscopic approach, either involving retrieval with primary repair or bowel resection and anastomosis. A few cases necessitated a laparotomy approach, often owing to either fishbone perforation complications (e.g., splenic abscess), or challenging sites (e.g., entero-enterostomy site of a Roux-en-Y gastric bypass). The data suggest that in hemodynamically stable patients an endoscopic approach is safe for accessible sites, while the laparoscopic approach is an alternative, depending on the surgeon's expertise in laparoscopy.

Biomechanics

The mechanics of intestinal contraction is crucial for understanding the mechanics of fishbone-induced intestinal perforations. The contraction of smooth muscle fibres within the intestines generates a mechanical force on the mucosal wall that imparts movement to the underlying contents, facilitating flow [35]. To understand this further, we formulated an equation to estimate the force with which a fishbone might perforate the wall of the intestines [Figure 4], we utilized our formula within a theoretical scenario of a fishbone perforating ileal wall, relying on numerical estimates derived from our systematic search results [4-33]. The typical thickness of the ileal wall is 2.5 mm, with a curvature radius of 20 mm, and an estimated tissue failure stress at 1.5 MPa and given a fishbone with a tip area of 0.5 mm², travelling at a momentum 1.4 x 10-3 Kg•m/s (a typical sized fishbone propagation through 5 cm of bowel) conveys a force of 255 MPa if the tip of the fishbone comes in contact with the bowel wall. However, a force of approximately 0.19 N could theoretically perforate the ileum (this force is less than the gravitational force acting on a small coin). Accordingly, perforation occurs if force applied by the fishbone exceeds the critical stress threshold of a tissue. Furthermore, in an attempt to expand the scope of our hypothesis we altered the numerical parameters in the equation, yet it did not yield substantial changes in results, even when varying the radius or wall thickness.

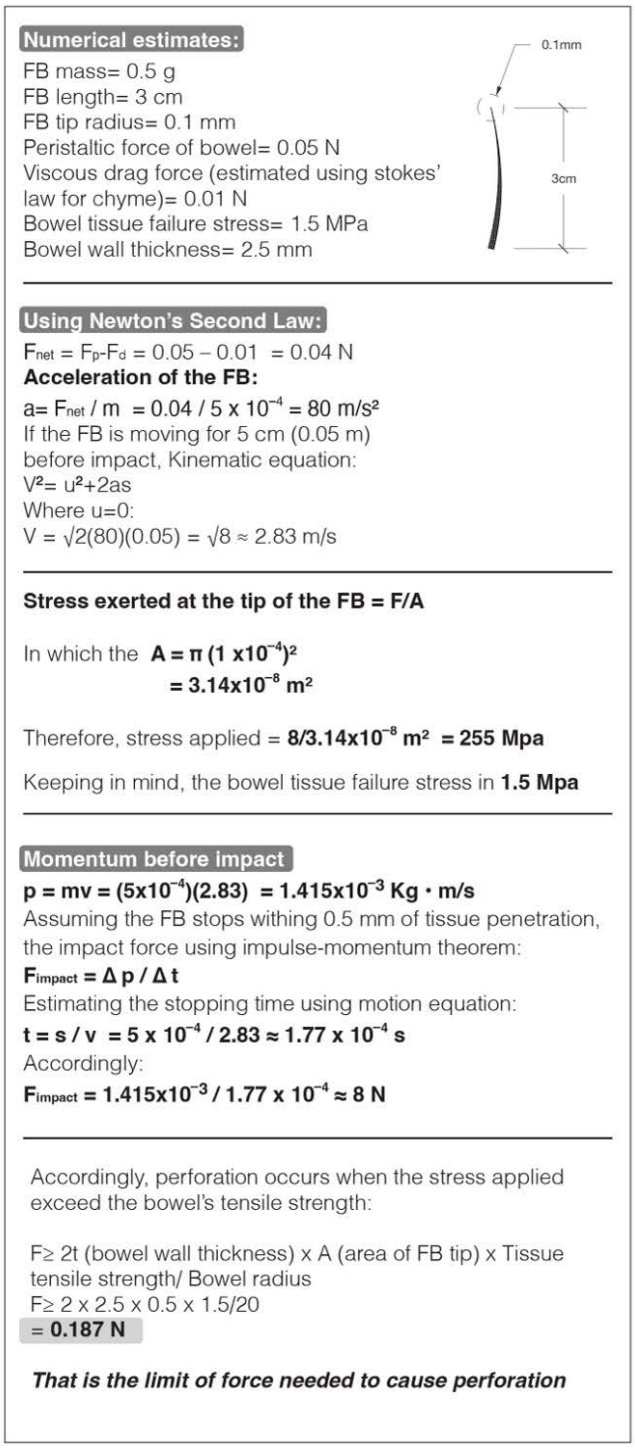


Figure 4: The utilization of physics laws to formulate an understanding of fishbone-induced perforation and related biomechanics. F: force, mm: millimetre, MPa: megapascal, N: newton, P: pressure, t: bowel wall thickness and FB: Fishbone.

Citation: Omar A. Bamalan, Abdulaziz A. Bazuhair, Omar Y. AlKhlaiwy, Ahmad S. Bubshait, Eman A. Almohawes, Khaldoon A. Alkhums. The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature. Archives of Internal Medicine Research. 9 (2026): 309-316.

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

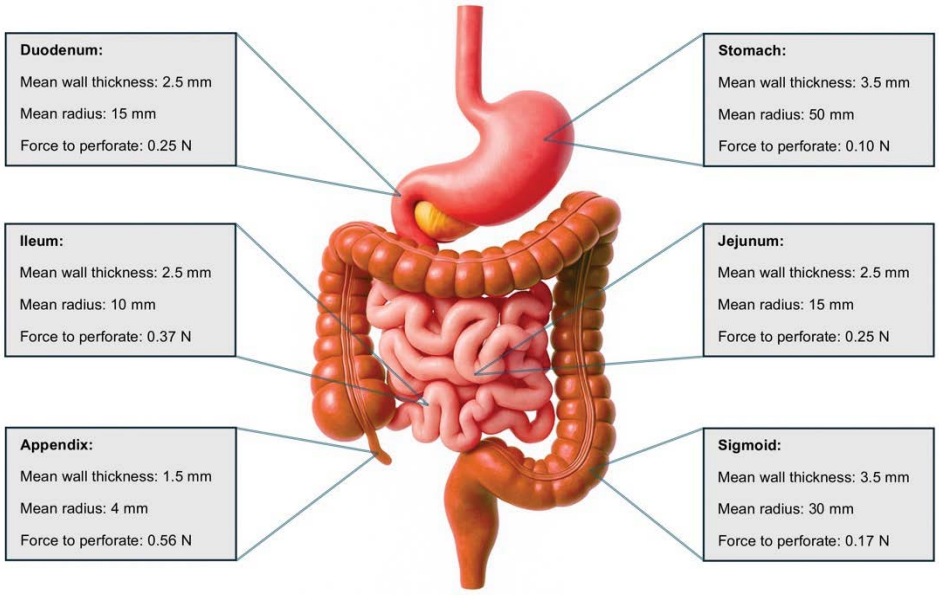


Figure 5: A demonstration of the equations applied at different sites of the gastrointestinal tract.

Conclusion

The qualitative and quantitative analysis of our case and systematic review indicates no clear correlation between fishbone size and perforation site, suggesting that an individual's mere ingestion of a fishbone poses an increased risk of perforation at any site of the gastrointestinal tract, despite anatomical and health factors being pivotal in determining outcomes in post-perforation sequalae (e.g., Sepsis). The risk has been analysed and proven to be present regardless of bowel diameter, wall thickness and content. This highlights the necessity for heightened awareness among healthcare professionals regarding the implications of fishbone ingestion (e.g., intra-abdominal abscess). Future research should focus on elucidating the biomechanics involved and developing standardized management protocols to enhance patient care and outcomes.

Ethics statement:

This study was performed in accordance with the Declaration of Helsinki. Ethics approval for this human study was waived by Security Forces Hospital. All adult participants provided written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for publication of the details of their medical case and any accompanying images.

Funding: No funding was granted

Declarations of interest: none

Acknowledgments

The authors would like to thank Naser F. Ashour for his support in editing the figures and illustrations used in this paper.

References

1. Choi Y, Kim G, Shim C, et al. Peritonitis with small bowel perforation caused by a fish bone in a healthy patient. World J Gastroenterol. 20 (2014): 1626-1629.
2. Ngan JH, Fok PJ, Lai EC, et al. A prospective study on fish bone ingestion. Experience of 358 patients. Ann Surg. 211 (1990): 459-462.
3. Elbakouri A, Yaqine K, Bouali M, et al. Fish bone perforation of the small bowel: A case report. Ann Med Surg (Lond). 65 (2021): 102348.
4. Dupont DH, Umejiego LM, Satoskar S, et al. Fishbone Foreign Body Ingestion With Gastric Impaction and Intestinal Micro-perforation in an Adult Female: A Case Report. Cureus. 16 (2024): e72099.
5. Imoto A, Nagata Y, Shinohara Y, et al. Colonic Fishbone-Induced Perforation Involving a Penile Colorectal Carcinoma: A Case Report. Case Rep Gastroenterol. 18 (2024): 431-438.
6. Saleem A, Alenezi S, Abdulbaqi S, et al. Multiple abdominopelvic abscesses caused by fishbone: A case report of rare etiology and literature review. Int J Surg Case Rep. 110 (2023): 108608.
7. Das A, Pandurangappa V, Tanwar S, et al. Fishbone-Induced Appendicular Perforation: A Rare Case Report of Amyand's Hernia. Cureus 15 (2023): e37313.
8. Demir MK, Turanoglur H, Yılmaz S. Fishbone perforation of the terminal ileum mimicking acute appendicitis. Br J Hosp Med (Lond). 83 (2022): 1.
9. Xia F, Zhu P, Chen XP, et al. Liver abscess in the caudate

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

lobe caused by a fishbone and treated by laparoscopy: a case report. BMC Surg. 22 (2022): 6.

10. Camacho Baca P, Caballero-Alvarado J, Centurión-Jáuregui G, et al. Perforation of Meckel's diverticulum by a fishbone. Khirurgiia (Mosk). (12. Vyp. 2) (2022): 78-80.

11. Crowley CD, Rieter WJ, Gordon L. Terminal ileal micro-perforation from an ingested fish bone incidentally diagnosed with 111In-leukocyte scintigraphy in an asymptomatic patient. Radiol Case Rep. 16 (2021): 2969-2971. Erratum in: Radiol Case Rep. Jan 15; 18 (2023): 1385-1386.

12. Ngoc Nguyen S, Duy Nguyen T, Tung Vu L, Ngoc Bao Hoang C. Intestinal perforation caused by fishbone in a child with the misdiagnosis of acute appendicitis: A case report. Clin Case Rep. 9 (2021): e04584.

13. Kanaoka Y, Hasuike Y, Fukuchi T, Tsuchida Y. Migration of an ingested fishbone to the uterine wall: A case report. J Obstet Gynaecol Res. 47 (2021): 1178-1181.

14. Enes Silva J, Pinelas S, Pacheco M, et al. Gastric perforation by fish bone with hepatic abscess formation presenting as prolonged fever. IDCases. 24 (2021): e01159.

15. Traynor P, Stupalkowska W, Mohamed T, et al. Fishbone perforation of the small bowel mimicking internal herniation and obstruction in a patient with previous gastric bypass surgery. J Surg Case Rep. 9 (2020): rjaa369.

16. Villanueva Campos AM, Martínez Rodríguez C, Tardáguila de la Fuente G, et al. Gastrointestinal perforation caused by ingested fish bone. Computed tomography findings in 58 patients. Radiologia (Engl Ed). 62 (2020): 384-391.

17. Abdel-Kader S, Mousa H, Vairavan M, et al. Fishbone bowel perforation mimicking acute diverticulitis: a diagnostic dilemma. ANZ J Surg. 90 (2020): 635-637.

18. Lemaître M, Cabral D, Salomon E, Geri G. En route to the liver: an fishbone's unexpected journey. Intensive Care Med. 44 (2018): 1148-1149.

19. Sierra-Ruiz M, Sáenz-Copete JC, Enriquez-Marulanda A, Ordoñez CA. Extra luminal migration of ingested fish bone to the spleen as an unusual cause of splenic rupture: Case report and literature review. Int J Surg Case Rep. 25 (2016): 184-187.

20. Jimenez-Fuertes M, Moreno-Posadas A, Ruíz-Tovar Polo J, et al. Liver abscess secondary to duodenal perforation by fishbone: Report of a case. Rev Esp Enferm Dig. 108 (2016): 42.

21. Loveluck M, Liu DS, Froelich J, Yellapu S. Fishbone perforation causing duodenocaval fistula and caval thrombus. ANZ J Surg. 85 (2015): 986-987.

22. Tumay V, Guner OS, Meric M, et al. Endoscopic Removal of Duodenal Perforating Fishbone - A Case Report. Chirurgia (Bucur): 110 (2015): 471-473.

23. Hakeem A, Shanmugam V, Badrinath K, et al. Delay in diagnosis and lessons learnt from a case of abdominal wall abscess caused by fishbone perforation. Ann R Coll Surg Engl. 97 (2015): e39-42.

24. Beecher SM, O'Leary DP, McLaughlin R. Diagnostic dilemmas due to fish bone ingestion: Case report & literature review. Int J Surg Case Rep. 13 (2015): 112-115.

25. Yamamoto T, Hirohashi K, Iwasaki H, et al. Pseudotumor of the omentum with a fishbone nucleus. J Gastroenterol Hepatol. 22 (2007): 597-600.

26. Law WL, Lo CY. Fishbone perforation of the small bowel: laparoscopic diagnosis and laparoscopically assisted management. Surg Laparosc Endosc Percutan Tech. 13 (2003): 392-393.

27. Christensen H. Fishbone perforation through a Meckel's diverticulum: a rare laparoscopic diagnosis in acute abdominal pain. J Laparoendosc Adv Surg Tech A. 9 (1999): 351-352.

28. Beh JC, Uppaluri AS, Koh BF, Cheow PC. Fishbone Perforated Appendicitis. J Radiol Case Rep. 10 (2016): 14-22.

29. Gao X, Dong T, Sun R, Xiao J. Deceiving duodenal erosion: a fishbone lies beneath. Rev Esp Enferm Dig. 116 (2024): 723-724.

30. Yi L, Cheng Z, Zhou Y, et al. Fishbone foreign body ingestion in duodenal papilla: a cause of abdominal pain resembling gastric ulcer. BMC Gastroenterol. 20 (2020): 323.

31. Mutlu A, Uysal E, Ulusoy L, et al. A fish bone causing ileal perforation in the terminal ileum. Ulus Travma Acil Cerrahi Derg. 18 (2012): 89-91.

32. Lau SC, Cheung M, Lee K, Wong Y. Fishbone impaction with cecal perforation mimicking acute appendicitis: A case report. J Pediatr Surg Case Rep. 96 (2023): 102700.

33. Zin MHM, Krishnasamy T, Kosai NR. Retro umbilical abscess mimicking infected urachal cyst: A rare presentation from migratory fish bone ingestion. GMJ. 32 (2021): 466-468.

34. Ngan JH, Fok PJ, Lai EC, et al. A prospective study on fish bone ingestion. Experience of 358 patients. Ann Surg. 211 (1990): 459-462.

35. Avvari RK. Biomechanics of the small intestinal contractions. In: Digestive System—Recent Advances. (2019): 1-25.

Citation: Omar A. Bamalan, Abdulaziz A. Bazuhair, Omar Y. AlKhlaiwy, Ahmad S. Bubshait, Eman A. Almohawes, Khaldoon A. Alkhums. The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature. Archives of Internal Medicine Research. 9 (2026): 309-316.

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

Supplementary Table 1.

Case report	Question (Q)	Low risk of bias	Intermediate risk of bias	High risk of bias
Information bias	3,4,7	Answer Yes 3 times	Answer Yes 1/2 times	Answer Yes 0 times
Selection bias	1,2	Answer Yes 2 times	Answer Yes 1 times	Answer Yes 0 times
Confounding	5,6	Answer Yes 2 times	Answer Yes 1 times	Answer Yes 0 times
Statistical quality	8	Answer Yes 1 times		Answer Yes 0 times

Cohort	Question	Low risk of bias	Intermediate risk of bias	High risk of bias
Information bias	2,3,7,8,9,10	Answer Yes 5/6 times	Answer Yes 3/4 times	Answer Yes 0/1/2 times
Selection bias	1,6	Answer Yes 2 times	Answer Yes 1 times	Answer Yes 0 times
Confounding	4,5	Answer Yes 2 times	Answer Yes 1 times	Answer Yes 0 times
Statistical quality	11	Answer Yes 1 times		Answer Yes 0 times

Supplementary Table 2.

The table below shows the results of the different JBI questionnaires (cohort studies and Case report studies).
Available on: https://jbi.global/critical-appraisal-tools

Cohort	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Campos et al, 2020 [16]	NA	NA	Yes	UC	UC	Yes	Yes	UC	NA	NA	Yes
Case Reports	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**			
Dupont et al, 2024 [4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Imoto et al, 2024 [5]	No	Yes	Yes	Yes	Yes	Yes	No	Yes			
Saleem et al, 2023 [6]	Yes	UC	Yes	Yes	Yes	Yes	Yes	Yes			
Das et al, 2023 [7]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Demir et al, 2022 [8]	UC	UC	Yes	Yes	UC	UC	UC	No			
Xia et al, 2022 [9]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Baca et al, 2022 [10]	Yes	UC	Yes	Yes	Yes	Yes	No	Yes			
Crowley et al, 2021 [11]	No	UC	UC	Yes	UC	Yes	UC	Yes			
Nguyen et al, 2021 [12]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Kanaoka et al, 2021 [13]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Silva et al, 2021 [14]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Traynor et al, 2020 [15]	UC	UC	Yes	Yes	Yes	Yes	Yes	UC			
Saleh et al, 2019 [17]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Lemaître et al, 2018 [18]	UC	UC	Yes	Yes	No	No	No	No			
Sierra-Ruiz et al, 2016 [19]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Jiménez-Fuertes et al, 2016 [20]	UC	UC	UC	Yes	Yes	Yes	UC	UC			
Maree et al, 2015 [21]	Yes	UC	Yes	Yes	Yes	Yes	Yes	Yes			
Tumay et al, 2015 [22]	UC	UC	UC	Yes	Yes	Yes	UC	Yes			
Hakeem et al, 2015 [23]	UC	Yes	UC	Yes	Yes	Yes	Yes	Yes			
Beecher et al, 2015 [24]	Yes	Yes	Yes	Yes	Yes	Yes	UC	Yes			
Yamamoto et al, 2007 [25]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Law et al, 2003 [26]	UC	Yes	Yes	Yes	Yes	Yes	UC	Yes			
Henrik Christensen, 1999 [27]	Yes	UC	Yes	No	Yes	Yes	UC	Yes			
Beh et al, 2016 [28]	Yes	Yes	Yes	Yes	Yes	Yes	UC	Yes			
Gao et al, 2024 [29]	UC	UC	UC	UC	Yes	Yes	UC	Yes			
Yi et al, 2020 [30]	Yes	UC	UC	UC	Yes	Yes	UC	Yes			
Mutlu et al, 2012 [31]	Yes	UC	Yes	Yes	Yes	No	No	Yes			
Lau et al, 2023 [32]	Yes	UC	UC	Yes	Yes	Yes	UC	Yes			
Zin et al, 2021 [33]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			

Abbreviations: NA=not applicable, Q=question, UC=unclear

Citation: Omar A. Bamalan, Abdulaziz A. Bazuhair, Omar Y. AlKhlaiwy, Ahmad S. Bubshait, Eman A. Almohawes, Khaldoon A. Alkhums. The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature. Archives of Internal Medicine Research. 9 (2026): 309-316.

Bamalan OA, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0257

Supplementary Table 3.

Cohort	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Campos et al, 2020 [16]	NA	NA	Yes	UC	UC	Yes	Yes	UC	NA	NA	Yes
Case Reports	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**			
Dupont et al, 2024 [4]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Imoto et al, 2024 [5]	No	Yes	Yes	Yes	Yes	Yes	No	Yes			
Saleem et al, 2023 [6]	Yes	UC	Yes	Yes	Yes	Yes	Yes	Yes			
Das et al, 2023 [7]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Demir et al, 2022 [8]	UC	UC	Yes	Yes	UC	UC	UC	No			
Xia et al, 2022 [9]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Baca et al, 2022 [10]	Yes	UC	Yes	Yes	Yes	Yes	No	Yes			
Crowley et al, 2021 [11]	No	UC	UC	Yes	UC	Yes	UC	Yes			
Nguyen et al, 2021 [12]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Kanaoka et al, 2021 [13]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Silva et al, 2021 [14]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Traynor et al, 2020 [15]	UC	UC	Yes	Yes	Yes	Yes	Yes	UC			
Saleh et al, 2019 [17]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Lemaître et al, 2018 [18]	UC	UC	Yes	Yes	No	No	No	No			
Sierra-Ruiz et al, 2016 [19]	UC	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Jiménez-Fuertes et al, 2016 [20]	UC	UC	UC	Yes	Yes	Yes	UC	UC			
Maree et al, 2015 [21]	Yes	UC	Yes	Yes	Yes	Yes	Yes	Yes			
Tumay et al, 2015 [22]	UC	UC	UC	Yes	Yes	Yes	UC	Yes			
Hakeem et al, 2015 [23]	UC	Yes	UC	Yes	Yes	Yes	Yes	Yes			
Beecher et al, 2015 [24]	Yes	Yes	Yes	Yes	Yes	Yes	UC	Yes			
Yamamoto et al, 2007 [25]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Law et al, 2003 [26]	UC	Yes	Yes	Yes	Yes	Yes	UC	Yes			
Henrik Christensen, 1999 [27]	Yes	UC	Yes	No	Yes	Yes	UC	Yes			
Beh et al, 2016 [28]	Yes	Yes	Yes	Yes	Yes	Yes	UC	Yes			
Gao et al, 2024 [29]	UC	UC	UC	UC	Yes	Yes	UC	Yes			
Yi et al, 2020 [30]	Yes	UC	UC	UC	Yes	Yes	UC	Yes			
Mutlu et al, 2012 [31]	Yes	UC	Yes	Yes	Yes	No	No	Yes			
Lau et al, 2023 [32]	Yes	UC	UC	Yes	Yes	Yes	UC	Yes			
Zin et al, 2021 [33]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			

Abbreviations: NA=not applicable, Q=question, UC=unclear

Citation: Omar A. Bamalan, Abdulaziz A. Bazuhair, Omar Y. AlKhlaiwy, Ahmad S. Bubshait, Eman A. Almohawes, Khaldoon A. Alkhums. The Biomechanics of Fishbone-Intestinal Perforation: A Case-Report and Systematic Review of Literature. Archives of Internal Medicine Research. 9 (2026): 309-316.