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Stented versus Non-Stented Endoscopic Transnasal Repair of Pediatric Choanal Atresia: A Systematic Review of Surgical Outcomes and Restenosis Risk

Ahmed Alahmari[1], Abdullah Alahmari[2], Abdulaziz Alshahrani[3], Khalid Alshahrani[3], Abdulrahman Alqahtani[3], Bander Alamrai[3], Khalid Alahmari[4]

[1]Pediatric ORLHNS Department, Aseer Health Cluster, Abha, Saudia Arabia
[2]Pharmacy Collage, Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudia Arabia
[3]ORLHNS Department, Aseer Health Cluster, Abha, Saudia Arabia
[4]Speech Pathology Department, King Khalid University, Abha, Saudia Arabia

Email: dr71013@hotmail.com, a.alahmari@pasu.edu.sa, Abdulazizmsalii@gmail.com, Kalazizabd@gmail.com, abo-jobran2015@hotmail.com, B.alamraimd@gmail.com, kaledkh09@gmail.com

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Abstract

Choanal Atresia (CA) is a rare congenital condition with variable surgical management in pediatric populations, and the role of postoperative stenting remains controversial. This systematic review aimed to compare surgical outcomes and restenosis risk between stented and non-stented endoscopic transnasal repair in children with CA. The review was conducted in accordance with PRISMA guidelines, with searches of PubMed, CINAHL, Scopus, Cochrane Library, and Web of Science through February 2026. The primary comparison was restricted to studies that directly evaluated both stented and non-stented groups; single-arm studies were considered indirect supportive evidence. Twelve studies involving 376 patients were included. Restenosis and patency outcomes varied substantially across studies, and direct comparative studies did not show a uniform direction or magnitude of benefit from either approach. Several comparative studies reported higher restenosis with stenting, whereas other studies showed substantial restenosis in non-stented groups. Differences in mucosal-flap technique, vomer resection, postoperative care, stent material and duration, and patient severity may have contributed to the observed heterogeneity. Overall, Reported restenosis rates varied substantially across studies and between treatment groups. Comparative studies generally suggested a higher risk of restenosis with stenting, but the magnitude of this difference was inconsistent, and some studies reported substantial

restenosis in both stented and non-stented groups. Therefore, the reported ranges should not be interpreted as uniformly representative of all included studies.

Keywords

Choanal Atresia, Transnasal Endoscopy, Stented Repair, Non-Stented Repair, Pediatrics

1. Introduction

Choanal Atresia (CA) is a rare congenital disorder that commonly presents clinical challenges to neonates and infants [1]. It arises from failure of the nasal cavity to communicate with the nasopharynx during fetal development, causing respiratory distress that worsens during feedings [2]. CA consists of unilateral and bilateral bony or mixed bony-membranous between the nose and nasopharynx. Approximately 70% of CA cases are mixed-bony membranous, while pure bony cases are rare, accounting for 30% of the cases [3]. Unilateral CA can be asymptomatic at birth and mostly diagnosed later in adulthood, while bilateral CA presents at birth and requires timely surgical intervention to prevent further complications that can be life-threatening [4].

Bilateral CA is managed through various surgical procedures, from transpalatal, transseptal, to transnasal procedures. In recent years, pediatric otorhinolaryngologists have increasingly favoured endoscopic transnasal procedure to manage bilateral CA because of its minimally invasive nature and direct visualization of the surgical field [5]. Post-operative stenting in the management of bilateral CA remains a common practice to maintain airway patency and prevent restenosis during the healing process, though there are considerable debates about its safety and efficacy. In stented endoscopic transnasal repair, a stent is placed within the nasal passage after creating an opening in the posterior nasal aperture [6]. Stenting protocols based on stent duration, material, and adjuncts, including antibiotics and steroids used with the stents [7].

Non-stented endoscopic transnasal repair uses mucosal flaps, such as the mirrored L-shaped septonasal flap, instead of stents for structural support to maintain airway patency [8]. It promotes faster healing without reliance on foreign materials and prevents adverse events associated with long-term stents [9]. Non-stented endoscopic transseptal repair technique is also an effective standard option for unilateral and bilateral choanal atresia management. While the technique demonstrates sustained neochoanal patency without a stent and prevents stent-related complications, it is associated with postoperative respiratory complications [10].

The efficacy and safety of stented compared to non-stented transnasal repair techniques for choanal atresia management have gained increased focus in recent years. This systematic review seeks to contribute to this debate by investigating

whether stent transnasal repair of bilateral choanal atresia offer favorable outcomes compared to non-stented transnasal repair. The review provides a robust and comprehensive evaluation of the effectiveness and the safety profile of stenting, which informs clinical practice and improves outcomes in choanal atresia management.

2. Methods and Materials

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and was registered in PROSPERO (CRD420261277985).

2.1. Literature Search Strategy

A search strategy was developed with the assistance of a medicine librarian and used in the literature search across selected databases. A comprehensive search of relevant articles was conducted in PubMed, CINHAL, Scopus, Cochrane Library and Web of Science databases in December 2025 and updated in February 2026. Keywords related to choanal atresia, endoscopy, stent, non-stented, and paediatrics were employed in the databases. Several keywords were joined using Boolean Operators such as "OR" and "AND" to generate more accurate results. The search query was refined based on each database's syntax.

2.2. Eligibility Criteria and Study Selection

This review included pediatric studies evaluating endoscopic transnasal repair of choanal atresia. For the primary comparative analysis, eligible studies were required to include both a stented and a non-stented group. Single-arm studies evaluating only stented or only non-stented repair were retained as indirect supportive evidence and were not used as direct comparative evidence. Eligible designs included randomized trials, clinical trials, retrospective cohorts, prospective cohorts, and retrospective case series. Studies focused on pediatric populations, particularly neonates and infants. Studies that did not evaluate endoscopic transnasal repair, studies without relevant outcome data, case reports, conference abstracts, systematic reviews, meta-analyses, editorials, non-English publications, and studies involving adult populations without separable pediatric data were excluded.

Studies that did not evaluate endoscopic transnasal repair of choanal atresia, or that did not provide relevant outcome data, were excluded. Case reports, conference abstracts, systematic reviews, meta-analyses, and editorials were also excluded. Studies with unclear or insufficient outcome data, studies published in languages other than English, and studies in adult populations without separable pediatric data were excluded. Single-arm studies were not excluded solely because they lacked a comparator; instead, they were classified as indirect supportive evidence and were not included in the primary stented-versus-non-stented comparison.

2.3. Data Extraction

Two reviewers independently reviewed and extracted data from the selected studies into a standardized Excel spreadsheet. Extracted variables included authors, year, study design, patient demographics, type of choanal atresia, comorbidities, surgical technique, mucosal-flap technique, vomer resection, postoperative dilation, topical therapy/postoperative medical treatment when reported, stent material and duration, and outcomes including patency, restenosis, surgical success, granulation tissue formation, and postoperative complications. Discrepancies were addressed through discussion or by engaging a third reviewer.

2.4. Quality Assessment

The Cochrane risk of bias (RoB 2) tool was used to assess the methodological quality of randomised controlled trials (RCTs) focusing on five domains: randomization process, missing data, deviation of intended intervention, measurement of outcomes and selection of results. The Newcastle Ottawa Scale (NOS) was used for quality assessment of non-randomized studies focusing on three key domains: selection, comparability and outcomes. Discrepancies were addressed through consensus or by engaging a third reviewer to break the tie.

2.5. Data Synthesis and Analysis

Data from the selected studies were synthesized narratively. The primary comparison was restricted to studies containing both stented and non-stented groups. Single-arm studies were summarized separately as indirect supportive evidence and were not used to infer a direct comparative effect of stenting. The prespecified primary outcome was restenosis, defined as postoperative narrowing or closure of the surgically created choanal opening as reported by the individual study, assessed at the study-defined follow-up endpoint; where multiple follow-up time points were reported, the longest clinically evaluable follow-up was used for the narrative comparison. Patency, surgical success, and revision were treated as secondary outcomes because definitions and assessment time points varied across studies. Co-interventions and technical factors were also considered because they could independently influence outcomes.

3. Results

The initial literature search yielded 718 English-language records. After removal of 15 duplicates, 703 records underwent title and abstract screening, of which 656 were excluded. Forty-seven full-text articles were assessed for eligibility. Seventeen were excluded because they were systematic reviews, case reports, or conference abstracts, and 18 were excluded because they did not provide complete outcome data, involved adult populations, or were published in a non-English language. Twelve studies met the eligibility criteria and were included in the review (**Figure 1**).

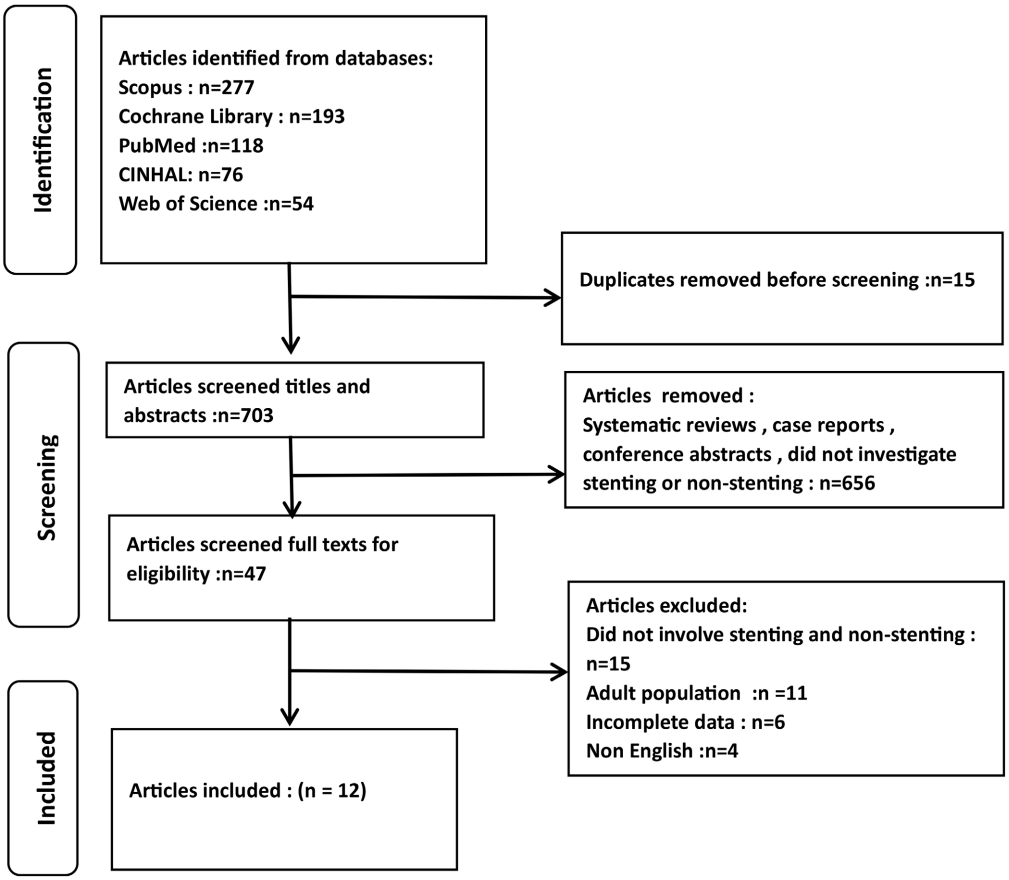

Figure 1. PRISMA flow chart showing selection of included studies.

3.1. Study Characteristics

Twelve studies were included, comprising 376 pediatric patients [5] [11]-[21]. Seven studies directly compared stented and non-stented groups [5] [13]-[16] [20] [21], whereas five studies were single-arm studies and were retained as indirect supportive evidence [11] [12] [17]-[19]. Sample sizes ranged from 7 to 112 patients. The patients ranged from neonates to adolescents, with infants and young children predominating. CHARGE syndrome and other congenital anomalies were reported in several cohorts. Endoscopic transnasal repair was the surgical approach across the included studies. Stent duration varied from several days to prolonged placement of up to 32 weeks. Because the included studies differed in disease severity, age, laterality, surgical technique, and postoperative management, direct outcome comparisons were considered heterogeneous (**Table 1**).

Table 1. Study characteristics.

Study	Study design	Sample (n)	Mean age (yrs/months)	Gender (M/F)	Type of CA (n)	Congenital anomalies	Intervention
[11]	Retrospective cohort	43	41 months	16/24	Unilateral/bilateral	CHARGE (15%), Treacher Collins Syndrome, small mandible & glossoptosis	Endoscopic repair (no prolonged stent)

Continued

[12]	Retrospective case series	13	45 months	7/6	Unilateral/bilateral	CHARGE (23%), Treacher Collins, facial clefts	Stentless endoscopic repair
[13]	Comparative cohort	42	11 days	5/37	Bilateral	Polyp, collunellar injury, pharyngeal ulceration	Endoscopic repair with and without a stent
[14]	Retrospective cohort	21	13.1 years	4/17	Unilateral/bilateral	N/A	Endoscopic repair with stent/stentless
[15]	Retrospective case series	9	8 days	N/A	Bilateral	CHARGE (11.1%), Down syndrome	Single-stage endoscopic transnasal repair (stent/stentless)
[5]	Retrospective cohort	112	8.75 days	25/87	Mixed/bony/ membranous atresia	CHARGE (54%), Syndromic CA	Endoscopic repair with and without stenting
[16]	Retrospective cohort	58	3 yrs	17/41	Congenital CA	N/A	Endoscopic repair with stent/stentless
[17]	Retrospective case series	7	6.7 days	3/4	Bilateral	Cardiac VSD, digital anomaly	Stentless endoscopic transnasal repair with vomer resection
[18]	Retrospective case series	15	3 yrs	5/10	Unilateral/bilateral/ unilateral stenosis	Cardiac, congenital anomalies	Transnasal endoscopic repair with a stent
[19]	Retrospective case series	25	6.6 days	18/7	Congenital CA	CHARGE (4%), cardiac, digital	Stentless transnasal endoscopic repair
[20]	Prospective comparative study	20	4 days	7/13	Bilateral	N/A	Endoscopic repair with vs without stent
[21]	Retrospective case series	11	1.5 years	5/6	Unilateral/bilateral	N/A	Endoscopic repair with vs without stent

3.2. Quality Assessment Scores

The methodological quality was assessed using the Newcastle-Ottawa Scale for assessing risk of bias of non-randomized trials (**Figure 2**). Overall, studies showed low to moderate risk of bias. Three studies [14] [17] [20] demonstrated low risk of bias reflected by comparative designs, clear cohort selections and adequate follow-up. Several studies demonstrated a moderate risk of bias, with comparability being a common limitation within the studies. This implies that some studies lacked adjustment for key confounders, including the type of choanal atresia or age during initial surgery. Selection and outcome assessment were generally adequate, with studies demonstrating a well-defined pediatric population diagnosed with CA, and adequately reporting patency or stenosis over meaningful follow-up durations, though success outcomes varied across studies.

3.3. Surgical Outcomes

Across the 12 studies, surgical outcomes following endoscopic repair for choanal atresia demonstrated substantial variability. The primary comparative synthesis

Study	Selection	Comparability	Outcome	Overall Risk
Van Den Abbeele et al. (2002)	●	●	●	Moderate
Schoem et al. (2004)	●	●	●	Moderate
Elmorsy (2011)	●	●	●	Moderate
Tatar et al. (2017)	●	●	●	Low
Zuckerman et al. (2008)	●	●	●	Moderate
Eladl et al. (2016)	●	●	●	Moderate
Bajin et al. (2021)	●	●	●	Moderate
El-Ahl & El-Anwar (2012)	●	●	●	Low
Josephson et al. (1998)	●	●	●	Moderate
El-Anwar et al. (2018)	●	●	●	Moderate
Saafan (2013)	●	●	●	Low
Wolf et al. (2016)	●	●	●	Moderate

Figure 2. Quality assessment using the Newcastle-Ottawa Scale for non-randomized trials.

was limited to the seven studies containing both stented and non-stented groups [5] [13]-[16] [20] [21]. The five single-arm studies [11] [12] [17]-[19] were interpreted as indirect supportive evidence only. Differences in age, unilateral versus bilateral disease, syndromic status, surgical technique, and postoperative care limited direct attribution of outcome differences to stent use alone.

3.4. Patency

Patency was reported across most studies but was assessed using heterogeneous definitions and follow-up intervals. Among direct comparative studies, patency did not demonstrate a consistent advantage for either strategy. Some cohorts favored stented repair, whereas others favored non-stented repair, and several studies did not report directly comparable patency data for both groups. Single-arm studies reporting high patency after non-stented repair provide supportive but indirect evidence and should not be interpreted as evidence of superiority. Variation in mucosal preservation, flap technique, patient severity, stent duration, and follow-up may explain part of the observed range.

3.5. Restenosis

Restenosis was the prespecified primary outcome and was defined as postoperative narrowing or closure of the neochoana according to each study's reported criteria. The assessment time point varied between studies; therefore, the longest reported clinically evaluable follow-up was used for narrative comparison when multiple time points were available. Among direct comparative studies, restenosis findings were heterogeneous. Several studies reported higher restenosis in stented groups, including comparisons in which stented versus non-stented rates were approximately 40% - 60% versus 15% - 25%; however, this range was not uniform across all comparative studies. Importantly, Saafan *et al.* [20] reported approximately 60% restenosis in the stented group versus 50% in the non-stented group, demonstrating substantial restenosis with both approaches. Single-arm studies also showed wide variability, including a small non-stented cohort with 100% restenosis [17]. Thus, the overall evidence suggests that restenosis is influenced by both stent use and important patient- and technique-related factors.

3.6. Granulation Tissue Formation

Granulation tissue formation was reported in several studies and varied substantially between cohorts. Higher rates were frequently observed with stenting, particularly with prolonged stent placement, but the outcome was not measured uniformly and was also influenced by stent material, mucosal trauma, and postoperative management. These findings support considering granulation as a potential stent-related complication while avoiding attribution of all between-group differences to stenting alone.

3.7. Surgical Success

Surgical success was defined variably in the included studies, including definitions based on patency, absence or degree of restenosis, and need for revision [5] [14] [19]. Because these definitions and follow-up periods were inconsistent, surgical success was treated as a secondary outcome and was not pooled or interpreted as a uniform endpoint. Reported success ranged from 39% to 100%, reflecting substantial clinical and methodological heterogeneity (Table 2).

Table 2. Surgical outcomes for stented vs non-stented endoscopic repair.

Author (Year)	Sample size	Type of CA	Intervention	Duration of stenting	Patency (stent/ non-stent)	Restenosis (stent/ non-stent)	Granulation tissue formation	Success	Follow-up	Need for Revision Surgery
Van Den Abbeele *et al.* (2002)	43	UCA/ BCA	Without stent	-	95%	20%	61.5%	-	18 months	14%
Schoem *et al.* (2004)	13	UCA/ BCA	Without stent	-	100%	-	54%	-	Up to 3 yrs	0%
Elmorsy (2011)	42	BCA	With stent	6 - 8 weeks	-	58%/15%	92.4% stent	-	20 - 48 months	10% stent
Tatar *et al.* (2017)	21	UCA/ BCA	With and without a stent	8 - 32 weeks	75%/40%	25%/60%	Minimal	75% stent	12 - 111 months	67%/38%
Zuckerman *et al.* (2008)	9	BCA	With and without a stent	4 - 6 weeks	100%	75%/None	Minimal	100%	1 - 13 months	75% stent
Eladl *et al.* (2016)	112	BCA	With and without a stent	2 - 6 weeks	-	42%/20.6%	Minimal	39.3%	6 months - 18 years	74.5%/20.6%
Bajin *et al.* (2021)	58	Congenital CA	With and without a stent	1 - 4 weeks	-	70%/15%	Minimal	100%	6 - 51 months	29%
El-Ahl & El-Anwar (2012)	7	BCA	Without stent	-	28.6%	100.0%	None	71.4%	11 - 23 months	11.10%
Josephson *et al.* (1998)	15	UCA/BCA/ unilateral stenosis	With stent	3 - 12 weeks	100%	6.70%	6.7%	-	7 years	7.1%

Continued

El-Anwar *et al.* (2018)	25	Congenital CA	Without stent	NA	24%	4%	None	72%	12 - 66 months	4%
Saafan (2013)	20	BCA	With and without a stent	4 weeks	40%/50%	60%/50%	50%	-	1 - 5 years	-
Wolf *et al.* (2016)	11	UCA/BCA	With and without a stent	5 - 90 days	100%	-	Minimal	High	3.1 years (mean)	-

3.8. Restenosis Risk

Restenosis was the primary outcome, but the evidence did not show a uniform relationship between stent use and restenosis. Several comparative studies reported higher restenosis with stenting, while other comparative evidence showed substantial restenosis in non-stented groups as well. The small non-stented cohort with posterior vomer resection reported 100% restenosis [17], illustrating the potential influence of surgical technique and patient severity. Neonatal age, bilateral disease, syndromic associations, and postoperative complications were also associated with poorer outcomes across studies. These factors, together with differences in stent duration, material, mucosal-flap technique, and postoperative care, limit causal attribution to stenting alone.

Higher restenosis rates were observed in some neonatal cohorts with bilateral CA and congenital anomalies, particularly CHARGE syndrome, in both stented and non-stented approaches [5] [13] [15] [17] [20]. Co-interventions also differed between studies. The included literature describes mucosal-preserving flap approaches, including the mirrored L-shaped septonasal flap in non-stented repair, and vomer resection in some stentless procedures [17] [19]. Stent material and duration also varied, including short-term soft/posteriorly positioned devices and longer stenting protocols. Postoperative dilation and topical therapy were not consistently reported across the included studies, preventing a reliable assessment of their independent effects. These differences may explain part of the heterogeneity in restenosis and patency outcomes.

4. Discussion

There is significant variation in how choanal atresia is managed in pediatric populations. Stented and non-stented endoscopic repairs are used to maintain choanal patency, but the comparative evidence remains heterogeneous. In this review, the primary comparison was restricted to seven studies that directly included both stented and non-stented groups, while five single-arm studies were retained as indirect supportive evidence. The findings do not demonstrate a uniform advantage of either approach. Several comparative studies reported higher restenosis with stenting, but substantial restenosis was also observed in some non-stented cohorts. Differences in age, bilaterality, syndromic association, surgical technique, mucosal-flap use, vomer resection, postoperative management, and stent characteristics are important potential confounders.

The use of a stent may contribute to scarring, granulation tissue formation, and in-stent occlusion through mechanical irritation, mucosal trauma, and foreign-body reaction. However, the observed outcomes cannot be attributed to stenting alone because the included studies used different surgical and postoperative protocols. Mucosal-flap techniques, including the mirrored L-shaped septonasal flap, and vomer resection were used in some non-stented procedures, while stent material and duration varied substantially. The available reports did not consistently describe postoperative dilation or topical therapy, so their independent contribution cannot be established. A clinically important finding is that some non-stented cohorts also had substantial restenosis, emphasizing that patient selection and surgical technique remain important determinants of outcome. Contemporary evidence supports the need for a cautious interpretation of these findings. A 2021 systematic review of bilateral choanal atresia found no significant patency advantage for stenting in pooled randomized trials, while stentless repair was associated with fewer granulation-related complications [22]. A separate 2021 systematic review highlighted substantial variation in stent materials, duration, and flap techniques [23]. More recently, a 2025 systematic review and meta-analysis restricted to pediatric comparator studies reported higher restenosis and granulation tissue formation with stenting, without a clear improvement in surgical success [24].

5. Conclusion

This review found heterogeneous outcomes after stented and non-stented endoscopic repair of pediatric choanal atresia. The primary comparative evidence from studies containing both groups does not support a uniform patency or restenosis advantage for either approach. Although several comparative studies reported higher restenosis with stenting, other studies demonstrated substantial restenosis in non-stented groups, and single-arm studies provide only indirect supportive evidence. Differences in mucosal-flap technique, vomer resection, postoperative care, stent material, and stent duration may contribute to outcome differences independently of stent use. Routine or prolonged stenting should therefore not be interpreted as universally beneficial or harmful on the basis of the current heterogeneous evidence. Future prospective multicenter studies should use standardized definitions of restenosis and patency, prespecified follow-up time points, and detailed reporting of co-interventions and stent characteristics.

Author Contributions

Ahmed Alahmari conceived and designed the study, conducted the literature search, performed study selection and data extraction, analyzed the data, and drafted the manuscript. Abdullah Alahmari, Abdulaziz Alshahrani, Khalid Alshahrani, Abdulrahman Alqahtani, Bander Alamrai, and Khalid Alahmari contributed to the literature review, data interpretation, and critical revision of the manuscript. All authors reviewed and approved the final version of the manu-

script and agreed to be accountable for all aspects of the work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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