Objective  Several techniques are used to repair the anal sphincter following injury. The aim of the present study is to comprehensively analyze the short- and long-term outcomes of overlap repair following anal sphincter injury.

Methods  A search was conducted in the PubMed, Medline, Embase, Scopus and Google Scholar databases between January 2000 and January 2020. Studies that described the outcomes that are specific to overlap sphincter repair for fecal incontinence with a minimum follow-up period of one year were selected.

Results  A total of 22 studies described the outcomes of overlap sphincter repair. However, 14 studies included other surgical techniques in addition to overlap repair, and were excluded from the analysis. Finally, data from 8 studies including 429 repairs were analyzed. All studies used at least one objective instrument; however, there was significant heterogeneity among them. Most patients were female (n = 407; 94.87%) and the mean age of the included individuals was 44.6 years. The majority of the procedures were performed due to obstetric injuries (n = 384; 89.51%). The eight included studies described long-term outcomes, and seven of them demonstrated statistically significant improvements regarding the continence; one study described poor outcomes in terms of overall continence. The long-term scores were significantly better compared with the preoperative scores. However, compared with the short-term scores, a statistically significant deterioration was noted in the long-term.

Conclusion  The majority of the studies described good long-term outcomes in terms of anal continence after overlap sphincter repair. However, further studies are needed...
Introduction

Fecal incontinence is defined as the involuntary evacuation of feces. It is a debilitating problem that causes physical, social and psychological impairments, with a considerable effect on the quality of life.\(^1\) This condition affects 2% to 17% of the overall population, and almost half of all nursing home residents.\(^2\) The etiology of fecal incontinence is multifactorial, and the most common factors are injury to the sphincter or neuronal damage associated with vaginal injuries, anorectal surgical procedures, and neurological conditions.\(^3\)

The outcome following the repair of an anatomical defect of the anal sphincter depends on several factors, including the age of the patient, the cause of the injury, the length of time between the injury and the repair, and the type of repair.\(^4,5\) Overlap and end-to-end are two widely-used techniques among several used to repair the anal sphincter following injury. The overlap repair is used for external anal sphincter defects, and it was described by Parks and McPartlin.\(^6\) Several studies have assessed both the short- and long-term outcomes following overlap sphincteroplasty after various types of sphincter injuries using different tools to assess fecal incontinence.

The objective of the present review is to analyze the short- and long-term outcomes of overlap repair for patients presenting with fecal incontinence.

Materials and Methods

A systematic review of the literature was performed including all observational and experimental studies on overlap sphincter repair, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The primary objective of the systematic review was to determine the short- and long-term outcomes and the success rates of the overlap sphincter repair. The secondary outcome was to identify the associated factors such as clinical and demographic parameters, and injury patterns in relation to the outcome.

Search Strategy

We searched the PubMed, Medline, Google Scholar, Embase and Scopus databases for articles published between January 2000 and January 2020 using the search terms anal sphincter OR fecal incontinence OR anal incontinence AND overlap repair OR overlap surgery in the title or abstract fields.
A non-English language database known as APAMED Central was searched using the same criteria to reduce publication bias. The search was limited only to human studies. The reference list provided in full papers was also used to identify additional papers to be review. The last search date was January 31, 2020. Both experimental and observational studies that considered the outcome of overlap sphincter repair were included in the qualitative analysis.

The initial screening for eligibility was performed by two investigators based on the titles, abstracts, and keywords of the citations from the electronic databases. Thereafter, the full texts of all relevant records were assessed based on the inclusion criteria. In cases of doubt, the opinion of senior investigators was sought. Studies with elective surgical treatments with a minimum follow-up period of one year were defined as eligible. Studies including immediate primary repair following injury were excluded, as the objective improvement in the sphincter function could not be assessed in them. Studies including other interventions in addition to overlap sphincter repair and those without objective assessment tools were excluded to minimize the bias and the confounding factors. The list eligible studies was then decided by consensus between two investigators.

Data from individual studies were tabulated, including study design, basic demographic and clinical parameters of the patients, injury pattern, timing of the surgery, preoperative investigations, postoperative short- and long-term outcomes, and complications. Finally, a qualitative analysis was performed with the available data. A meta-analysis could not be performed due to the heterogeneity in: the methodology of the studies, the treatment options, and the description of the outcomes. The assessment of the risk and bias of the eligible

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**Fig. 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart.
<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Study design</th>
<th>N</th>
<th>Demographics</th>
<th>Injury pattern</th>
<th>Timing of the surgery</th>
<th>Preoperative investigations</th>
<th>Type of surgery</th>
<th>Short-term outcome (less than 1 year)</th>
<th>Long-term outcome (more than 1 year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Maldonado et al., 2019</td>
<td>United States</td>
<td>Retrospective study</td>
<td>29</td>
<td>All-female sample (mean age: 31.8 years)</td>
<td>Fourth-degree lacerations (cloacal-like deformities)</td>
<td>Mean: 68.1 months</td>
<td>Preventing symptoms and physical examination</td>
<td>EAS OLR</td>
<td>NA</td>
<td>53.8% reported complete continence at a mean follow-up of 7.0 ± 6.6 years</td>
</tr>
<tr>
<td>2 Khafagy et al., 2017</td>
<td>Egypt</td>
<td>Case-control study</td>
<td>Total 40 ORLs in 20 patients</td>
<td>N = 11 (55%); F = 9 (45%); mean age: 30.6 ± 17.5 years</td>
<td>Anal fistula (n = 19; 47.5%); Perineal trauma (n = 6; 15%); Obstetric trauma – third degree perineal tear (n = 5; 12.5%); Perianal necrotizing fasciitis (n = 5; 12.5%); Hemorrhoidectomy (n = 3; 7.5%); Strictureotomy for anal stenosis (n = 2; 5%)</td>
<td>1.01 ± 0.35 years</td>
<td>Wexner continence score, anorectal manometry, Endoanal US</td>
<td>EAS OLR +/- BMAC</td>
<td>6 months to 12 months; mean Wexner continence score changes from 7.7 to 7.4</td>
<td>NA</td>
</tr>
<tr>
<td>3 El-Gazzaz et al., 2012</td>
<td>United States</td>
<td>Retrospective study</td>
<td>197</td>
<td>All-female sample; 146 (74.1%) patients in group A (&lt; 60 years old); 51 (25.9%) patients in group B (&lt; 60 years old); Overall mean age at surgery: 50.4 years</td>
<td>Obstetric injuries</td>
<td>NA</td>
<td>RQI; FSI</td>
<td>EAS OLR</td>
<td>NA</td>
<td>The mean FIS score changed from 27.2 to 29.8 over an average of 7.7 years of follow-up</td>
</tr>
<tr>
<td>4 Zutschi et al., 2009</td>
<td>United States</td>
<td>Prospective</td>
<td>N = 44 at the 5-year follow-up, and n = 31 at the 10-year follow-up</td>
<td>Median age at surgery: 5-year follow-up group: 38.5 years; 10-year follow-up group: 44 years</td>
<td>Obstetric trauma: 70.4%; Iatrogenic: 15.9%; Trauma: 6.8%; not reported: 6.8%</td>
<td>NA</td>
<td>RQI; FSI; Bristol Stool Form Scale</td>
<td>EAS OLR</td>
<td>NA</td>
<td>Changes in scores from 5 years to 10 years of follow-up: a) mean patient-related FSI from 21 to 39.39; b) mean surgeon-related FSI – from 20 to 39.9; c) mean FISI – from 12 to 10.82</td>
</tr>
<tr>
<td>5 Dobben et al., 2007</td>
<td>Netherlands</td>
<td>Prospective</td>
<td>30</td>
<td>97% of females; mean age: 50 Years (± 12 years)</td>
<td>Obstetric trauma: 97%</td>
<td>Median: 65.5 years (0.5–22 years)</td>
<td>Vaizey incontinence score and Endoanal US, and MRI</td>
<td>EAS OLR</td>
<td>After surgery, the mean Vaizey score improved from 18 to 13 (p &lt; 0.001)</td>
<td>NA</td>
</tr>
<tr>
<td>6 Baisic et al., 2006</td>
<td>Serbia</td>
<td>Prospective</td>
<td>65</td>
<td>Females: 55 (84.6%); males: 10 (15.38%); Mean age: 35.9 years (range: 18–64 years)</td>
<td>Obstetric trauma: 72.3%; Fistulotomy: 13.8%; Non-specific Trauma: 9.2%; Vaginal injury: 4.6%</td>
<td>Range: 0.5 to 20 years</td>
<td>Wexner score; Browning–Parks scale; anal Manometry; Electromyography; Electography</td>
<td>EAS OLR</td>
<td>Wexner score improved from 17.8 preoperatively to 3.6 months after the operation</td>
<td>Wexner deteriorated over time to 6.3 after an average of 80.1 months of follow-up</td>
</tr>
<tr>
<td>7 Tjandra et al., 2003</td>
<td>Australia</td>
<td>Randomized controlled trial</td>
<td>Total 23; OLR -11 direct end-to-end repair -12</td>
<td>All female; DR 47y (32–71); OLR 45y (31–68);</td>
<td>Obstetric trauma</td>
<td>1 year</td>
<td>Endoanal US, Anorectal manometry, Neurophysiologic, Cleveland Clinic Continence Score</td>
<td>DR ; OLR</td>
<td>Mean Cleveland score changed from 17 to 3 postoperatively; maximum squeeze pressure changed from 80 mm Hg to 130 mm Hg postoperatively</td>
<td>Median follow-up of 18 months - improvement in continence scores (p &lt; 0.05).</td>
</tr>
</tbody>
</table>

(Continued)
studies was performed using standard risk-assessment tools. (► Supplementary Table S1)

Results

The initial search revealed 571 studies. After excluding the duplicates and the articles that were not relevant, a total of 22 studies describing the outcomes of overlap sphincter repair were selected (► Fig. 1). However, 14 studies used other surgical techniques in addition to overlap repair; therefore, they were excluded from the analysis. Data from 8 studies including 429 repairs were used in the final analysis; there were 4 prospective studies, 7–10 3 retrospective studies,11–13 and 1 randomized control trial.14 The majority of the patients were female (n = 407; 94.87%), and the mean age of the included individuals was 44.6 years. The most common etiology for sphincter damage was obstetric injuries (n = 384; 89.51%). Every study used at least one validated tool for the pre- and postoperative assessment of the continence. In total, 5 studies8,9,12–14 (n = 164; 38.22%) used endoanal ultrasound and/or manometry for the preoperative assessment. Only 2 studies9,14 (n = 31; 7.22%) used endoanal ultrasound and/or manometry for the assessment postoperatively.

All included studies described long-term outcomes, and seven7–13 of them described statistical significant improvements in the continence. However, 1 study14 (n = 11; 2.56%) described a poor outcome in terms of overall continence. Two studies7,14 mentioned both short- and long-term outcomes. The long-term scores were significantly better compared with the preoperative scores. However, compared with the short-term scores, a statistically significant deterioration was noted in the long-term (► Table 1).

Discussion

The objective of the present review was to analyze the short- and long-term outcomes of overlap anal sphincter repair for patients presenting with fecal incontinence. There was considerable heterogeneity in terms of study designs, pre- and postoperative assessment methods, and tools used for the assessment of the outcome. Most of the data available in the present systemic review came from prospective studies. ► Table 2 shows the availability of information in the respective studies in relation to the objective of the study. In the present study, we were able to combine the relevant data regarding the overlap as the sole surgical technique. The continence was assessed through validated questionnaires and other assessment tools.

The present review included studies that analyzed anal sphincter injuries of different etiologies. However, most of the traumas were associated with obstetric injuries. Previous reviews15,16 mainly analyzed only obstetric anal sphincter injuries. The study conducted by Khafagy et al.9 has the most diverse etiologies, including anal fistula, perineal necrotizing fasciitis, trauma after hemorrhoidectomy, and injuries following stricturotomy for anal stenosis. As the etiology for the majority of the cases of anal sphincter injury was obstetric trauma in the present review, most patients included in the studies reviewed were female. Even though there are several

<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Study design</th>
<th>N</th>
<th>Demographics</th>
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<th>Type of surgery</th>
<th>Preoperative investigations</th>
<th>Short-term outcome (less than 1 year)</th>
<th>Long-term outcome (more than 1 year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malouf et al.,13 2000 United Kingdom</td>
<td>Retrospective</td>
<td>38</td>
<td>All-female sample; mean age: 43 years (26–67 years)</td>
<td>Obstetric-related trauma</td>
<td>OLR</td>
<td>Modified Park’s continence score; resting anal pressure; maximum squeeze anal pressure; sphincter length; pudendal nerve latencies; Endoanal US</td>
<td>Outcome assessed at a median of 15 and 77 months; at 15 months, median Modified Park’s score preoperatively: 4; 15 months postoperatively: 2; and 77 months postoperatively: 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: BMAC, bone marrow aspirate concentrate; DR, direct repair; EAS OLR, external anal sphincter overlap repair; F, female; FIQL, Fecal Incontinence Quality of Life Scale; FISI, Fecal Incontinence Severity Index; M, male; MRI, magnetic resonance imaging; NA, not available; ORL, overlap repair; US, ultrasound.
In the included studies, outcomes and the paucity of level-1 data precluding a meta-


different objectives in terms of outcome. A previous review


These findings reveal the need for proper pre- and postopera-

tive assessments in future studies.


Conclusion


Most of the included studies good long-term outcomes in

terms of anal continence after overlap sphincter repair. However, further


studies are needed to identify the factors associated with poor outcomes to assist in patient selection for

overlap repair. In future researches, preoperative and postoperative assessments with imaging exams and physi-

ology studies will be necessary.


Declarations


Ethical approval and consent to participate: ethical approval and consent to participate are not applicable

for this type of study.


Availability of Data and Materials

The datasets generated and analyzed during the current study are included in the manuscript.


Authors’ Contributions


KL, OB and UJ formulated the concept and design of the study; designed the tables; collected, analyzed, and interpreted data; and wrote a draft of the article; DNS contributed to the design and concept of the study, revising it critically for important intellectual content. All authors have read and approved the final version of the manuscript.


Conflict of Interests


The authors have no conflict of interests to declare.


References


7. Barisic GI, Krivokapic ZV, Markovic VA, Popovic MA. Outcome of overlapping anal sphincter repair after 3 months and after a mean of 80 months. Int J Colorectal Dis 2006;21(01):52–56

Table 2 Availability of information in the studies included in relation to the objective of the systematic review

<table>
<thead>
<tr>
<th>Author</th>
<th>Objective preoperative assessment</th>
<th>Objective postoperative assessment</th>
<th>Short-term outcome</th>
<th>Long-term outcome</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maldonado et al. 12</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Fecal Incontinence Severity Index</td>
</tr>
<tr>
<td>2</td>
<td>Khafagy et al. 9</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Wexner Continence Score</td>
</tr>
<tr>
<td>3</td>
<td>El-Gazzaz et al. 11</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Fecal Incontinence Quality of Life Scale, Fecal Incontinence Severity Index</td>
</tr>
<tr>
<td>4</td>
<td>Zutshi et al. 10</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Fecal Incontinence Quality of Life Scale, Fecal Incontinence Severity Index</td>
</tr>
<tr>
<td>5</td>
<td>Dobben et al. 8</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Vaizey Incontinence Score</td>
</tr>
<tr>
<td>6</td>
<td>Barisic et al. 7</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Wexner Score, Browning-Park’s Scale</td>
</tr>
<tr>
<td>7</td>
<td>Tjandra et al. 14</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Cleveland Clinic Continence Score</td>
</tr>
<tr>
<td>8</td>
<td>Malouf et al. 13</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Modified Park’s Scores</td>
</tr>
</tbody>
</table>
repair with or without the injection of bone marrow aspirate concentrate: a case-control study. Colorectal Dis 2017;19(01):O66–O74


