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Perspective

Integrating Sankey Diagrams Into Meta-Analysis Reporting: A Novel Approach to Visualizing Intergroup Relationships, Study Inclusion, Event Rates, and Statistical Outcomes in Systematic Reviews and Meta-Analysis of Pediatric Surgery

Dear Editor,

Meta-analyses are among the most valuable methodologies in clinical research, as they integrate data from multiple studies to generate stronger and more reliable conclusions. Traditionally, statistical outcomes in meta-analyses are displayed through forest plots, funnel plots. These tools are the core of meta-analysis and are useful for displaying results. Nevertheless, these tools are limited in their ability to provide an integrated visualization of key meta-analytic outcomes—such as intergroup relationships, number of included studies, number of patients, percentages, and p-values—within a single figure. At this point, Sankey diagrams emerge as a significant innovation in meta-analysis reporting.

As we have recently published, the use of Sankey diagrams in pediatric surgery offers significant potential for improving data transparency, accessibility, and interpretability, and enhancing the presentation of complex data [1]. Therefore, when integrated into meta-analyses, Sankey diagrams can effectively summarize all outcomes within a single figure, offering a comprehensive and intuitive overview.

Using sample data from our previously published meta-analysis [2], we constructed a Sankey diagram to demonstrate its methodological applicability, demonstrating its potential utility as a robust visualization tool for enhancing clarity and interpretability in meta-analytic reporting.

The Sankey diagram is presented in Fig. 1, which we interpret as follows.

A total of 11 studies were included in the meta-analysis comparing laparoscopic and open surgical repair of congenital duodenal atresia. The outcomes included in the Sankey diagram are as follows:

1. Anastomotic leak

Four studies reported anastomotic leak. The pooled event rate was 3.6 % (5 events/138 cases) for the laparoscopic group and 2.6 % (3 events/113 cases) for the open group. The random-effects model demonstrated no statistically significant difference between groups (OR = 0.76; 95%CI: 0.12−4.67; $p = 0.76$).

2. Anastomotic stricture

Seven studies reported anastomotic stricture. The incidence was 3.9 % in the laparoscopic group (7 events/180 cases) and 3.8 % in the open group (7 events/185 cases). The random-effects model demonstrated no statistically significant difference between groups (OR = 1.12; 95%CI: 0.39−3.20; $p = 0.83$).

3. Wound infection

Five studies reported wound infection. The event rate in the laparoscopic group was 0.9 % (2 events/224 cases), compared with 3.5 % (40/1144 cases) in the open group. The random-effects model demonstrated a significant reduction in wound infection following laparoscopic repair (OR = 0.26; 95 % CI: 0.08−0.82; $p = 0.02$).

4. Postoperative ileus

Four studies reported postoperative ileus. The event rate was 5.9 % (5/85 cases) for laparoscopy and 12.4 % (13/105 cases) for open group. Although numerically lower in the laparoscopic group, the difference did not reach statistical significance (OR = 0.60; 95 % CI: 0.21−1.74; $p = 0.34$).

5. Overall complications

All 11 studies reported overall complications. According to the Sankey diagram, the laparoscopic group had an event rate of 13.6 % (46/338 cases), while the open group showed a slightly lower rate of 9.5 % (121/1277 cases). The random-effects model demonstrated no statistically significant difference between groups (OR = 0.86; 95 % CI: 0.42−1.74; $p = 0.68$).

6. Anatomy of a Sankey diagram

A Sankey diagram is a flow diagram that emphasizes the anatomy of connections between categories. Its structure is composed of nodes (labels) and links (bands). Nodes represent stages, variables, or outcomes, while links indicate the flow of quantity between them. The width of each link is proportional to the magnitude of flow, visually quantifying relationships. Flows can branch, merge, or cross, illustrating complex distributions clearly. Colors are often used to distinguish groups or highlight differences. This anatomy allows Sankey diagrams to communicate proportional relationships, transitions, and contributions across multiple pathways in visual form.

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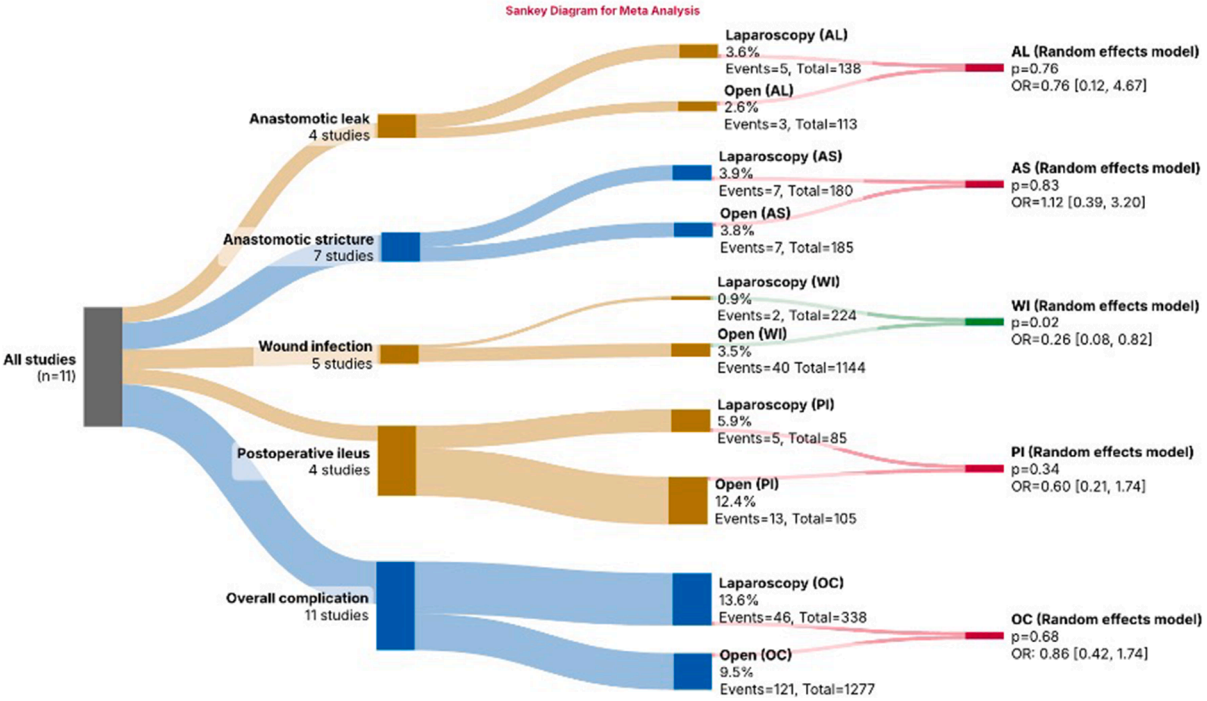

Fig. 1. Sankey diagram. AL: Anastomotic leak, AS: Anastomotic stricture, WI: Wound infection, PI: Postoperative ileus, OC: Overall complications, OR: Odds ratio, Green color: $p < 0.05$, Red color: $p > 0.05$, Blue color: At least 50 % of the included studies provided data on the relevant outcome.

Looking at the diagram in detail: the first node represents the total number of articles included in our study. The second group of nodes lists the outcomes, and directly beneath each outcome, the number of studies reporting that specific outcome is indicated. Moving to the third groups of nodes, the laparoscopic and open surgery groups are compared. In the second line, the percentages demonstrate the incidence within each group, while the third line provides the number of events and the total sample size for each group. Finally, in the last node, the p-value, odds ratio with 95 % confidence interval, and the statistical model applied (random vs. fixed effects) are reported. These nodes were divided into two colors: green and red. Green indicates outcomes with a *p*-value <0.05 (statistically significant), whereas red represents the opposite. This provides the reader with an immediate and direct visual impression. Additionally, since the number of included studies was eleven, we also applied a color distinction for the outcomes themselves. If more than 50 % of the included studies reported a given outcome, it was assigned the same color, whereas outcomes reported in less than 50 % of the studies were assigned another color. This was purely a stylistic choice, intended to enhance visual memory and comprehension. Readers and future authors, however, are naturally free to adopt different color schemes when designing their own future meta-analyses.

In conclusion, our study highlights the potential of Sankey diagrams as an innovative visualization tool in meta-analysis reporting. By integrating key parameters—such as number of included studies, outcomes, event rates, percentages, p-values, and confidence interval—into a single intuitive figure, Sankey diagrams provide a comprehensive and reader-friendly overview of complex data. While traditional forest and funnel plots remain indispensable, the Sankey diagram adds an additional layer of transparency and accessibility, making it a valuable complementary method for future meta-analyses across surgical and clinical research.

Use of AI

We have used AI only for English editing.

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Conflicts of interest

None.

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