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Rapid Recovery Pathways after Surgery in Children: A Systematic Review and Meta-Analysis

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Research Article

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Abstract

Introduction: In adult surgical patients rapid recovery pathways after surgery have shown improvement in postoperative complications and length of hospital stay. Enhanced recovery after surgery is a concept which includes patient management protocols beginning from the preoperative period, continues in the intraoperative period and the postoperative period. This concept aims to improve postoperative outcome. In pediatric patients rapid recovery pathways are beginning to develop. This study was undertaken to analyse whether enhanced recovery after surgery improved postoperative outcome in terms of postoperative complications and length of hospital stay in children.

Methods: After registration of this study in Prospero under the number [CRD42018103518], a systematic review and meta-analysis of randomised and non randomised trials was realised in April 2019 using electronic databases in children less than 18 years old where enhanced rapid recovery pathways after surgery were applied and compared to standard care. Statistic analysis was realised with RevMan 5.3 software.

Results: 6 studies with 1620 children <18 years old were included in hypospadias, idiopathic scoliosis and appendicitis surgery.

1) In 1482 children, the number of patients with postoperative complications (infections, reoperations, bleeding) was lower in the enhanced recovery group, odds ratio 0.49 [0.26-0.91], p=0.02.

2) In 1168 children, length of hospital stay was lower in the enhanced recovery group, p= 0.0002.

Conclusion: This study demonstrated that when enhanced recovery protocols were applied in hypospadias, idiopathic scoliosis and appendicitis surgery, the number of patients with postoperative complications and length of hospital stay were reduced.

Keywords: Enhanced Recovery Pathways; Children; Outcome

Introduction

In adult surgical patients rapid recovery pathways after surgery have shown improvement in postoperative complications and length of hospital stay [1]. Enhanced recovery after surgery (ERAS) is a concept which includes patient management protocols beginning from the preoperative period, continues in the intraoperative period and the postoperative period. For instance preoperatively anticipating blood transfusion in potential hemorraghic interventions by improving preoperative hemoglobin levels by administrating iron or erythropoeitin, anticipating the nutritional patient status, reducing preoperative fasting times [2-4].

Intraoperatively, ERAS includes titration of fluid therapy to avoid hypovolemia or fluid overload by using means or goals to improve end organ perfusion and oxygen delivery; includes protective invasive or noninvasive lung ventilation if necessary; includes optimal analgesia using non opioid medications (for instance loco-regional analgesia), prevention of postoperative nausea and vomitting, using minimal invasive surgical technics such as laparoscopy, robotic surgery, interventional radiology [5,6]. Postoperatively ERAS includes rapid oral intake, preferring enteral alimentation, prevention of postoperative nausea and vomiting, rapid mobilisation, physiotherapy, avoiding naso-gastric tubes, urinary bladder catheters or tubes if not necessary, early intravenous access withdrawal if not necessary [7-10]. The objective of this study was to analyse whether ERAS improved postoperative outcome in pediatric surgical patients.

Methods

This study was registered under the number CRD42018103518 in PROSPERO, the international registration database for systematic reviews and meta-analysis. Since this was a systematic review and meta-analysis ethical approval from the local ethic committee was not necessary. Types of studies included were randomised and non randomised.

Types of Participants: Children aged 0-18 years (inclusion criteria) were included and patients above 18 years were excluded (exclusion criteria).

Types of Interventions: Surgical pediatric patients in whom rapid recovery pathways after surgery were applied compared to interventions where these protocols were not applied. Primary outcome was morbidity defined as postoperative complications. Secondary outcome was length of hospital stay. Primary outcome measures were defined by the number of patients with postoperative complications defined as organ failure or dysfunction and infections. Secondary outcome measures determined by the number of days spent in hospital after surgery. Titles and abstracts were electronically searched using these keywords ' Enhanced recovery pathways after surgery in children OR Rapid recovery pathways after surgery in children OR Fast-tracking after surgery in children OR Enhanced recovery pathways after surgery in children and Outcome OR Rapid recovery pathways after surgery in children and outcome OR Fast-tracking after surgery in children and outcome OR ERAS in children OR

Enhanced recovery pathways after surgery in children in randomised and non randomised trial OR Rapid recovery pathways after surgery in children in randomised and non randomised trials'. Electronic search was realised in medline, embase, central, Google Scholar, Clinicaltrials.Gov, Abstarct Conference And Dare see flow chart in figure 1.

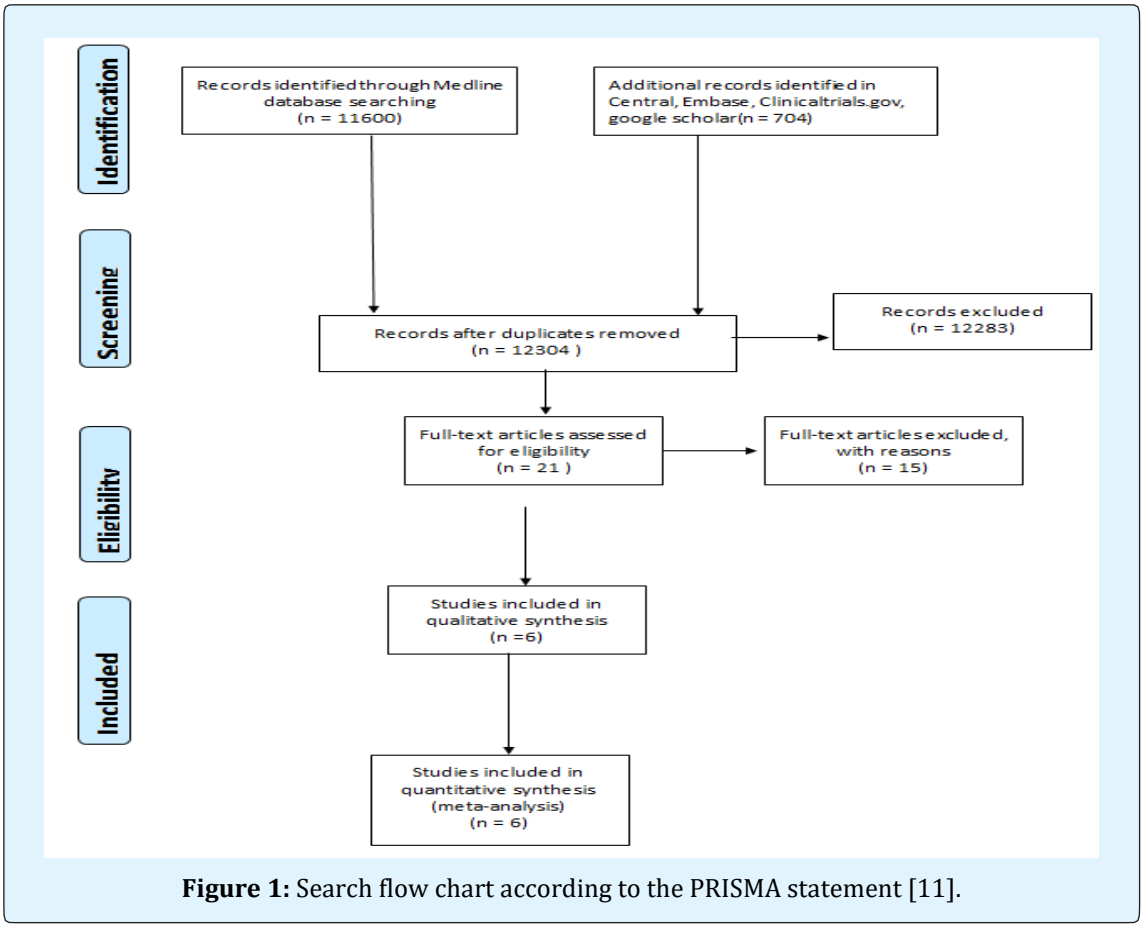

Figure 1: Search flow chart according to the PRISMA statement [11].

Data collection and statistic analysis was realised with Review Manager (RevMan) [Computer program] Version 5.3.

Copenhagen the Nordic Cochrane Centre, The Cochrane Collaboration 2014. Assessment of risk of bias in the included studies was realised using the tools proposed by the Cochrane Handbook for Systematic reviews of Interventions included with the software.

Measures of treatment effect: Were dichotomous for morbidity (how many patients complicated) and was presented as odds ratio with 95%CI.

Was continuous for length of hospital stay, LOS with measurement of weighted mean difference. Missing data was not included. Forest plots and I^2 statistics were used to assess for heterogeneity. A p-value ≤ 0.05 was considered significant. Funnel plots were used to assess for publication bias. The level of evidence was assesed using the Grading of Recommendation Assessment, Development, and Evaluation (GRADE) system [12].

Results

6 retrospective studies with 1620 children were included (Table 1) in idiopathic scoliosis surgery (572 patients), in hypospadias (302 patients) and in appendicectomy (746 patients) [13-18].

Study ID	Wong 2018 [13]	Fletcher 2017 [14]	Gornitzky 2016 [15]	Sanders 2016 [16]	Cundy 2017 [17]	Skarda 2015 [18]
Methods	Retrospective monocentric trial	Retrospective bicentric study	Retrospective monocentric trial	Retrospective monocentric trial	Retrospective/prospective case control trial	Retrospective monocentric trial
Participants	302 children aged between 22 months [15-38] and 36 months [21-50] hypospadias surgery	150 children aged between 10-18 years in adolescent idiopathic scoliosis	138 children aged between 14.8±2.3 and 15±2.3 years in adolescent idiopathic scoliosis surgery	284 children aged between 10 and 18 years in adolescent idiopathic scoliosis surgery	166 children aged between 12.0±3.0 and 12.2±2.9 years in appendicitis surgery	580 children aged between 9.7± 3.4 and 10.3±3.4 years in non non ruptured appendicitis surgery by laparoscopy or open surgery
Interventions	176 children (control group) treated with the old service protocol were compared to 126 children (experimental group) treated with the new service protocol =enhanced recovery pathway protocol	105 children from one center using an accelerated discharge pathway (experimental group) were compared to 45 children from a second center using a traditional discharge pathway (control group)	80 children in the conventional pathway (control group) were compared to 58 children in the rapid recovery pathway	194 children in the traditional pathway (control group) were compared to 90 children in the accelerated pathway (experimental group)	83 children treated before the multidisciplinary criteria-led protocol CLD = preprotocol group or control group, were compared to 83 children treated according to the CLD protocol (experimental group)	285 children treated prior to the new protocol= control group were compared to 295 children treated according to the new protocol
Definition of the interventions	old service protocol= patients remained in the hospital until removal of the urethral catheter, IV antibiotics, wound care by medical staff, 6 pediatric surgeons took care of the patients. The new service protocol=	The traditional discharge pathway was defined as the treatment on basis of the surgeon's preferences without a formal pathway i.e patient postoperative surveilliance realised in	Conventional pathway was characterised by pain management with intraoperative methadone and postoperative IV morphine or hydromorphone patient controlled	The Accelerated protocol was defined as where effort was coordinated by nursing, physiotherapy,	The multidisciplinary criteria-led discharge (CLD) protocol consisted of limiting postoperative antibiotics to 2 IV doses, avoidance of postoperative intravenous opioid analgesia, administration of	The new protocol was defined as a criteria-based postoperative treatment management where postoperative antibiotics were avoided and discharge faciliated with bedside

	enhanced recovery pathway=patients discharged on day 2 or 3 postoperatively with the urethral catheters, 3 pediatric surgeons specialised in pediatric urology were in charge of the patients, parents given instructions of wound care with saline instillation at home, oral antibiotics and patients returned for catheter removal a day after.	the surgical unit, transition to oral pain medications from PCA pump on postoperative day 3 after tolerating oral intake, Foley removed on day 1-2, drain removed on day 2-3, mobilisation with physiotherapy once daily on day 1, transition to solid diet on day 2 after flatus and discharge home after bowel movement on day 4-5. The accelerated pathway was defined as a highly standardised pathway including patient postoperative surveillance on the surgical floor, transition to oral pain medications from PCA pump from postoperative day 1, Foley removed on postoperative day 1, drains removed on postoperative day 1-2, mobilisation with physiotherapy on from day 1 twice a day, transistion to solid diet	analgesia (PCA); transition to oral medication (oxycodone and acetaminophen) as tolerated from day 3 to 4, diazepam for muscle spasme; bed rest on day 1 and physiotherapy and dietary progress on day 2; discharge criteria were oral oxycodone, acetaminophen, diazepam with bowel regimen (prevention of narcotics side effects). Rapid recovery pathway included preoperative gabapentin and acetaminophen; intraoperative IV methadone and acetaminophen; postoperative hydromorphine PCA and diazepam, IV acetaminophen, gabapentin and ketorolac on day 1 ; ambulation and full diet on day 1; accelerated physiotherapy on day	pain management and orthopedic surgery to facilitate early ambulation and standardised pain management	intraoperative non-steroidal anti-inflammatory drugs, early oral intake and ambulation	nurses to evaluate readiness to leave the hospital

		on postoperative day 1 and discharge home on postoperative day 2-3	0, 3 times a day bed to chair and walking on day 1; discharge home criteria included drain removal, same medication as in the conventional pathway			
Outcomes	Early morbidity [urine/wound swab culture) and/or documentations of urethral catheter dislodgement, wound bleeding, or wound gaping in the early postoperative period], Length of hospital stay, unplanned hospital stay, long-term complications (=meatal stenosis, neo-urethra dehiscence, urethral fistula, urethral stricture or diverticulum)	Lenth of hospital stay, LOS and postoperative complications	Pain scores, LOS, remaining postoperative pathway (removal of PCA and urinary catheter)	LOS, complications, postoperative pain management	LOS, complications, total number of antibiotics dosages, postoperative opioid analgesia usage, postoperative anti-emetic requirement and direct in-hospital costs	LOS, costs of care, readmissions and complications
Number of patients with postoperative morbidity (organ dysfunction or infection) Control group	Early morbidity 28 [3 urinary tract infections, 2 catheter dislodgements, 24 wound related (infection, bleeding, gaping)] /Long-term complications 61 [=Overall operative failure]	9 (4 conservative wound, 1 operative wound, 3 revisons, 1 medical)	NA (non applicable)	25 (return to the OR, postoperative medical problems, wound complications)	6 (1 re-presentation with nausea and vomiting, 1 re-admission for abdominal pain, 2 wound site infections, 1 re-admission for intra-abdominal collection treated with IV antibiotics, 1 clostridium difficile)	5 (inpatient readmission, observation readmission, post discharge emergency, abdominal abscess, reoperation, interventional radiology drainage, subcutaneous abscess, clostridium difficile

						colitis, postoperative CT imaging)
Number of patients with postoperative morbidity (organ dysfunction or infection) Experimental group	Early morbidity 7 [0 urinary tract infections, 4 catheter dislodgements, 3 wound related (infection, bleeding, gaping)] /Long-term complications 22 [=Overall operative failure]	8 (6 conservative wound, 1 operative wound, 1 medical)	NA	5 (return to the OR, postoperative medical problems, wound complications)	4 (1 wound site suture granuloma, 1 wound site hematoma, 2 wound site infections)	9 (inpatient readmission, observation readmission, post discharge emergency, abdominal abscess, reoperation, interventional radiology drainage, subcutaneous abscess, clostridium difficile colitis, postoperative CT imaging)
Length of hospital stay in days median [IQR] or mean ± SD Control group	10 [8-12]	4.2 [4.04-4.92]	5.0±0.8	5.0±1.26	27.7 [19.6] hours	40.1±27.5 hours
Length of hospital stay in days median [IQR] or mean ± SD Experimental group	2 [2-2]	2.17 [2.11-2.23]	3.5±0.8	3.7±0.93	19.6 [6.3] hours	23.5 ± 20.8
Risk of Bias	High	High	High	High	High	High

Table 1: characteristics of the included studies

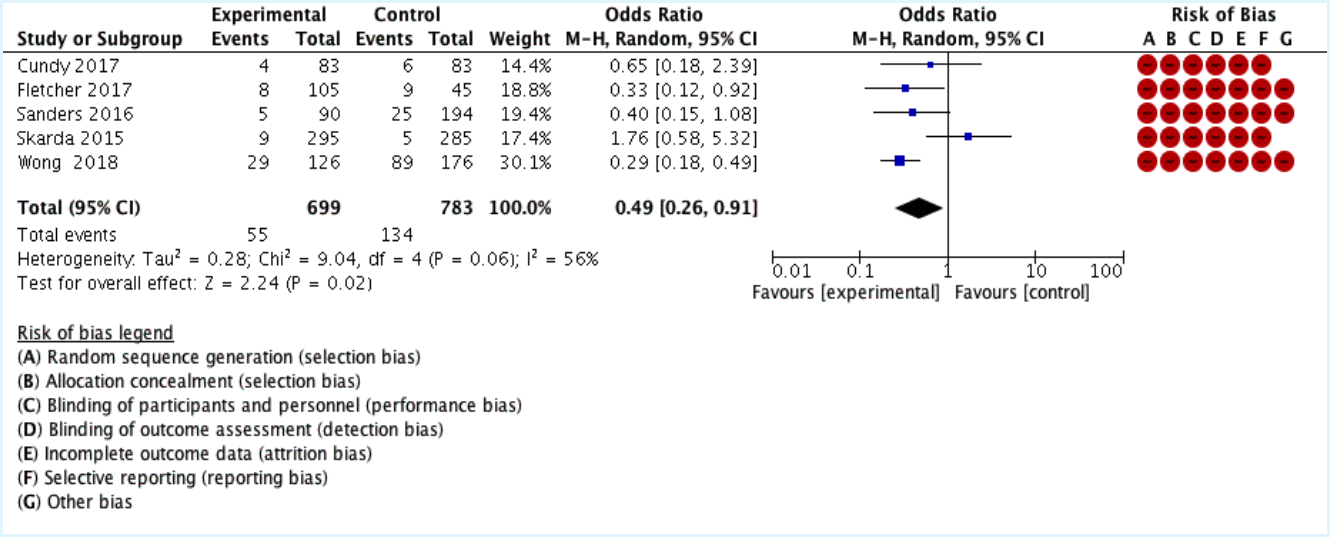

Figure 2: Forest plot of enhanced recovery after surgery compared to standard care, for number of patients with postoperative complications.

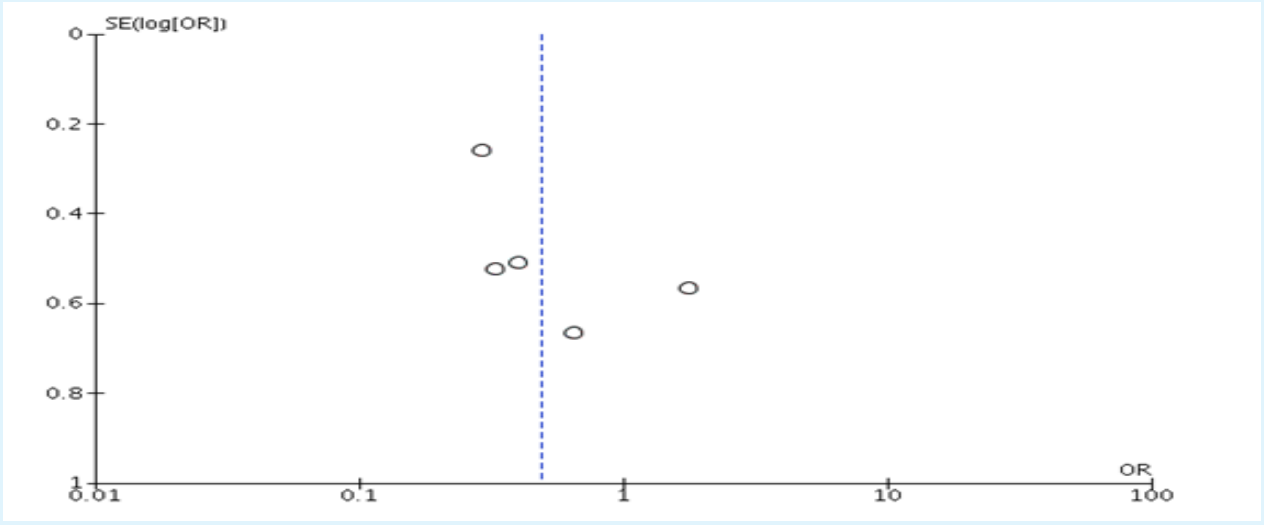

Figure 3: Funnel plot of comparison enhanced recovery after surgery compared to standard care, for outcome number of patients with postoperative complications.

Postoperative Morbidity Defined as Organ Dysfunction or Infections

Five studies with 1482 patients analysed this outcome (Figures 2 & 3) [13,14,16-18]. Organ dysfunction or infections (see table 1 for details) were lower in the enhanced rapid recovery group, odds ratio (OR), 0.49 [0.26, 0.91], p=0.02. Heterogeneity was low, the risk of bias was high in all the studies (Figure 2). Publication bias was present see figure 3. The level of evidence (GRADE) was low (bias) to moderate (low heterogeneity and great number of patients)

Length of Hospital Stay, LOS

Four studies were included in this analysis with 1168 children (Figure 4) [15-18]. LOS was lower in the enhanced recovery group, p=0.0002. Heterogeneity was high and all studies had bias. Publication bias was also present (Figure 5). The level of evidence (GRADE) was low.

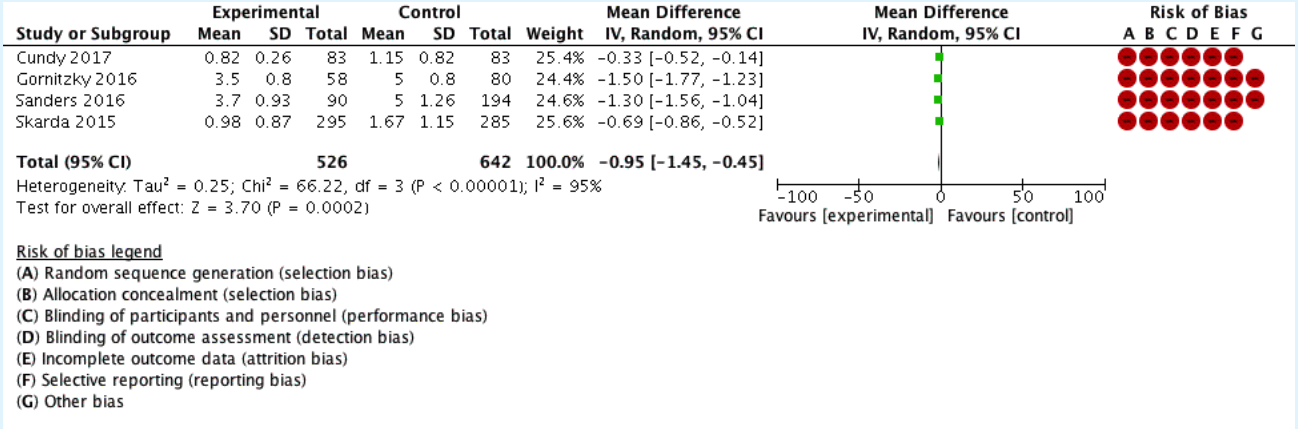

Figure 4: Forest plot of enhanced recovery after surgery compared to standard care for outcome length of hospital stay LOS.

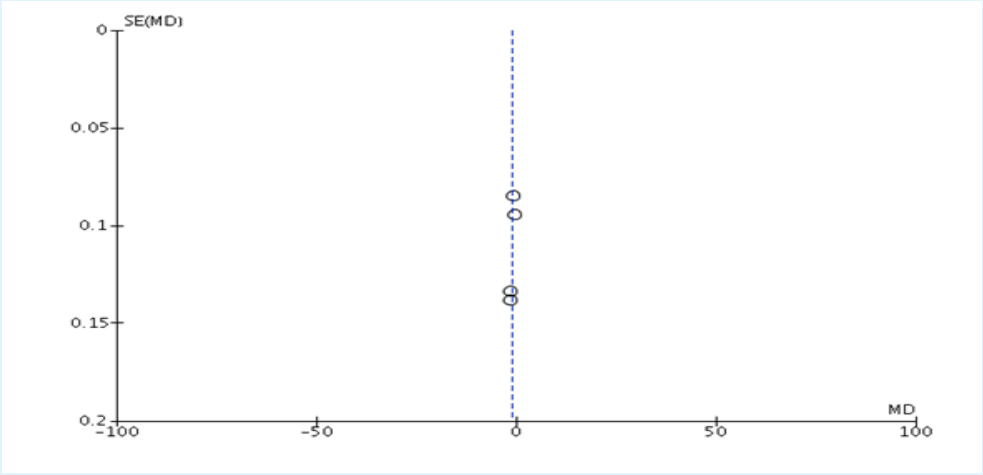

Figure 5: Funnel plot of enhanced recovery after surgery compared to standard care for outcome length of hospital stay LOS.

Discussion

This meta-analysis showed that in hypospadias, idiopathic scoliosis and appendicectomy surgery, the number of patients with postoperative complications in terms of infections, reoperations and bleeding and length of hospital stay were reduced when enhanced recovery pathways were applied. In adult surgery these protocols begun to develop since 20 years and have proven improved postoperative morbidity and length of hospital stay in certain surgical populations [8,9]. In children rapid recovery protocols after surgery are just beginning to develop [8,9]. This systematic review and meta-analysis of retrospective trials has brought some evidence that

these protocols reduce LOS and complications. It has been shown previously that LOS was a predictive factor of postoperative complications in surgery like scoliosis [19]. Effort must be done to continue to develop this clinical practice to improve patient outcome in children. Future prospective randomised controlled trials will definitely confirm this evidence in the pediatric population.

Limits: Only retrospective studies were included. The strength of this study was the great number of patients included.

Conclusion

This study demonstrated that when enhanced recovery protocols were applied in hypospadias, idiopathic scoliosis and appendicitis surgery the number of patients with postoperative complications and length of hospital stay were reduced.

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