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# A Meta-Analysis on the Comparison Between Pediatric Inguinal Herniotomies Performed With and Without Incising the External Oblique Aponeurosis in Terms of Recurrence and Complications

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**Rationale**: There is a diversity of methods in performing pediatric inguinal herniotomy, but no consensus on which is the gold standard. The two most common are the Ferguson technique and the Mitchell-Banks technique. The objective of this meta-analysis was to compare the two techniques in terms of hernia recurrence and post-operative complications: namely hematoma, hydrocele, testicular ascent, and testicular atrophy.

**Methods**: Three randomized controlled trials and one multi-center retrospective study were included in this meta-analysis. Using the Cochrane Collaboration tool and Newcastle-Ottawa quality assessment scale, all studies included were deemed to be of good quality and have low risk of bias. Revman 5.3 was used for all statistical analyses.

**Results**: There was no significant difference in terms of hernia recurrence between the two techniques (OR = 0.85, 95% CI = 0.31-2.36). For post-operative complications, hematoma (OR = 0.64, 95% CI = 0.37-1.13), testicular ascent (OR = 0.28, 95% CI = 0.05-1.50), and testicular atrophy (OR = 2.02, 95% CI = 0.54-7.52) did not differ between the two techniques. Only the incidence of post-operative hydrocele significantly differed between the two techniques, being higher when the external oblique aponeurosis was opened (OR = 0.44, 95% CI = 0.27-0.70).

**Conclusion**: Performing pediatric inguinal herniotomy without opening the external oblique aponeurosis is a safe procedure and may be recommended as an optimal choice of method for uncomplicated cases.

**Key words**: Pediatric herniotomy, Mitchell-Banks, Ferguson, external oblique aponeurosis

Inguinal herniotomy is the most common surgery performed by pediatric surgeons. There are varying surgical techniques yet a lack of an overall consensus on which technique is considered the gold standard. The two most common techniques are the Ferguson technique, which involves opening the external oblique aponeurosis prior to sac ligation, and the Mitchell-Banks technique wherein high ligation is performed without opening the external oblique aponeurosis.

Proponents of the Mitchell-Banks technique say that in children under two years of age, the inguinal canal is too short to have separated internal and external rings, hence it is recommended that herniotomies can be done without incising the external oblique aponeurosis.[1]

On the other hand, Osuiji, et al. stated that children with inguinal hernia even younger than 2 years of age have a measurable inguinal canal and thus suggesting that excision of the hernia sac superficial to the external inguinal ring runs the risk of leaving substantial sac behind proximal to the transfixing suture, even when traction is applied.[1]

In a clinical trial by Askarpour, et al. there was no significant difference in the rate of recurrence and complications between the two herniotomy techniques, with exception made to the incidence of post-operative hydrocele, which was significantly higher in the technique where the external oblique aponeurosis was opened.[2]

The authors wanted to know if there was a significant difference between pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis in terms of hernia recurrence and post-operative complications.

The general objective of this study was to determine if pediatric inguinal herniotomies performed without incising the external oblique aponeurosis would have similar if not better outcomes than the more traditional technique wherein

the external oblique aponeurosis is incised. Specifically, the authors would evaluate and compare these in terms of the rate of hernia recurrence and compare the occurrence of post-operative complications: hematoma, hydrocele, testicular ascent and testicular atrophy.

## Methods

A systematic literature search was performed using the databases of PubMed, Cochrane Library, Medline, and Ovid. This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search was conducted for studies published from 1990 to December 2018. The following MESH terms were used: "Herniotomy", "Mitchell-Banks", "Ferguson", "External Oblique Aponeurosis". Two reviewers independently assessed the methodological quality of each study by reviewing the full text. A senior reviewer was consulted to resolve any disagreements for inclusion.

### *Inclusion Criteria*

Randomized controlled trials and retrospective studies that compared pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis in terms of hernia recurrence and other complications.

### *Exclusion Criteria*

Studies that compared pediatric herniotomy techniques other than the Ferguson and Mitchell-Banks techniques and studies that involved adult hernia patients.

### *Operational Definitions*

Ferguson Technique – ligation of the sac after opening the external oblique aponeurosis

Mitchell-Banks Technique – High ligation of the sac done through the external inguinal ring without opening the external oblique aponeurosis

### *Risk of Bias Assessment*

Randomized trials were assessed using the Cochrane Collaboration for assessing risk of bias. All included studies were evaluated based on randomization, concealment of allocation, blinding, treatment of incomplete outcome data, selective reporting, and other bias. A rating of "low risk of bias," "high risk of bias," or "unclear risk of bias" was given for each category.

For Turk, et al.[5], the modified Newcastle–Ottawa quality assessment scale was used. The Newcastle–Ottawa quality assessment scale consists of three factors: Patient selection, Comparability of the study groups, and Assessment of outcomes. A score of 0-9 was used to indicate the quality of each study. Studies with six or more stars were labeled as high quality.

### *Statistical Analysis*

All data outcomes were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Morbidity rates per treatment group from each study were used to calculate pooled ORs using the inverse variance method. The point estimate of the OR was considered statistically significant at the $p < 0.05$ level, if Z-statistic is greater than 1.91, or if the 95% CI for the overall RR did not overlap the null value of "1.0". The fixed effects model was used to perform the meta-analysis since little heterogeneity was expected. The reviewers used RevMan 5.3 for all statistical analyses.

### *Risk of Bias of Included Studies*

The assessment of risk of bias of randomized controlled studies included in this meta-analysis is summarized in Figure 1. All studies had low risk for attrition and reporting bias. However, all have high risk for performance bias and unclear risk for selection bias. Due to the nature of the procedure being studied, blinding of the surgeons was not possible. However, all studies did not report how they were able to conceal the patient allocation in the treatment groups. No other sources of bias were identified in all studies. Details of the risk of bias assessment are described in Figure 2.

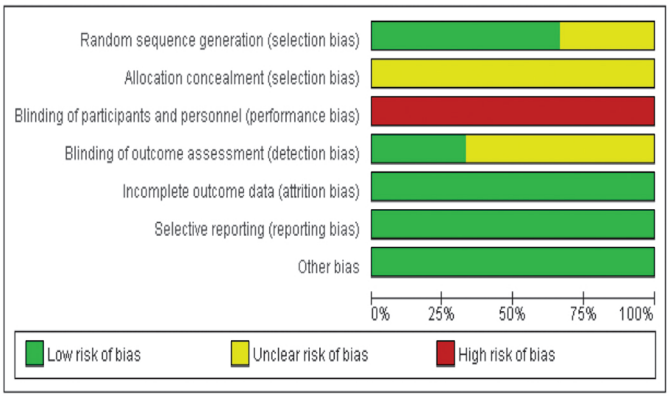


**Figure 1.** Risk of bias graph for randomized controlled trials using Cochrane Collaboration's assessment criteria.

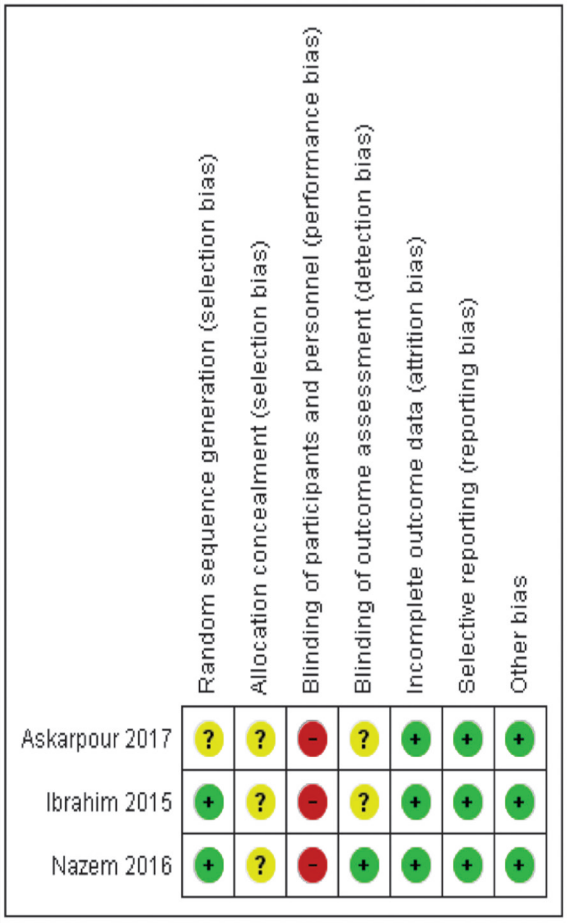


**Figure 2.** Risk of bias assessment for randomized controlled trials using Cochrane Collaboration's assessment criteria.

For the observational study of Turk, et al[5], Figure 3 shows the risk of bias assessment using the Newcastle-Ottawa quality assessment scale. The study has low risk for bias.

| Turk 2013 | |
|---|---|
| Representativeness | ★ |
| Sample size | ★ |
| Non-respondents | ★★ |
| Ascertainment of exposure | - |
| Control of confounding | - |
| Assessment of outcome | ★★ |
| Statistical test | ★ |
| **Total** | 8 |

**Figure 3.** Risk of bias assessment using modified Newcastle-Ottawa assessment scale for observational study.

## Results

Four studies reported the incidence of hernia recurrence after pediatric inguinal herniotomy. PRISMA flow diagram (Figure 4) illustrates the process. Included articles for final analysis were published from 2013 to 2017. The studies included in this meta-analysis are listed in Table 1.

Among patients who underwent inguinal herniotomy without incising the external oblique aponeurosis, the incidence of hernia recurrence was 0.25% (8/3151), while the incidence of hernia recurrence for those whose external oblique aponeuroses were incised was 0.33% (7/2138). Results of the meta-analysis (Figure 5) showed that the risk for hernia recurrence did not differ significantly between patients who underwent either of the inguinal herniotomy techniques (OR = 0.85, 95% CI = 0.31-2.36). The studies were homogenous ($I^2$ = 0%).

**Table 1.** Summary of included studies.

| Author | Study Design | Total Subjects (No opening : With opening the external oblique aponeurosis) | Mean Age of Subjects | Other Outcomes Measured (Apart from Recurrence, Hematoma, Hydrocele, Testicular Atrophy, Testicular Ascent) | Results/Conclusions |
|---|---|---|---|---|---|
| **Askarpour 2017** | Randomized clinical trial | 800 (400 : 400) | No mean age specified. Majority of subjects for both groups were in the 3 to 5 years old range. | 1. Ileoinguinal nerve damage<br>2. Ischemic orchitis | No significant difference in hernia recurrence and other postoperative complications except for post-operative hydrocele, which was higher when the external oblique aponeurosis was opened. |
| **Ibrahim 2015** | Multicenter prospective randomized controlled trial | 428 (330 : 98) | Mitchell Banks: 4.59 years<br>Ferguson: 4.87 years | 1. Induration<br>2. Wound infection | Hernia repair in children with opening the external oblique aponeurosis confers no advantage. |
| **Nazem 2016** | Randomized clinical trial | 66 (33 : 33) | Mitchell Banks: 3.43 +/- 1.70 years<br>Ferguson: 3.68 +/- 2.15 years | 1. Fever<br>2. Sensory impairment<br>3. Operation time | Early and late complications of the two repair methods were similar. Operation time was shorter without opening the external oblique aponeurosis. |
| **Turk 2013** | Retrospective review | 3995 (2388 : 1607) | Mitchell Banks: 5.1 +/- 0.19 years<br>Ferguson: 4.6 +/_ 1.15 years | 1. Wound infection<br>2. Mortality | Not opening the external oblique aponeurosis during herniotomy is safe. |

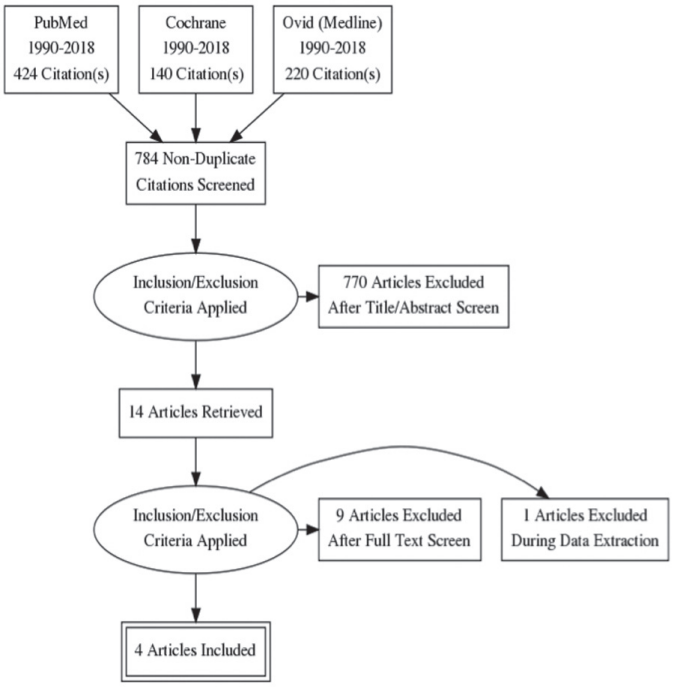


**Figure 4.** PRISMA flow diagram.

Four studies reported the incidence of hematoma after pediatric inguinal herniotomy. Among patients who underwent inguinal herniotomy without incising the external oblique aponeurosis, the incidence of hematoma was 0.83% (26/3151), while the incidence of hematoma for those whose external oblique aponeuroses were incised was 1.36% (29/2138). Results of the meta-analysis (Figure 6) showed that the risk for hematoma did not differ significantly between patients who underwent either of the herniotomy techniques (OR = 0.64, 95% CI = 0.37-1.13). The studies have low heterogeneity ($I^2$ = 31%).

In terms of occurrence of post-operative hydrocoele, three studies reported an incidence rate of 0.95% (29/3044) for patients who underwent inguinal herniotomy without incising the external oblique aponeurosis, and a rate of 2.80% (57/2033) for those whose external oblique aponeuroses were incised. Results of the meta-analysis (Figure 7) showed that the risk for post-operative hydrocele was significantly lower when the external oblique aponeurosis was not incised (OR = 0.44, 95% CI = 0.27-0.70). The studies were homogenous ($I^2$ = 0%).

Three studies reported the incidence of testicular ascent after pediatric inguinal herniotomy. Among patients who underwent inguinal herniotomy without incising the external oblique aponeurosis, the incidence of testicular ascent was 0.06% (2/3044), while the incidence for those whose external oblique aponeuroses were incised was 0.34% (7/2033). The study of Ibrahim, et al. (2015) reported no incidence of testicular ascent in the either group. Results of the meta-analysis (Figure 8) showed that the risk for testicular ascent did not differ

significantly between patients who underwent either of the herniotomy techniques (OR = 0.28, 95% CI = 0.05-1.50). The studies were homogenous ($I^2$ = 0%).

Four studies reported the incidence of testicular atrophy after pediatric inguinal herniotomy. Among patients who underwent inguinal herniotomy without incising the external oblique aponeurosis, the incidence of testicular atrophy was 0.28% (9/3151), while the incidence for those whose external oblique aponeuroses were incised was 0.14% (3/2138). The study of Ibrahim,

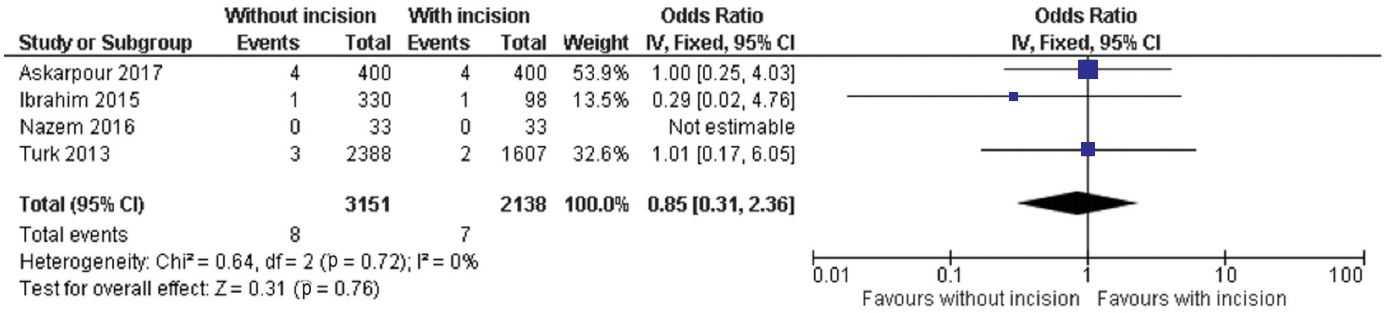


**Figure 5.** Meta-analysis comparing the incidence of hernia recurrence between pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis.

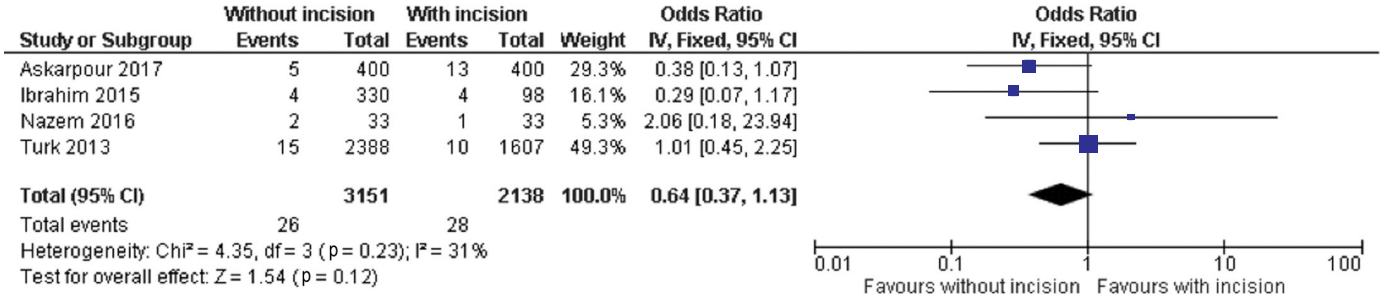


**Figure 6.** Meta-analysis comparing the incidence of post-operative hematoma between pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis.

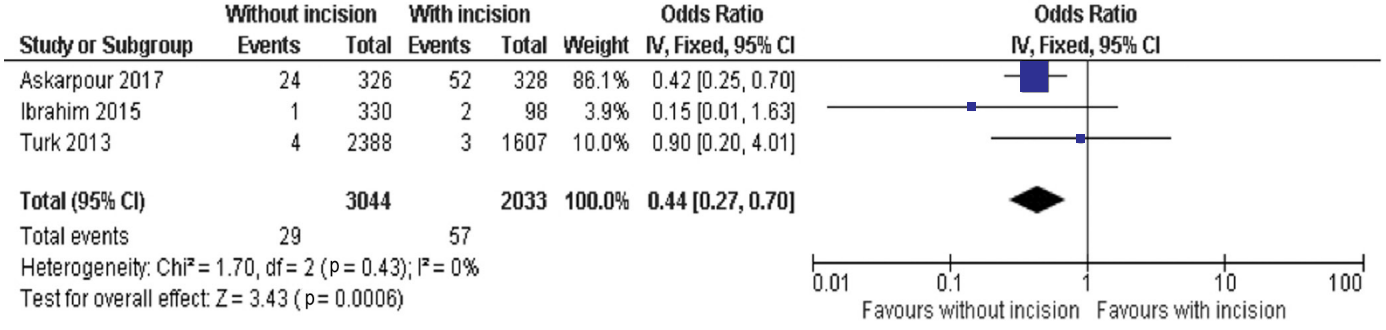


**Figure 7.** Meta-analysis comparing the incidence of post-operative hydrocele between pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis.

et al. reported no incidence of testicular atrophy in either group. Results of the meta-analysis (Figure 9) showed that the risk for testicular atrophy did not differ significantly between patients who underwent either of the herniotomy techniques (OR = 2.02, 95% CI = 0.54-7.52). The studies have low heterogeneity ($I^2$=13%).

## Discussion

The reported incidence of pediatric inguinal hernia is 1-3% in full-term, but as high as 30% in premature infants. As such, inguinal herniotomy has become the most common surgical procedure performed by pediatric surgeons.

After reviewing literature on inguinal herniotomy, although there are trends, there is a lack of consensus among pediatric surgeons on which technique is superior. It is possible that surgical mentorship or the tradition of learning from mentors, has contributed more to a surgeon's choice of technique as opposed to adamant adherence to prevention of anticipated complications.[3] Thus, inguinal herniotomy has evolved into various forms, each being an amalgamation of the surgeon's training and analysis of outcomes over time.[4]

This meta-analysis compared the two most common techniques in pediatric inguinal herniotomy, namely the Ferguson technique and the Mitchell-Banks technique. Present results showed that there was no significant difference between the two techniques in terms of hernia recurrence.

Advocates of the Mitchell-Banks technique believe that the inguinal canal in children is different from

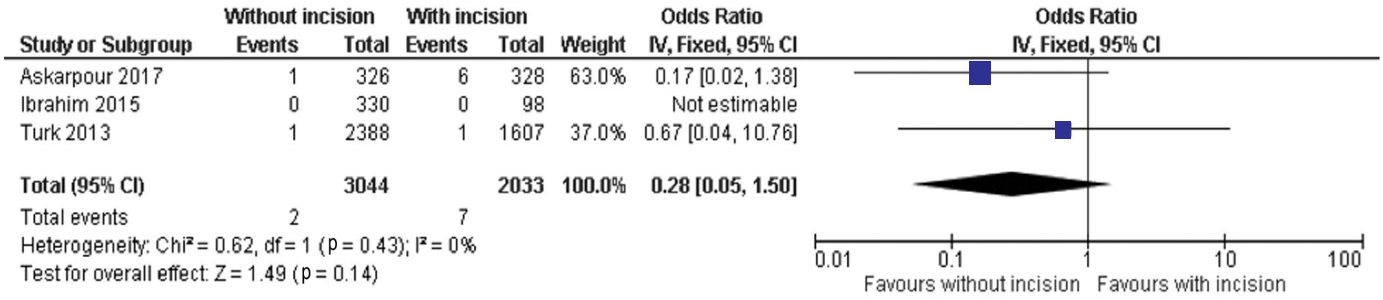


**Figure 8.** Meta-analysis comparing the incidence of post-operative testicular ascent between pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis.

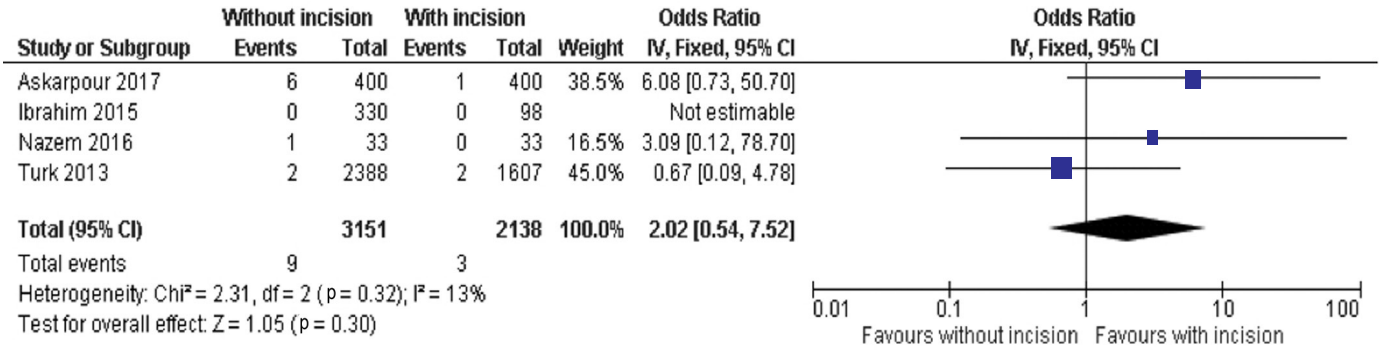


**Figure 9.** Meta-analysis comparing the incidence of post-operative testicular atrophy between pediatric inguinal herniotomies performed with and without incising the external oblique aponeurosis.

that of adults. First, it is shorter, measuring 4-23 mm in children aged 0-12 years, compared to 40-50 mm in adolescents. Second, it lies in a less oblique plane, having a more antero-posterior orientation. Third, its tissues are more flexible, enabling the internal and external rings to move closer to each other with caudal traction applied on the hernia sac.[5]

According to a survey among North American pediatric surgeons conducted by Levitt, et al. (2002), the Mitchell-Banks technique had been used safely in children aged up to 11 years, with a recurrence rate similar to the Ferguson technique.[6] In support of this, the study of Askarpour (2017) divided subjects into age subgroups as follows: less than 3 months, 3 months to 2 years, 3 to 5 years, and 6 to 12 years. Subjects per age subgroup were equally distributed between the Mitchell Banks and Ferguson techniques. According to their analysis, there was no significant difference among the age subgroups in the incidence of hernia recurrence and post-operative complications using either herniotomy technique.

Kurlan, et al. postulated that the most common causes of inguinal hernia recurrence were actually the failure to identify and excise the sac or to note a proximal tear on the sac.[7] With that said, surgeon-related factors such as training, experience, and extent of manipulation, played a key role in the incidence of herniotomy related complications.[8-9]

Grosfeld, et al. enumerated other factors contributing to inguinal hernia recurrence, which included post-operative wound infection, hematoma, injury to the floor of the inguinal canal, and usage of inappropriate suture materials.[10]

With regard to post-operative complications, selection of outcomes for analysis was based on the most prevalent complications of pediatric inguinal herniotomy. These were also the outcomes that were common among the four studies included. In terms of clinical significance, although hydrocele is the most common complication documented, testicular atrophy is the most devastating complication for a patient since this may lead to infertility. This meta-analysis showed that there was no significant difference between either technique in terms of hematoma, testicular ascent, and testicular atrophy. The only significant difference found between the two techniques was the incidence of post-operative hydrocele, which was higher in the Ferguson technique.

Hydroceles are a product of an imbalance of scrotal fluid production and absorption.[11] Hydroceles that occur following inguinal herniotomy are usually of the non-communicating type and are likely due to increased serosal fluid production secondary to inflammation.[12] It is postulated that more surgical manipulation results in more oxidative stress, and consequently more inflammation.[13] This could support the findings in this study wherein the Ferguson technique, which involved more manipulation by opening the external oblique aponeurosis, resulted in a significantly higher incidence of post-operative hydrocele.

Another theoretical benefit of the Mitchell-Banks technique is that if the hernia sac can be isolated and dissected at the external ring without opening the external oblique aponeurosis, the chance of injuring the ilioinguinal nerve is minimized and weakening of the posterior wall of the inguinal canal is avoided.

Apart from technical advantages, Ibrahim, et al. stated that when the external oblique aponeurosis was not opened, mean operation time, anesthesia time, and post-operative pain were reduced.[3] They also went on to state that opening the external oblique aponeurosis had no positive effect on the quality of the repair or reduction of complications.

It is imperative to note however that the Mitchell-Banks procedure should not be employed in all cases of pediatric inguinal hernia. In patients who have coincident undescended testis and/or incarcerated hernia, opening the external oblique aponeurosis will facilitate the procedure.[14]

A limitation of this study is the possibility of publication bias since only published studies were included in the analysis.

## Conclusion

This meta-analysis supports the assumption that there was no significant difference in terms of hernia recurrence on whether or not the pediatric inguinal herniotomy technique used involved opening the external

oblique aponeurosis. The Ferguson technique resulted in a significantly higher incidence of post-operative hydrocele as compared to the Mitchell-Banks technique. Outcomes of other post-operative complications such as hematoma, testicular atrophy, and testicular ascent did not significantly differ between the two techniques. In elective pediatric inguinal herniotomies, use of the simpler Mitchell-Banks technique is safe and recommended.

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