fTitanium elastic nails versus Spica cast in pediatric femoral shaft fractures: A Systematic Review and Meta-analysis of 1012 patients.

ABSTRACT:

BACKGROUND

There is a general consensus on the management of femoral fractures in children younger than two years and adolescents older than sixteen years. The best treatment for patients younger than sixteen years of age is still debatable. Titanium Elastic Nails (TEN), is widely used with some evidence, nonetheless, we performed a systematic meta-analysis to synthesize evidence from published studies about the efficacy of TEN compared to Spica cast for the management of femoral shaft fracture in children aged between 2 to 16 years old.

METHODS

A computer literature search of PubMed, Scopus, Web of Science, CINAHL and Cochrane Central was conducted using relevant keywords. We included clinical trials and observational studies that compared TEN versus Spica cast; Records were screened for eligible studies and data were extracted and synthesized using Review Manager version 5.3 for Windows. Our search retrieved 573 unique articles. Following the abstract and full text screening, 12 studies with a total of 1012 patients were eligible for the final analysis

RESULTS

In terms of union (in weeks), the reported effect sizes favoured the TEN group in two included studies only. Moreover, the overall standardized mean difference in sagittal (SMD -0.48, 95% CI [-0.70 to -0.26], P<0.001) and coronal angulations (SMD -0.66, 95% CI [-1.00 to -0.31], P <0.001) favored TEN fixation in management of femoral fractures younger than 16 years. The reported length of hospital stay was not consistent across studies. The overall risk ratio of malalignment (RR=0.39, 95% CI [0.27 to 0.57], P<0.001) favored the TEN as well as walking independently. Based on our analysis, TEN treatment is superior to traction and hip spica for femoral-shaft fractures in children younger than 16 years old.

CONCLUSION

Based on our analysis we recommend the use of TEN fixation in management of pediatric femoral fractures in patients younger than 16 years.

KEYWORDS

Femoral fractures, spica cast, titanium elastic nails, flexible nails

1. INTRODUCTION

Femoral shaft fractures represent 1.4 % to 1.7 % of all pediatric fractures (1). There is a bimodal pattern being more in early childhood and mid-adolescence and more common among boys than girls (2). The reported annual incidence is up to 1/5000- they represent the most frequently pediatric fracture requiring a hospital admission. There are different mechanisms of injury described; this includes but not limited to road traffic accidents, falls, Non-accidental injuries, incidental findings, sports related injuries and pathologic fractures (3). In children less than 4 years and toddlers, child abuse would be a main concern (4). In mid-adolescence motor vehicle accidents represent a common cause (5).

When choosing the treatment modality in this age group, several issues including the final outcome ought to be considered; as they have impact on psychological and developmental effects: on the child, family and social ramifications and financial implications (if a parent has to take time off work).

There is a general consensus on the management of femoral fractures in children younger than two years and adolescents aged 16 or more (6). The ideal treatment for patients between two and sixteen years of age is debatable (7). Closed reduction and Spica cast (CRSC) (6, 8-12), external fixation (13-16), plate and screws (17, 18), intramedullary nails (19-25) and flexible intramedullary nails (26-29) have been described for management of femoral fractures in this age group.

Titanium Elastic Nails (TEN) is used globally for the operative fixation of femoral fractures in children younger than 16 years old, despite the paucity of studies evaluating their risks and benefits (26-29). TEN have been used in Europe since the eighties (30) and historically stainless-steel Ender nails have been used elsewhere (31). The surge of TEN in North America has led to an over- spill in their use (32).

We performed a systematic review and meta-analysis to analyse the evidence about the efficacy of flexible nails compared to Spica cast for the management of femoral fracture in children younger than 16 years old.

2. METHODS

We followed the PRISMA statement guidelines for the preparation of this review and meta-analysis.

2.1. Inclusion and Exclusion criteria

Those studies satisfying the following criteria were included in the present study: 1 Clinical trials and observational studies that compared titanium elastic nails versus hip spica; 2 studies whose population was children below the age of 16 years with femoral shaft fractures; 3 studies where the experimental/observation group underwent titanium elastic nails/ flexible intramedullary nails; 4 studies with control group receiving immediate hip Spica cast or traction followed by Spica; 5- studies that were prospective or retrospective studies; and 6 studies whose outcomes were presented as continuous outcomes reliable for analysis; and 7 studies reporting the outcomes of hospital stay, union duration, sagittal angulations, malunion, complications, parents satisfaction, coronal angulations, malalignment, and independent walking milestones. We excluded studies that were not available in English language, theses, conference abstracts, and studies whose data were not reliable for extraction and analysis.

2.2. Literature Search Strategy

A computer literature search of PubMed, Scopus, Web of Science, CINAL and Cochrane Central was conducted using the following keywords: ((("Bone Nails"[Mesh] OR "Titanium"[Mesh] OR (titanium elastic nailing)) AND ("Casts, Surgical"[Mesh] OR (hip spica casting) OR (spica cast) OR "Traction"[Mesh] OR (conservative management)) AND ("Femur"[Mesh] OR pediatric femur fracture OR femur shaft fracture))) OR ((Bone Nails AND Traction AND "Fractures, Bone"[Mesh])). Additionally, we hand-searched references of the identified articles. Two authors screened the titles and abstracts of the retrieved citations. Eligibility criteria were performed in two steps. An initial abstract screening was commissioned followed by a full-text retrieval of eligible articles and further screening for eligibility to meta-analysis.

2.3. Data Extraction

Two authors extracted the data independently using an online data extraction form. The extracted data included the following: 1) study design; 2) study population; 3) risk of bias domains; and 4) specific study outcomes: hospital stay, time to union, sagittal angulations, coronal angulations, malalignment, and walking independently; Disagreements were resolved by consensus.

2.4. Quality assessment

The quality of the Randomized Clinical Trials was assessed according to the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0 (updated March 2011) using the quality assessment table provided in the same book (Part 2, Chapter 8.5). The Cochrane risk of bias assessment tool includes the following domains: sequence generation (selection bias), allocation sequence concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias) and other potential sources of bias. The authors' judgment is categorized as 'Low risk', 'High risk' or 'Unclear risk' of bias. The NOS contains eight items, categorized into three dimensions including selection, comparability, and—depending on the study type—outcome (cohort studies) or exposure (case-control studies). For each item a series of response options is provided. For observational studies, we used the Newcastle-Ottawa Scale (NOS) for quality assessment (33). NOS is based on a star system and is used to allow a semi-quantitative assessment of study quality. The NOS ranges between zero up to nine stars.

2.5. Measures of treatment effect

The primary outcomes were union duration, malunion rate, the length of stay, independent walking, angulations (Sagittal and coronal) in both groups. The secondary outcomes were: complications and parents' satisfaction.

2.6. Dealing with missing data

In the case of missing Standard deviation (SD) of mean change from baseline, calculations were performed using the standard error or 95% confidence interval (CI), according to Altman (34).

2.7. Data Synthesis

Hospital stay, time to union, sagittal angulations, coronal angulations, malunion and walking independently were pooled as standardized mean difference (SMD) in the random effect model meta-analysis described by Der-Simonian and Laird(35). The incidence of malalignment in both groups was pooled as relative risk (RR) in the meta-analysis model using the Mantel-Haenszel (M-H) method. Statistical analyses were conducted using Review Manager 5.3 for Windows.

2.8. Assessment of heterogeneity

Heterogeneity was assessed by visual inspection of the forest plots and measured by I-square and Chi-Squared tests. According to the Cochrane Handbook of Systematic Reviews and Meta-analysis of interventional studies, the Chi-squared test assesses whether observed differences in results are compatible with chance alone. According to Higgins 2002 (36) and Higgins 2003 (37), the heterogeneity test I-squared is calculated from the following equation: $\left[\frac{Q-df}{Q}\right]x100\%$ where Q is the chi-squared statistic and df is its degrees of freedom. I-squared test can be interpreted as follows: 0% to 40%: might not be important; 30% to 60%: may represent moderate heterogeneity; 50% to 90%: may represent substantial heterogeneity; and 75% to 100%: considerable heterogeneity.

2.9. Publication bias

According to Egger *et al.* (38), publication bias assessment is not reliable for less than 10 pooled studies. Therefore, in this study, we could not assess the existence of publication bias by Egger's test for funnel plot asymmetry.

3. RESULTS

3.1. Search results

Our search retrieved 573 unique articles. Following the abstract and full text screening, 12 studies(28, 32, 39-49) with a total of 1012 patients were eligible for the final analysis (See PRISMA flow diagram; [**Figure 1]**). The reasons for study exclusion are shown in Supplementary File no.1.

Of the 12 included studies, two studies were randomized controlled studies; the summary of the included studies and their main results are shown in **[Table 1]**.

3.2. Quality of included studies

The quality of the included studies was from moderate to high quality according to the Cochrane risk of bias assessment tool and the NOS. Therefore; included studies have acceptable quality for inclusion in our review. The summary of quality assessment domains of included studies is shown in supplementary file.

Primary Outcomes

3.3. Duration to Union (in weeks)

In terms of duration till union (in weeks), reported effect sizes were heterogeneous and were not reliable for pooling in a meta-analysis model to give an overall effect estimate [**Figure 2**]. The duration till union was significantly less in the TEN group than the control group in two studies (40), (41); while in the third study of (39).

3.4. Malunion

The pooled risk ratio of malunion showed less rate of malunioin in the TEN group compared with the Spica group (RR 0.43, 95% CI [0.26, 0.71], P <0.001, [**Figure 3**]. Pooled studies were homogenous (P>0.1; I-square=0%).

3.5. Sagittal Angulations

The overall standardized mean difference in sagittal angulations favored TEN group than the control group (SMD -0.48, 95% CI [-0.70 to -0.26], P<0.001, [**Figure 4**]. Pooled studies were not heterogeneous (Chi square P=0.90; I-square=0%).

3.6. Coronal Angulations

The overall standardized mean difference in coronal angulations favored TEN group than the control group (SMD -0.66, 95% CI [-1.00 to -0.31], P <0.001, [**Figure 5**]. Pooled studies were not heterogeneous (Chi square P=0.14; I-square=48%).

3.7. Hospital stay (days)

Three retrospective studies favored the CRSC group over the TEN group. The remaining retrospective study did not favor either of the two groups. The two RCTs (42), (43) reported a statistically significant difference favoring shorter hospital stay in the case of TEN than the CRSC group (Mean Difference = -13.60 days, 95% CI [-16.25 to -10.95], and Mean Difference = -12.28 days, 95% CI [-13.26 to -11.30], respectively). The overall effect estimates did not favor any of the two groups (Mean Difference = -3.13, 95% CI [-7.44, 1.18], P =0.15, [**Figure 6**]); the pooled effect estimate was highly heterogeneous (Chi square P <0.001; I-square=99%)

3.8. Malalignment

The overall risk ratio of malalignment favored TEN group than control group (RR=0.39, 95% CI [0.27 to 0.57], P<0.001, [**Figure 7**]). Pooled studies were not heterogeneous (Chi-square P=0.40 and I-square=0%).

3.9. Walking independently

Four studies (two retrospective studies and two RCTs) investigated the ability of patients to walk independently. All the four studies reported a statistically significant difference in walking independently favoring the TEN group than the control group [**Figure 8**].

Secondary Outcomes

3.10. Parent Satisfaction

Two studies reported parent satisfaction; both studies showed higher satisfaction rate following TEN than Spica. The pooled RR of parent satisfaction did not significantly favored the TEN group than the Spica group (RR 1.65, 95% CI [0.94, 2.88], P =0.08, [**Figure 9**].

3.11. Complications

The complications of each procedure are mutually independent. Therefore, we cannot compare both procedures for the same complications. Therefore, the percentages could not be expressed as Risk Ratio between the two groups. Summary of complications is summarized in [**Table 2]** and [**Table 3]**.

4. DISCUSSION

Our analysis showed a statistically significant difference favoring the TEN group in the duration of union when compared with CRSC - as well as malunion, sagittal and coronal angulations in the management of femoral fractures in patients younger than 16 years old. We report a statistically significant difference favoring shorter hospital stay in the case of TEN when compared to the CRSC group. Likewise, the overall risk ratio of malalignment favored TEN group than CRSC. Similarly, we have observed a statistically significant difference in independent walking and parents' satisfaction favoring the TEN group than the CRSC group. Subsequently, based on our observations, the results showed significant benefits of TEN compared to CRSC in the treatment of femoral-shaft fractures in children younger than 16 years old.

Traditionally, conservative treatment was the method of choice for diaphyseal fractures in children and adolescents, because it avoided surgical risks. However, spica use requires lengthy immobilisation and a higher risk for limb length discrepancy (LLD). TEN fixation thus superseded other surgical options in the pediatric population, as it is: simple, effective, reproducible and minimally invasive. It allows: a stable fixation, rapid healing and a prompt return to normal activity [32, 37, 41, 48]

4.1. Overall completeness of evidence

Shemshaki *et al.* (42) compared spica cast with TEN in management of peadiatric femoral fractures and reported superior results in the TEN group with earlier discharge from hospital (P< 0.001), return to independent walking (P< 0.001), return to school (P< 0.001) and better parent satisfaction (P = 0.003); the two groups were similar in baseline characteristics. The Range of knee motion was 138.7 ± 3.4 and 133.5 ± 13.4 degrees in the CRSC and the TEN groups respectively (P = 0.078). Malunion was observed three patients (13.0%) in the CRSC group compared with none in the TEN group (P = 0.117). Postoperative infection was observed in three patients (13.0%) in the TEN group.

Similarly, Soleimanpour *et al.*(43) reported superior results in the TEN group in regards to absence time from school, length of hospital stay, time needed for walking and angular deviation (varus or valgus) were when compared with the CRSC group. They observed no statistically significant difference between the two groups in regards to malunion, wound complications and hospital charges.

4.2. Union

Heffernan *et al.* (39) showed no statistical significant difference between the two groups in regards to the time to union. However, Sasseendar *et al.* (41) and Flynn *et al.* (32) showed a statistically significant difference favoring the TEN group than the control group.

Sela *et al.* (44) reported 100% union rate, less than 8% rate of LLD and a complication rate of less than 5% with CRSC. Only one of the 151 patients treated with CRSC needed a re-operation. Assaghir *et al.* (40) retrospectively evaluated 104 pediatric femoral fracture in children with a mean age of 4.5 years managed with wither TEN or spica cast followed up for a minimum of 3 years. TEN was statistically better in terms of union ($P < 0.001$), and shortening ($P = 0.016$) subsequently leading to earlier weight bearing ($P < 0.001$). Saseendar *et al.* (41) demonstrated that fracture union happens earlier in the TEN group (6 weeks) than in the spica group (8 weeks) ($P = 0.001$).

Heffernan *et al.* (39) performed a multicenter retrospective analysis of 215 patients aged 2 to 6 Years. Although there was no significant difference in healing times between TEN and the spica groups ($P=0.652$), they recommended that TEN is a reasonable option for treatment of femur fractures in young children when compared with CRSC with shorter time to independent ambulation and full activities ($P=0.023$). They strongly recommended the utilization of TEN in high-energy mechanism fractures.

4.3. Complications

In our analysis, reported complications in TEN group included: painful nail ends, pin migration, superficial infection, painful scar and painless limb. On the other hand, complications in CRSC group ranged from: sores, ulcers, infected pin, wedging of the spica, revision and limbing.

Sela *et al.* (44) reported that CRSC were associated with more side effects- mainly contact dermatitis. The main complication was the risk of re-manipulation due to loss of reduction. They also had 10.5% more LLDs (>2 cm shortening or <1 cm lengthening). Similarly, Flynn *et al.* (32) reported that the rate of complications associated with TEN compared favorably with that associated with CRSC. In their cohort, none of the children treated with TEN had more that one cm of LLD compared to 2/35 (4%).

Say *et al.* (45) detected no significant differences in regard to complications and results. Although the complications are statistically alike in both procedures, they highlighted that the complications of TEN are more challenging.

4.4. Malunion, sagittal, and coronal angulation

Our analysis showed lower rate of malunion in the TEN group compared with the CRSC group. Similarly, the overall standardized mean difference in sagittal angulation (P<0.0001) and coronal angulation (P=0.0002) favored TEN group than the CRSC group. Acceptable angulation in pediatric shaft femoral fractures has been set by Kasser (50): angulation of 30° in both planes, 20° on the sagittal plane and 15° on the coronal plane and 10° on the coronal plane and 15° on the sagittal plane in patients younger than 2 years, between 2 and 5 and between 5 and 10 years, respectively. When angulations during spica cast treatment occur beyond these ranges, different strategies must be considered - such as cast wedging (3). Loss of acceptable angulation after reduction of femoral fracture in children treated with spica casting has been reported (28, 32, 41). Assaghir *et al.* (40) reported statistically significant differences in favor of TEN over CRSC in regards to shortening (P =0.016); sagittal angulation (P =0.018); coronal angulation (P =0.022); rotation (P =0.014).

Heffernan *et al.* (39) reported lingering angulation was higher in the CRSC vs. TEN group in both the sagittal plane (P =0.002) and coronal plane (P =0.006). Similarly, outcome success represented by coronal and sagittal angulation less than 10° and shortening less than 15 mm was attained in 92 % of the TEN group compared to 67% in the CRSC group (odds ratio for TEN group 9.28 (1.6–54.7); p = 0.0138) (28). Saseendar *et al.* (41) demonstrated that Spica casting led to increased coronal plane angulation (P = 0.001), higher rotational malalignment (P= 0.001), higher limb length discrepancy at 1-year follow-up (P<0.001) when compared with the TEN group.

Shemshaki *et al.* (42) reported a 13.0% of nonunion in the CRSC group whereas none occurred in the TEN group in their randomized controlled trial (P = 0.117). In the younger age groups. Assaghir *et al.* (40) retrospectively evaluated femoral fracture in children with a mean age of 4.5 years. TEN was statistically better in terms of sagittal angulation (P = 0.018), coronal angulation (P = 0.022), rotation (P = 0.014).

4.5. Cost effectiveness

Buechsenschuetz *et al.* (46) retrospectively undertook a cost analysis comparing both modalities. They looked at different aspects including hospital, physicians, physiotherapy and facility costs. Inpatient costs were higher in the TEN group regarding the overall surgeon's and physiotherapy costs paid (p< 0.001). The metalwork removal procedure was included as well in the TEN group. Facility costs, however, were higher in the spica group (p< 0.015), resulting in a slight difference in overall inpatient costs between the two groups (p < 0.047). Finally, they reported that the total overall costs of femoral shaft fractures with TEN was significantly less expensive (average, $11,077) than traditional CRSC approach (average, $13,490), with a value of p < 0.04. On the other hand, Clinkscales and Peterson(48) reported that costs for patients in the traction group were equal to the intramedullary nail group. Similarly, Flynn *et al.* (32) and Soleimanpour *et al.* (43) reported that costs for the two treatment options were similar. Flynn *et al.* (32)

demonstrated that although the surgical costs is significantly higher in the TEN group (P<0.0001), the hospitalization cost was significantly higher in the CRSC group (P<0.001), yielding to insignificant total costs' differences between both groups.

4.6. Parent satisfaction

Two studies (40, 46) reported parent satisfaction. Both studies showed higher satisfaction rate following TEN than Spica. Also similar to our findings, there was lower parent satisfaction in the CRSC group, with superior parental acceptance of the TEN treatment. This was also reported by Clinkscales and Peterson(48). This observation could be attributed to the various social and psychological aspects of treating femoral fractures with spica casts that was highlighted by different studies (51-53)

Buechsenschuetz *et al.* (46) reported that nearly all of the children in the TEN group were reintegrated with their social environment sooner than their CRSC counterparts. Patients in the TEN group were able to return to school within 2 to 3 weeks of their surgery, and in some cases even before the CRSC group patients were released from their initial hospitalization. They showed that two children in the CRSC group had to repeat a school grade. This led to parental dissatisfaction and had adverse implications on the child. One parent felt their child was "emotionally scarred" during the cast period, and another child ultimately needed psychiatric counseling after removal of the cast. Though these observations cannot be generalized, this is inferred as a direct consequence of the CRSC procedure, as was previously reported by Streissguth and Streissguth (54).

4.7. Length of hospital stay

Two RCTs (42, 43) reported a statistically significant difference favoring shorter hospital stay in the case of TEN than the CRSC group. Shemshaki *et al.* (42) reported a short length of stay in the TEN group when compared with the CRSC group with a mean of 6.9 ± 2.9 days in the TEN group to 20.5 ± 5.8 days in the CRSC group ($P<0.001$). Likewise, Soleimanpour *et al.* (43) and Flynn *et al.* (32) reported a shorter hospitalization in the TEN group, when compared with CRSC group ($p< 0.05$) and ($p < 0.0001$) respectively. Flynn *et al.* reported a mean of 5 days of hospitalization in the TEN group compared to 24 days in the CRSC group. However, the remaining included studies reported different results with shorter hospital stay in the CRSC group. Our pooled effect estimate did not favor any of the two group

4.8. Independent walking and return to school

Similar to our findings, Shemshaki *et al.* (42) reported a short time interval to independent walking in the TEN group when compared with the CRSC group.

They reported a mean 17.6 ±10.2 days to supported walking in the TEN group compared to 65.6 ± 10.7 in the CRSC group ($P<0.001$). Additionally, they demonstrated that the children in the TEN group took a shorter time to return to school sooner. It took the patients in the TEN group a mean of 31.5 ± 13.4 to return back to school compared to 64.3 ±19.6 days in the CRSC group ($P< 0.001$). Similarly, Flynn *et al.*(32) reported an earlier return to supported walking and independant walking in children in the TEN group, and a quicker return to school and these differences were significant when compared with CRSC group (48 days in the TEN compared to 103 days in the CRSC group ($p < 0.0001$)). The same observations were reported by Soleimanpour *et al.* (43); they demonstrated that mean non-attendance time from school, time needed for walking with and without help were significantly lower in the group treated by TEN ($p< 0.05$). Assaghir *et al.* (40) demonstrated TEN was statistically better in terms of earlier weight bearing ($P <0.001$), and earlier return to nursery ($P = 0.000$) in children less than 6 years old.

4.9. Quality of the evidence

The quality of this evidence is credible as it is based on high quality studies as indicated by the quality assessment. Search methods and eligibility criteria were well defined. We followed PRISMA checklist to prepare this study, and we performed all the steps in strict accordance with the Cochrane Handbook for

Systematic Reviews of Interventions. We should mention that in our study, we combined data from RCTs and observational studies. However, most effect estimates were pooled without significant heterogenity. Furthermore, the effect estimates of RCTs were not significantly different from those of observational studies except in terms of hospital stay. Therefore, we believe that evidence obtained from our analysis is robust.

4.10. Limitations

This meta-analysis included retrospective and observational studies together with two RCTs. It is well established that RCTs are the gold standard comparative studies providing class one evidence. Given this, we recommend further RCTs comparing the TEN with Spica hip. Additionally, the included studies did not study comprehensively different aspects of femoral shaft fractures and subsequently, this has been under-reported in our meta-analysis. These include factors like fracture type, patients' skeletal maturity and associated co-morbidities in those children. As these are important factors that should be considered when choosing the preferred treatment method.

4.11. Authors' conclusions

Based on our analysis we recommend the use of TEN fixation in management of pediatric femoral fractures in patients younger than 16 years old. The results imply that a child with a femoral fracture when treated with a TEN, achieves recovery milestones significantly faster than a child treated with traction and spica cast. Further studies with longer follow-ups and comparison of TEN with other surgical methods, such as external fixation, in children's femoral fractures are required.

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CONFLICT OF INTEREST

All authors confirm no financial or personal relationship with a third party whose interests could be positively or negatively influenced by the article's content.

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Figures Legend

Figure 1 shows PRISMA flow diagram for study selection.

Figure 2 shows the standardized mean difference between the two groups in the duration to union (in weeks) with 95% confidence intervals. IV=Inverse variance

Figure 3 shows the risk ratio of malunion between the two groups with 95% confidence intervals. M-H=mantel Haenzel

Figure 4 shows the standardized mean difference between the two groups in the sagittal angulations with 95% confidence intervals.

Figure 5 shows the standardized mean difference between the two groups in the coronal angulations with 95% confidence intervals.

Figure 6 shows the mean difference between the two groups in the length of hospital stay with 95% confidence intervals. IV=Inverse variance

Figure 7 shows the risk ratio between the two groups in the rate malalignment with 95% confidence intervals.

Figure 8 shows the standardized mean difference between the two groups in the walking independently with 95% confidence intervals. IV=Inverse variance

Figure 9 shows the risk ratio between the two groups in the parent satisfaction with 95% confidence intervals.

- TABLES

Table 1: Summary of included studies.

Table 2 Complications for the TEN group

Table 3: Complications for the Cast Group

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