

## Original Article



# Comparison of Z-Technique and Sliding Technique for Achilles Tendon Lengthening in Cerebral Palsy with Equinus Deformity: A Meta-Analysis

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### Abstract:

**Background:** Equinus foot deformity in Cerebral Palsy (CP) might cause functional and aesthetic disturbances. Equinus deformity can be managed by achilles tendon lengthening surgery. Currently there is no meta-analysis comparing Z-technique and sliding technique for achilles tendon lengthening. This meta analysis aimed to compare the recurrence and functional outcome of achilles tendon lengthening using Z-technique versus Sliding technique in CP patients with equinus deformity.

**Subjects Methods:** A meta-analysis was performed according to PRISMA guidelines. We extensively searched Pubmed and CochraneLibrary database from inception up to January 2023. The quality and risk of bias assessment were performed using Joanna Briggs Insitute checklist. Pooled recurrence and AOFAS score were analysed by Rev Man 5.4 software.

**Results:** We included a total of four studies consisting of two non-randomized clinical trials and two retrospective studies. A total of 271 limbs were involved, with follow up time ranging from 19.5 months into 42 months. Recurrence rate was higher in Z-technique (OR= 3.01, 95% CI1.01 to 18.97, p=0.05). AOFAS was significantly lower in Z-technique (MD=-10.36, (% CI -13.54 to -7.17, p<0.001)

**Conclusion:** Based on low quality of evidence, this meta analysis concluded that sliding technique is more recommended compare to Z-technique as it had less recurrence and better AOFAS. However, RCT study is needed to validate this finding.

**Keywords:** Z-lengthening, sliding technique, achilles lengthening, cerebral palsy, equinus deformity

## Background

Children with cerebral palsy frequently have the deformity called equinus foot. It was estimated that the prevalence of equinus deformity in CP was 93%.(Horsch *et al.*, 2021) Equinus is defined as the foot inability to performed dorsiflexion, so the foot always stays in plantar-flexion and extended knee position. This defect might cause functional and cosmetic disturbances toward the children, as it will interfere gait and mobility.(Shore, White and Kerr Graham, 2010) There are two types of equinus deformity, namely

dynamic equinus and fixed or static equinus.(Steinwender *et al.*, 2001; Svehlík *et al.*, 2010) Dynamic equinus which occurs due to spasm of gastrosoleus muscles can be managed conservatively using foot orthosis and physical therapy. In fixed or static equinus, there was an evidence of achilles tendon shortening, therefore it need to surgically treated by lengthening the achilles tendon.(Horsch *et al.*, 2022)

Achilles tendon lengthening surgery can be performed in open or percutaneous approach, and

the technique can be performed in sliding technique or Z-technique.(Ozyalvac *et al.*, 2020) Sliding technique is a newer technique compared to traditional Z-technique. In sliding technique, two or three hemi-cuts must be made in the tendon. There is a chance that the tendon will be completely severed. In Z-technique, a longitudinal incision is performed over the posteromedial border of the Achilles tendon. Deep dissection may damaged the blood supply in this procedure.(Kim *et al.*, 2014) The most common complication after surgery in CP patients is the recurrence of equinus deformity, showing that an effective technique is needed to reduce this recurrence.(Joo *et al.*, 2011)

Currently, there is no meta-analysis comparing z-technique and sliding technique. It is important for orthopedic surgeon to determine the optimal technique to achieve the best outcome for patient. Therefore, we performed a meta-analysis to compare the recurrence and functional outcome of achilles tendon lengthening using Z-technique versus Sliding technique in CP patients with equinus deformity.

## Subjects and Method

### PICO

The PICO of this study were as follow:

**P:** Cerebral Palsy patient with Equinus Deformity who underwent Achilles Tendon Lengthening Surgery

**I:** Z-Technique OR Z-Lengthening OR Z-Plasty

**C:** Sliding Technique OR Sliding Method or Sliding

**O:** Recurrence, The American Orthopedic Foot and Ankle Score (AOFAS)

### Search Strategy

We performed an extensive search in Pubmed and Cochrane Library database from inception up to January 2023. The keywords used during literature searching were including but not limited to as follows: ("Z-Technique" OR "Z-Lengthening" OR "Z-Plasty"), ("cerebral palsy"),

("equinus deformity" OR "equinus foot" OR "equinus foot deformity"), ("Achilles Tendon Lengthening" OR "Tendon Lengthening" OR "Tendo Achilles Lengthening"), ("Sliding Technique" OR "Sliding Method" or "Sliding")

## Study Selection and Extracted Data

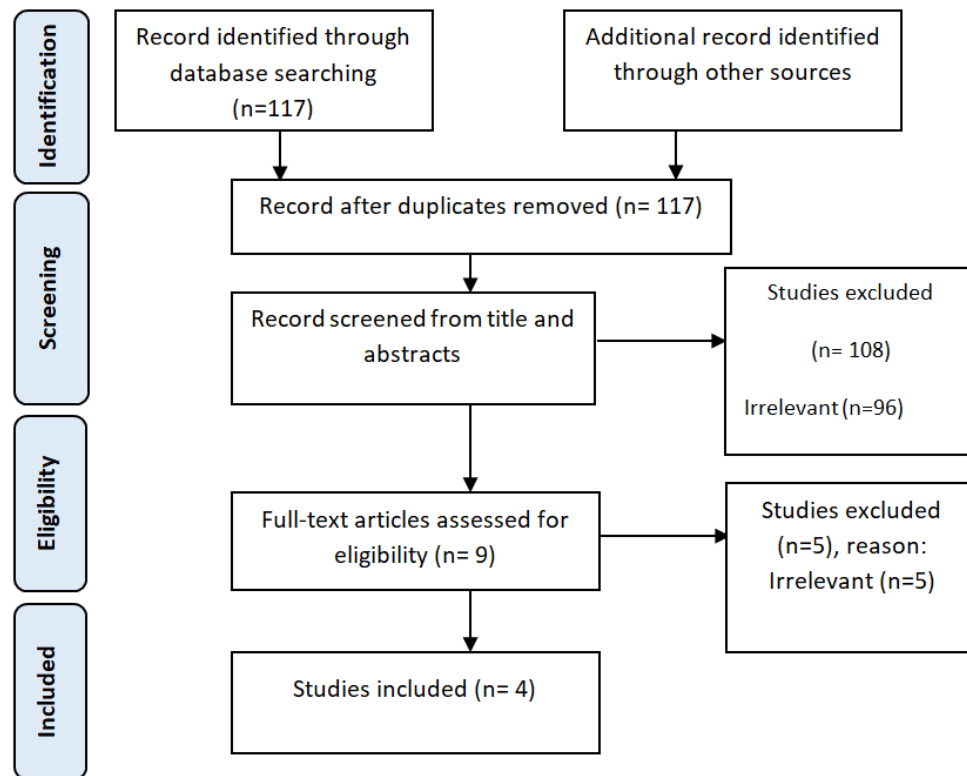
We included all of the original research investigating the comparison of Z-technique and sliding technique during achilles tendon lengthening surgery in cerebral palsy with equinus deformity. Study published in non-English language, unaccessible fulltext, case reports, case series, letters, editorials, review articles, and involving non human subjects were excluded from this study. The data obtained from the literature were name of author, year of publication, study design, sample size, recurrence rate of each surgical technique, and AOFAS of each surgical technique.

## Quality Assessment

After initial research in database and removing duplicate study, two reviewers independently screened all of the literatures based on abstract, evaluating the eligibility of studies, and assessed the quality of study and risk of bias. When there is adisagreement between both reviewers, it was solved based on consensus. The quality of study and risk of bias were assessed by Joanna Briggs Insitute checklist for RCT. Each item from the checklist contributed to one point. A study was considered as high quality if it got minimal half of the maximum total points and regarded as low quality if it got less than the half point of the total score.

## Results

The initial literature search from database obtained a total of 117 studies. After screening based on title and abstracts, 108 studies were excluded due to various reasons. Nine studies were assessed for eligibility based on full text. After exclusion of five articles, finally four studies were included in this meta-analysis. The flowchart of the study were shown in **Figure 1**.



**Figure 1. Flow chart of study selection**

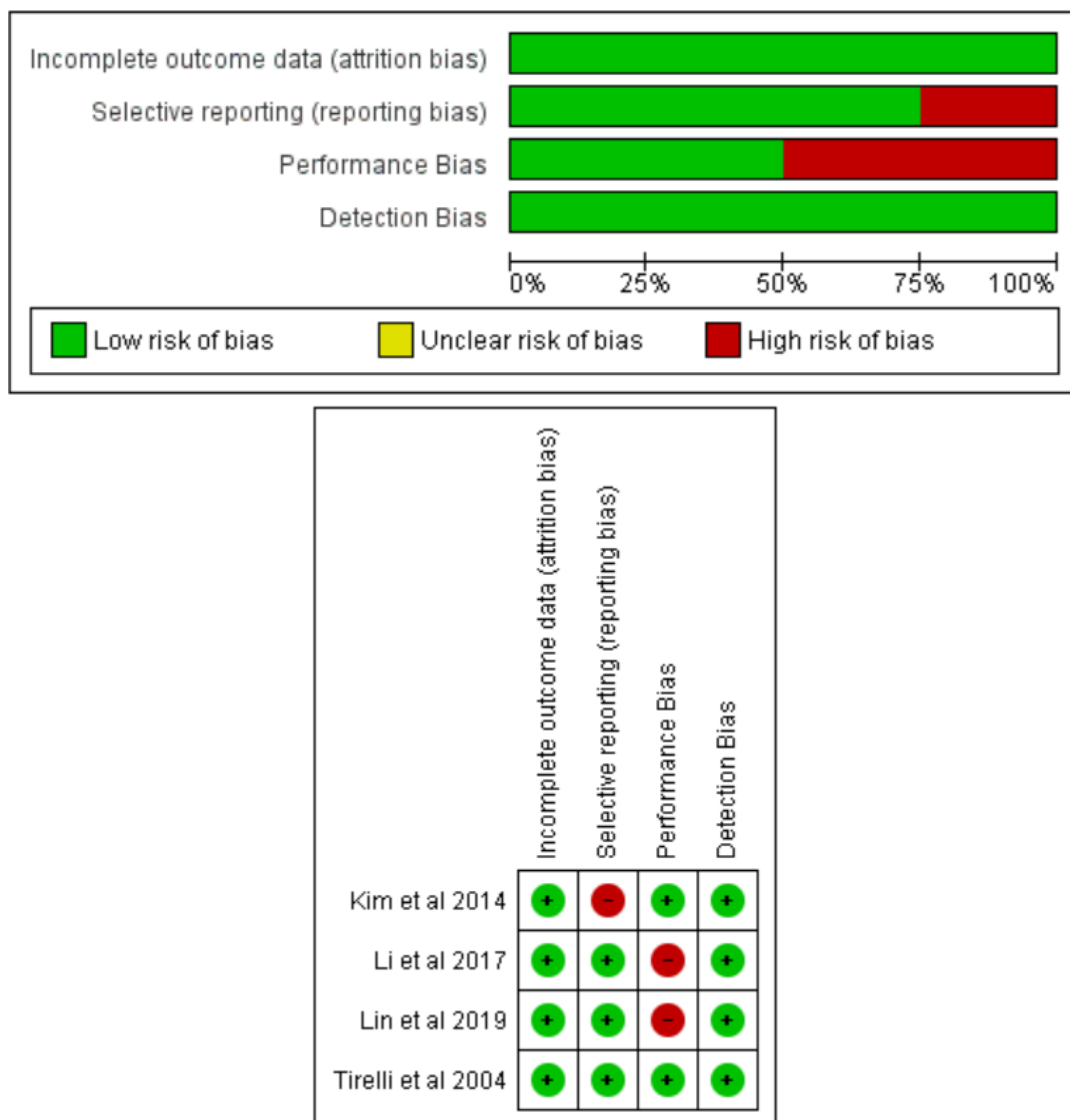
The included studies consisting of two non-randomized clinical trials and two retrospective studies. A total of 271 surgery were involved, with follow up time ranging from 19.5 months into 42 months. The studies were published from 2004-2019. The summary of the studies can be seen in **Table 1**.

**Table 1. Characteristics of Included Studies**

Author	Study Design	Sample Size		Subjects	Length of Follow-Up	Conclusion
		Z-technique	Sliding			
Kim et al., 2014(Kim <i>et al.</i> , 2014)	Non randomized trial	95	18	Mild – Severe equinus, age 4-28 years	2.2 years (range, 1.1 to 5.4 years).	Z-technique has lower rate of recurrence compared to sliding technique
Lin et al., 2019(Lin <i>et al.</i> , 2019)	Retrospective	30	25	Severe equinus, age 5-57 years	42.04 months in sliding technique, 61.7 months in Z-technique	No statistical difference between therapeutic effect of sliding and Z-technique, but less recurrence, operative time, hospital stay in sliding technique

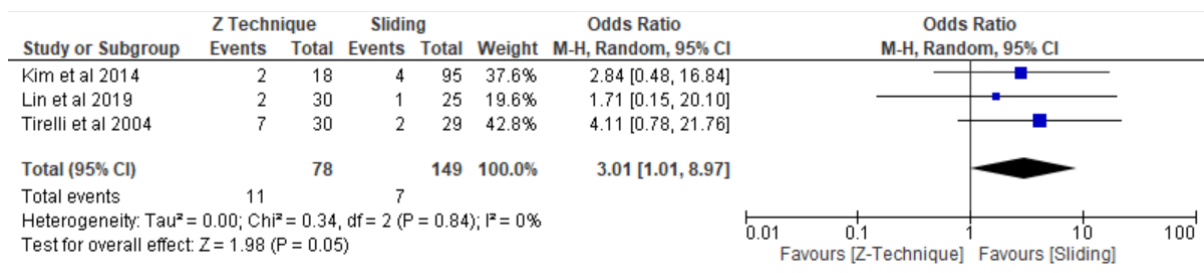
Li et al., 2017(Li <i>et al.</i> , 2019)	Non randomized trial	25	28	Mild – Severe equinus, mean age 11.1 SD 2.8 years	19.5 ± 5.4 months (range from 10 to 29 months).	Sliding technique has higher AOFAS and greater correcting angle compared to Z-technique
Tirelli et al., 2004	Retrospective	30	20	Mild – Severe equinus, 3-17 years	2.7 years (range, 1.0–6.0 years) in sliding technique, 4.1 years (range, 1.5–6.5 years), in Z-technique	Similar satisfaction and recurrence between groups

All of the studies have low quality of evidence. The risk of bias can be seen in **Figure 2**.



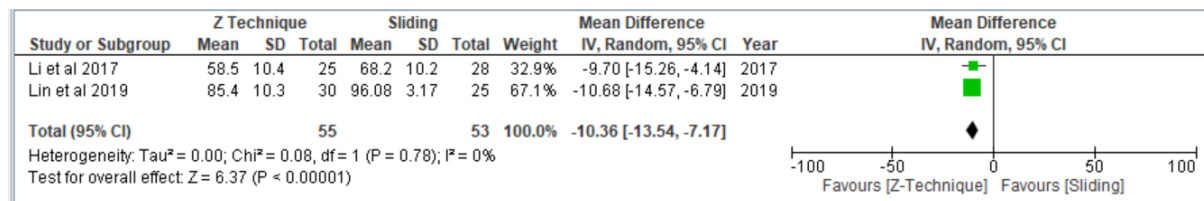
**Figure 2. Risk of Bias Assessment**

Based on random effect model, recurrence rate was higher in Z-technique (OR= 3.01, 95% CI1.01 to 18.97, p=0.05) (**Figure 3**).



**Figure 3. Forrest Plot of Recurrence in Z-Technique and Sliding Technique**

AOFAS was significantly lower in Z-technique (MD=-10.36, (% CI -13.54 to -7.17, p<0.001) (Figure 4).



**Figure 4. Forrest Plot of AOFAS in Z-Technique and Sliding Technique**

**Discussion**

This is the first meta-analysis comparing Z-technique versus sliding technique for achilles tendon lengthening in cerebral palsy patient with equinus deformity. Persistent plantarflexion in equinus deformity occurs due to achilles tendon strength is stronger in plantar flexion compare to dorsiflexion. Therefore, the principle of sliding technique is to weaken Achilles tendon strength in plantar flexion by creating hemi-cuts to the tendon.(Zhang *et al.*, 2021) This method was first introduced by Hoke in 1931.(Hatt and Lamphier, 1947) The first cut is incision of tendon sheath and medial half of achilles tendon, just above its insertion into calcaneus. The second cut is performed by by incise tendon sheath and lateral half of achilles tendon, just below the musculotendinous junction. The third cut is performed between the two previous cuts.(Al-Azzawi and Mohammed, 2016) In Z-technique, the achilles tendon was cut in Z-fashion. The lower end of this Z-incision is the insertion of tendon, and the middle of tendinous fibers was incised by medial longitudinal incision. At the top end of the incision, the tendon is transected laterally at level of the musculotendinous junction. After incision, the Achilles tendon was suture in maximum ankle dorsiflexion position. Z-technique is currently the standard and most commonly use technique for achilles tendon lengthening. (Zhang *et al.*, 2021) Both Z-technique and sliding technique can be performed

in open or percutaneous approach. After surgery, the leg needs to be immobilized during 3-4 weeks with short leg cast. Several authors reported comparable outcome with only two-weeks immobilization and early weight bearing, as prolonged ankle immobilization may cause joint contracture, muscle weakness, and delayed returned to daily activities. A rehabilitation protocol still needs to be performed after surgery. (Katz *et al.*, 2000)

The most frequent complication in equinus foot deformity is recurrence.(Joo *et al.*, 2011; Chung *et al.*, 2015) Study with long term follow-up after surgery of equinus foot in cerebral palsy patient revealed that the overall recurrence rate was 43.8%.(Joo *et al.*, 2011) The most significant risk factor of equinus recurrence is the pre-operative severity of equinus deformity. Another risk factors are younger age at surgery ( $\leq 8$  years old) and hemiplegia.(Joo *et al.*, 2011). Lin *et al.*, (2019) investigated patients who suffered from recurrence and reported that the patient was not adhere to post-operative rehabilitation training. Therefore, patients and their parents need to be given an understanding regarding the possibility of recurrence after surgery and the importance of sticking to rehabilitation protocol. Revision surgery may be helpful to correct the recurrence equinus deformity and usually performed with open Z-lengthening. (Lin *et al.*, 2019)

The American Orthopaedic Foot and Ankle Society (AOFAS) score is one of the most often

utilized tools for evaluating the outcome of treatment in individuals who have suffered ankle or hindfoot injuries. It has three subcategories: pain, function, and alignment. The questionnaire consists of patient-reported part and clinician-reported part. This instrument can be used to measure functional outcome after achilles tendon lengthening surgery. (Van Lieshout *et al.*, 2017)

Kim *et al* recommend that sliding technique is the choice of surgery for mild and moderate contracture in equinus deformity, while Z-lengthening is more appropriate for severe equinus deformity. Our study could not find sufficient data to categorize patient based on its severity. In study by Kim *et al*, the recurrence rate in sliding technique was 22.23% while in Z-technique was only 4%. However this study only measured AOFAS score in Z-technique and not in Sliding technique. (Kim *et al.*, 2014)

In study by Lin *et al*, operative time and length of hospital stay was significantly longer in Z-technique compared to sliding technique (35 minutes vs 10 minutes; and 6 days vs 3 days, respectively). The post-operative AOFAS score improved compare to pre-operative value in both techniques, but the AOFAS score was better in sliding technique compare to Z-technique (96 vs 85). In contrary with study by Kim *et al*, the recurrence rate in sliding technique is only 4% while in Z-technique was 21.4%. This may attributed due to Z-technique is usually preferred for equinus with a more severe degree of contracture and revision surgery, therefore has worse outcome. (Lin *et al.*, 2019) Similar with Lin *et al*, study by Li *et al* reported that patient in sliding technique had lower post-operative recovery time. The AOFAS score was higher in sliding technique but not statistically significant. The short term and long term correction angle were statistically significant in sliding technique group. (Li *et al.*, 2017) In study by Tirelli *et al.*, sliding technique had 6.8% recurrence rate while Z-lengthening had 23.3% recurrence rate. (Tirelli *et al.*, 2004)

This study has several limitations. First, due to specific population (cerebral palsy with equinus deformity), there were only few numbers of available studies. There is no randomized controlled trial (RCT) and all of the studies were low quality. It may create uncertainty regarding

the strength of evidence. Second, there were high variability between study in the term of participants characteristics, such as contracture severity before surgery, types of surgery (primary or revision), and surgeon skill. Higher contracture severity may result in worse surgical outcome. Most of our studies include all degree of contracture severity, with only one study only included severe ankle contracture. The included study didn't explain the outcome based on severity. Lastly, due to limited data, we only able to conducting meta-analysis in two outcomes. There are still many outcomes which have not been investigated, such as correction angle, MRI result, scar, and infection.

This meta-analysis concluded that, based on low quality of evidence, sliding technique is more recommended compare to Z-technique, as it had less recurrence and better functional outcome based on AOFAS. However, RCT study is needed to validate this finding. As pre-operative equinus severity is a significant predictor for recurrence, controlling this variable is essential for further research.

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None

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#### Conflict of Interest

The authors declare that the study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

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