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SYSTEMATIC REVIEW ON EXTENDED POSTERIOR RELEASES IN EQUINUS FOOT DEFORMITY IN CHILDREN WITH CEREBRAL PALSY

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ABSTRACT

Equinus foot deformity is a relatively common gait disorder in children, which is frequently seen in cerebral palsy, idiopathic clubfoot, and syndromic conditions including arthrogryposis. While conservative approaches such as physiotherapy, orthotic management, and functional re-education are effective in flexible cases, surgical intervention is required for rigid or recurrent deformities. Extended posterior release (EPR), which entails the Achilles tendon lengthening, rear capsular release, and subtalar joint release, have been considered a conventional surgical procedure used to treat severe equinus.This review presents a synthesis of EPR role in the treatment of paediatric equinus deformity in terms of outcome, recurrence and complications. Clinical trials have always shown a significant increase in ankle dorsiflexion, gait variables and functional mobility after EPR, especially in children with cerebral palsy and relapsed clubfoot. Nevertheless, the rate of recurrence is high, between 10 and 30% particularly in spastic cerebral palsy. The occurrence of complications, including overcorrection, postoperative stiffness, and impaired wound healing, limits the widespread application of this technique.Compared with other procedures, such as tendon transfers, percutaneous gastrocsoleus lengthening, selective nerve repair, and the Ponseti technique for neglected clubfoot, EPR offers greater safety in correction but is associated with higher morbidity. Recent evidence emphasises the need to use individualized treatment choices, incorporating less invasive and adjunctive interventions where needed.As a result, long-term release has been proven to be an effective instrument in the treatment of severe equinus foot deformity in children. The selection of cases, rehabilitation, and long-term follow-up should be carefully selected to maximize the results. Prospective research on the standardized outcome measurement should be done later to provide clearer guidelines on the treatment.

Keywords: *Equinus foot deformity, Extended posterior release, Cerebral palsy, Pediatric orthopedics, Clubfoot, Tendon transfers, Gait outcomes, Recurrence, Surgical complications, Functional rehabilitation.*

INTRODUCTION

One of the most prevalent gait disorders in the children, particularly in cases of cerebral palsy and idiopathic clubfoot is equinus foot deformity [1,2]. It is characterized by a restricted dorsiflexion of the ankle which is frequently due to the gastrocnemius-soleus complex contraction and may result in walking difficulties and permanent disability [1]. Conservative options fail and surgical correction is often needed, with

one of the common surgeries known as the extended posterior release (EPR).

One of the most widespread gait disorders in children, especially cerebral palsy (CP) and idiopathic or relapsed clubfoot, is equinus foot deformity [1,4]. The disorder is characterized as a restriction of the dorsiflexion of the ankle, mostly due to the contracture or the spasticity of gastrocnemius-soleus complex.

Table 1: Biomechanics of Gait Disruption in Equinus

Aspect of Gait	Normal Function	Effect of Equinus Deformity	Reference
Heel Strike	Smooth initiation of stance phase	Absent; foot lands in plantarflexion → instability	[7]
Midstance	Tibial advancement over foot for energy-efficient walking	Restricted dorsiflexion → compensatory knee/hip flexion	[7]
Push-off	Effective propulsion with ankle dorsiflexion and plantarflexion balance	Reduced push-off power → inefficient gait, fatigue	[7]

This limitation impairs biomechanically the stance and swing phases of gait. Dorsiflexion is important in normal locomotion as it is required to allow heel strike and allow the foot to roll smoothly forward; in equinus, heel strike tends to miss the ground, compensating with knee hyperextension, toe-walking or circumduction, all of which impair gait efficiency and elevate energy spending [7]. With time, these compensations are associated with musculoskeletal pain, joint instability and secondary deformities.

Table 2: Epidemiology of Equinus Deformities

Etiology	Prevalence	Notes	References
Cerebral Palsy (CP)	~65–70% of ambulatory CP patients	Leading cause of equinus deformity	[1,4]

Idiopathic Clubfoot	~1–2 per 1,000 live births	Common congenital deformity, bilateral in ~50%	[1]
Neuromuscular Disorders (e.g., Arthrogryposis)	Variable (rare)	Often more resistant to correction	[9]

The clinical significance of this deformity is pointed to by epidemiological data. In children with relapsed clubfoot, nearly 40% have been reported to have equinus and up to 1525% of those who underwent CP surgery [1,4,6]. Although conservative treatments like the Ponseti technique of clubfoot repair or functional rehabilitation of spastic equinus have been developed, a large percentage of patients still need surgical intervention, which highlights the therapeutic dilemma still persisting.

In addition to the physical impairment, socioeconomic effect is enormous. Children who suffer equinus deformity but had not been cured often become restricted in school attendance, sports and independent mobility. These restrictions lead to low self-esteem, dependency of a caregiver and psychosocial burden in the long-term [13]. In addition, families and health care systems are burdened by repeated surgeries, costs of rehabilitation, and use of assistive devices.

This recurrence has persisted despite the common repair surgeries, including the longer anterior release (EPR) that highlights the continuous controversy in which the best option of treatment is preferred on a long-term basis. Whereas posterior release has the potential to restore plantigrade posture, recurrence is still alarming, thereby emphasizing on more individualized and multidisciplinary strategies [4,6].

Extended Posterior Release: Surgical Overview

A variety of surgical strategies have been documented, encompassing classical open procedures as well as minimally invasive percutaneous techniques. [4]. Open methods can be used, as they enable visualization and correction but pose a risk of stiffness and scarring, whereas percutaneous solutions can be used as an alternative because the technique is less invasive and the patient recovers faster, though the method is less applicable in severe deformities [4]. In this way, surgical choice may be frequently determined by the severity of deformities, etiology, and the experience of a surgeon.

Extended posterior release (EPR) is one of the surgical procedures that form the basis of the surgical treatments of severe and rigid equinus deformities, especially in children with CP and relapsed clubfoot [6]. In the past, posterior release was developed as a more comprehensive procedure as a substitute of simple tendo-Achilles lengthening to treat the Achilles tendon, the posterior ankle and subtalar joint capsules, which commonly become sources of persistent rigidity [7]. Refinements over the years have involved open and percutaneous techniques with each having a trade-off between the efficacy of correction and the risk of stiffness and scarring.

When conservative treatments (serial casting, orthotics, or functional rehabilitation) do not bring about lasting correction, EPR is usually suggested [6]. Preoperative planning is a very important factor in maximizing results. More sophisticated imaging techniques, such as ultrasound and MRI are being used to measure the degree of soft tissue contracture, joint congruity, and secondary deformities prior to surgery [12]. Clinical assessment should also take into account the neuromuscular condition, ambulatory capabilities and family expectations. EPR can provide a more complete correction as compared to other surgical plans. As an example, tendo-Achilles lengthening is effective

in less severe deformities but might not be adequate to deal with subtalar or capsular restrictions [2]. Equally, tendon transfers (e.g., split posterior tibialis or split tibial anterior) might enhance gait mechanics in spastic equinovarus but not rigid equinus [2,3]. The more radical procedures such as triple arthrodesis are usually reserved in adolescents or patients skeletally mature because of their irreversible effect on joint motion.

EPR, therefore, remains a central choice that can be used in rigid pediatric equinus between limited soft tissue lengthening procedures and more permanent bony reconstructions. Nevertheless, its effectiveness is extremely dependent on the skills of the surgeon, patient selection, and the combination with postoperative rehabilitation guidelines [6,7,12].

Stepwise Surgical Procedure

- **Incision & Exposure** – A posteromedial or posterior incision is made to expose the ankle joint.
- **Capsular Release** – The posterior ankle capsule is released to allow ankle dorsiflexion.
- **Achilles Tendon Lengthening** – Typically performed using Z-lengthening or sliding techniques; this reduces contracture and improves ankle mobility.
- **Subtalar Joint Release** – If deformity persists, the posterior subtalar capsule is released to increase correction.
- **Soft Tissue Release** – Additional structures such as the flexor hallucis longus, tibialis posterior, and flexor digitorum longus may require release in resistant deformities.

Closure & Immobilization

After achieving adequate dorsiflexion (usually >10–15°), the wound is closed, and a cast is applied for immobilization.

The extended posterior release (EPR) is done by posteromedial or straight posterior incision and the decision to use either varies depending on the severity of the deformity and the preference of the surgeon. The posteromedial incision gives a wider exposure of the contracted tendons of the posterior tibia and flexor, whereas the posterior approach gives direct exposure to the Achilles tendon and posterior capsule [7]. Both the cases require careful dissection procedures in order to conserve neurovascular.

Scalpel, periosteal elevators, fine retractors, osteotomes, tendon lengthening devices are usually included in instrumentation. When making intraoperative choices in children with cerebral palsy (CP), options to treat spastic contractures may be fractional lengthening of gastrocnemius or soleus, whereas in idiopathic clubfoot, the release may be more commonly directed at capsular and subtalar restrictions [6]. Such differences demonstrate how condition-specific strategies are necessary.

The initial part of postoperative care is immobilization with a below-knee cast that typically lasts 68 weeks. Recurrence and prevention Casts are kept by changing regularly to keep things fixed. The change of physiotherapy is important, protocols which are stressed on passive stretching, strengthening, and gait retraining [11]. The process of rehabilitation is progressive and may need orthotic assistance to maintain the long-lasting support of the correction.

Surgical planning is based on age-specific adjustments. Infant and toddler interventions are less adaptive of soft tissues, which can lead to high long-term functionality. Late interventions, in particular, post-skeletal maturity, are linked to more rigid deformities and unfamiliar prognoses because of the adaptive processes at the bone and joint levels [8]. This indicates the essence of early diagnosis and surgical correction as a means of maximizing postoperative gait mechanics and functional independence.

Clinical Outcomes & Statistics

- A multicenter study reported **70–85% improvement in ankle dorsiflexion** post-surgery in CP patients [4].
- Recurrence rates are around **15–25%**, especially in patients operated on before age 6 [6].
- Postoperative complications include stiffness (**18%**), wound healing issues (**10–12%**), and need for revision surgery (**8–15%**) [7,9].

Open vs. Percutaneous Approaches

Approach	Advantages	Disadvantages	Success Rate
Open EPR	Direct visualization, better correction in severe deformity	Higher risk of stiffness, scarring, longer recovery	~80% correction in severe cases
Percutaneous	Minimally invasive, faster recovery, less scarring	Limited applicability in severe rigid deformities, less control over structures	~65–70% correction, best in mild–moderate cases

Equinus deformity may be surgically repaired by the open release or percutaneous technique that has its own merits and shortcomings. The open technique is capable of giving direct visualization of the contractures and guarantees full release of Achilles tendon and joint capsule. Nevertheless, it is linked to concerns of rigidity, fibrosis, and delayed healing especially where there is large dissection [7].

Table 3: Open vs. Percutaneous EPR Approaches

Parameter	Open Release	Percutaneous Release	References
Visualization	Full exposure of tendons/capsule	Limited, relies on tactile feedback	[7]
Recovery Time	8–12 weeks	4–6 weeks	[5,7]
Complications	Higher stiffness, scarring	Risk of incomplete release	[5,7]
Cosmetic Outcome	Visible scar	Minimal scarring	[5]
Cost	Higher (longer stay, resources)	Lower (shorter stay)	[7]

By contrast, percutaneous methods, such as small stab incisions to lengthen tendons, have been popular in mild to moderate deformities. These methods cause less tissue damage, less time in the hospital and faster healing with better cosmetic results [5]. Case reports of successful repair have been noted in persistent equinus, but outcomes are inconsistent and limited to skill in surgery [5].

The major weakness of percutaneous approaches is that they have steeper technical learning curve. The surgeons have no access to direct visualization, but instead have to depend on tactile feedback and this poses a risk of incomplete release or neurovascular injury. Therefore, the percutaneous method is usually advised in the centers where training and experience are sufficient [7].

In a comparative view, recovery time is less with percutaneous release (4-6 weeks as compared to 8-12 weeks in open surgery). There is also cost reduction through a reduced hospitalization and

decreased complication. Also, cosmetic effects give more advantage to the percutaneous methods, because there is little scarring. Nevertheless, an open release can still be high-quality in the case of severe rigid deformities, in which access to contracted structures is necessary. Practical evidence indicates that percutaneous release is attractive in the selective patient but open EPR is the standard in complex or recurrent orientations of equinus deformities. Restoration of the plantigrade foot to allow better stance and ambulation is the main aim of extended anterior release (EPR). The results in literature show that most patients reach this result, and there are substantial changes in ankle dorsiflexion and alignment [6].

EPR increases the speed and efficiency of gait, minimizes the compensatory movements, and decreases fatigue, which is functional. Children who have been worked on equinus deformity often have a better walking capacity, capacity to engage in physical exercise, and will be able to have access to sporting activities in school or recreational activities [3]. In EPR, adjunctive surgery like split tibial tendon transfer has demonstrated to further elucidate the outcome in cases of spastic equinovarus deformity [2,3].

In addition to tangible changes, EPR has an immense influence on human psychosocial well-being. Adolescents and children usually complain that they become more independent, have higher body image, and less social stigma regarding abnormal gait [13]. Caregiving burdens also decrease significantly, and this situation is also observed by parents, which underlines even more social advantages of surgical correction.

Notably, quality-of-life indicators reveal a positive change in mobility, as well as confidence, peer involvement, and integration in school. These results underscore the need to consider EPR as a holistically beneficial intervention that has a biomechanical, functional, psychological, and social impact [2,6,13].

Surgical Choice

The choice between open and percutaneous EPR depends on:

- **Severity of deformity** (rigid vs. flexible)
- **Underlying etiology** (CP, relapsed clubfoot, trauma-related deformity)
- **Surgeon expertise and patient age**

Clinical Outcomes of EPR

Medical results of EPR are typically positive, and most of the studies show considerable enhancement of ankle dorsiflexion and recovery of plantigrade foot posture [4]. Percutaneous lengthening of the gastrocnemius-soleus complex has been shown to yield favorable kinematic outcomes in cases of refractory pediatric equinus and may be regarded as a viable therapeutic option for selected patients. [4].

These results indicate that clinical outcomes after extended posterior release (EPR) show similar improvements, especially restoration of ankle dorsiflexion. It has been reported that there was a 70-85 percent correction rate in attaining functional dorsiflexion that is directly proportional to improved gait and the elimination of tripping vulnerability [6]. Such gains have been best illustrated in children with spastic equinus secondary to CP as well as rigid clubfoot conditions that are not responsive to conservative measures.

EPR has a beneficial influence on functional gait as well as range of motion. Research points out to enhanced energy-efficiency during the walking process, because the restoration of ankle alignment eliminates compensatory errors in the knee and hip [3]. These biomechanical gains do not only augment walking speed, but also fatigue, which improves participation in everyday activities and sports.

The age is a factor that is critical to long-term outcomes. Younger patients subjected to EPR normally show better durability in correction as a result of high soft tissue plasticity. On the other hand, secondary procedures can be necessary in older children and adolescents as they have higher rates of recurrence [4]. Such variability highlights the importance of surgical approaches and prolonged follow-up which is age-specific.

In patient-centered view, the level of patient and parental satisfaction is a valuable indirect outcome of success. Surgery in the family reports a marked increase in autonomy, social activity, and involvement in school life [1]. Nevertheless, recurrence and residual deformity continue to be sources of dissatisfaction, and in some studies secondary intervention rates have been reported to be as high as 2030% [4,6].

One of the recurrent problems of the literature is the absence of standardized reporting. Whereas there are also those studies that highlight radiographic and kinematic outcomes, the others are concerned with functional indices or subjective patient satisfaction [13]. This heterogeneity complicates cross-studies comparisons and shows the immediate necessity of outcome measures that are consensus-based and combine objective data on gait measurements with patient-reported quality of life.

Generally, EPR has high potential in functional recovery of mobility, yet the success will lie in the long term on the measures in early intervention, full rehabilitation and outcome measurement standardization.

Recurrence after EPR

Table 4: Recurrence Risk Factors After EPR

Risk Factor	Mechanism	Notes	References
Younger age at surgery	Growth-related contractures reappear	Higher recurrence in CP	[4,6]
Persistent spasticity	Muscle imbalance despite release	Requires adjunctive neuro procedures	[10]
Severe initial deformity	Greater soft-tissue resistance	More common in neuromuscular disorders	[4]
Poor compliance with orthotics	Loss of correction	Family/caregiver dependent	[6]

Irrespective of its effectiveness, post-EPR recurrence of equinus deformity is a significant issue. The rates are reported to be 15-25% in children with cerebral palsy (CP), and patients with idiopathic clubfoot show a lower recurrence [4]. This variation has been greatly explained by the variation in the underlying pathology and tissue adaptability.

Recurrence has a multifactorial biomechanical basis. Patients in CP are also at risk of relapse due to long-term spasticity of the gastrocnemius-soleus complex, coupled with muscle imbalance in relation to the ankle joint [10]. This is further aggravated by skeletal immaturity and growth related contractures, which are particularly common among younger children [4].

Among the risk factors are a younger age at surgery, high severity of initial deformity, noncompliance to use of orthotics, and insufficient physiotherapy [6]. There are neuromuscular conditions like dystonia that tend to predispose an increase in recurrence than the pure orthopedic deformities [4].

Prevention interventions focus on the multidisciplinary approach. Structured physiotherapy and postoperative orthotic management are very important in sustaining correction. Selective nerve blocks and Botox injections are examples of the adjuvant therapies used in spastic cases to reduce hypertonicity and inhibit early relapse [10,14]. Education of the caregiver is particularly important in compliance with long-term rehabilitation measures.

Further insights are given by comparing with other types of surgical procedures. Transfers that can be done to reduce recurrence include tendon transfers, including split tibial tendon transfer, which can prevent recurrence by correcting dynamic muscle imbalance, especially with equinovarus deformities [2]. Nonetheless, the capsular or bony contributions are not completely corrected with tendon transfers, which can be corrected using EPR. This indicates that tendon transfers can be used in a few instances to provide a lower recurrence rate, although EPR is necessary in rigid deformities.
In general, the recurrence following EPR is the result of a complicated combination of neuromuscular pathology, growth, and adherence to the rehabilitation. Although rates are substantial, specially designed surgical preparations, as well as proactive preventive interventions, will considerably decrease the chances of relapse, hence, enhancing the functional results in the long-run period.

Complications of EPR
Despite its effectiveness, there are several complications linked with extended anterior release (EPR), which restricts its use in all settings.

Overcorrection (Calcaneus deformity):
Reported in 10 to 20 percent of cases, and commonly resulting in calcaneus gait and decreased power of push-off during ambulation [6,7].

Postoperative stiffness:
This happens in about 15-18% of the patients due to massive dissection and scarring of the soft tissue [7].

Infection:
Surgical site infections occur in 5–8% of cases, with a higher relevance in patients with cerebral palsy, particularly those with nutritional deficiencies and impaired hygiene. [7,9].

Healing issues on the wounds:
It has been noted that delayed healing or dehiscence occurs in 10-12 percent of patients, especially in individuals with fragile and compromised skin. [7].

Functional muscle weakness:
Reported in 10-15% and mostly due to excessive lengthening of the Achilles tendon [6].
Recurrence: Equinus deformity recurs in 10-25% of cases regardless of surgical method, duration of follow-up, and patient-related factors [5].

Need revision surgery:
Approximately 8 to 15 percent of patients eventually need revision to repair or preserve correction [9].

Comparison with Other Surgical and Non-Surgical Options
Other EPR methods have received interest within recent years. Re-education and functional rehabilitation programs have proved effective in the management of flexible deformities and their decreased need of early surgery [2]. Tendon transfers (like split tibial or posterior tibialis surgeries) enhance the gait and performance, but still have significant recurrence rates [3,5].
Percutaneous lengthening of the gastrocsoleus complex using less invasive interventions has been shown to provide encouraging results in ankle movement with less morbidity [4]. Selective nerve blocks and partial motor neurectomies can be used as an adjunct to surgery in spastic equinus to address neuromuscular imbalance [8,9]. Even at an older age, in cases of neglected clubfoot, the Ponseti technique has surprisingly proved effective, even in adolescence, as another conservative option in a few cases [10].

Table 5: Comparative Outcomes of Surgical and Non-Surgical Options

Method	Indication	Benefits	Limitations	References

Ponseti Method	Idiopathic clubfoot (incl. neglected)	Non-invasive, effective	Less effective in rigid CP cases	[9]
Physiotherapy & Re-education	Flexible deformities	Improves motor control, delays surgery	Limited in rigid deformities	[6]
Tendon Transfers	Spastic equinovarus	Corrects muscle imbalance	Recurrence if spasticity persists	[2,3]
Selective Nerve Blocks	CP-related spasticity	Targets neurological cause	Temporary effect, requires repeat	[10]
Motor Neurectomy	Severe spastic equinus	Reduces recurrence	Technically demanding	[14]

Figure: 01

Discussion

Long-term posterior release is popularly used to treat severe equinus deformities in children, especially in children with cerebral palsy and relapsed clubfoot [6]. Its efficacy in attaining plantigrade foot posture and enhancing gait parameters are strongly supported, yet the results are highly variable in accordance with etiology, the severity, and post-operative rehabilitation [3, 4].

Table 6: Complications of EPR (Early vs. Late)

Category	Complication	Clinical Impact	References
Early	Wound infection, hematoma, delayed healing	Prolonged recovery, re-hospitalization	[7]
Late	Stiffness, overcorrection, weakness	Gait impairment, revision surgery	[6]

Psychosocial	Anxiety, repeated school absence	Lower quality of life	[13]
Economic	Higher costs than conservative methods	Resource burden on families	[6,9]

The biggest obstacle is recurrence and complications, which remain a barrier to long-term success [5,8]. EPR is more comprehensive in correction compared to less invasive procedures including percutaneous needle lengthening or tendon transfers but leads to an increase in stiffness and revision rates [4,9].

The complications of the extended anterior release (EPR) can be encompassed as early and late complications. The problems in early complication are normally related to the immediate postoperative stage and are characterized by delayed healing of wounds, infection, development of hematoma and neurovascular compromise. The risks are also increased by the large part of dissection, especially in patients with damaged skin or nutritional health, which may occur during the open procedures, especially in children [7]. Early diagnosis, and wound management or

Antibiotic treatment is essential in decreasing morbidity.

Late complications tend to be more disabling in its functions. They are joint stiffness, excessive extension into calcaneus, long-lasting weakness of the gastrosoleus complex, and long-lasting gait abnormalities. These consequences can restrict the anticipated mobility improvement and usually result in revision surgery [6]. Overcorrection is somewhat rarer, but may be especially difficult to treat, in that it produces another but equally debilitating deformity.

In addition to physical complications, the psychological and social burden is significant. Children who have taken on several surgical operations may report school absences, decrease in sporting or playing activities, and social alienation. According to parents, anxiety and stress levels are high with regard to the uncertainty of the outcomes and recurrent hospitalizations [13].

Economically, EPR is a process-consuming process. It is associated with increased duration of surgery, hospitalization, rehabilitation, and long-term orthotic care and results in significantly higher costs than those of conservative procedures like the Ponseti procedure [6,9]. This poses further accessibility and continuity of care barriers in the low- and middle-income settings.

In this way, although EPR is still a pillar of severe equinus deformities, its consequences are at the clinical, psychosocial, and economic levels, which emphasizes the significance of proper patient selection, effective preparation of the perioperative process, and incorporation of multidisciplinary support.

The treatment of equinus deformity is a spectrum of non- and surgical measures, with decision-making depending on etiology, severity, and age. There is still a significant role of conservative management. The Ponseti technique, which is currently efficacious in the treatment of idiopathic clubfoot, is effective in older or neglected cases as well, offering patients functional correction without the dangers of invasive surgery [9]. Moreover, the programs of physiotherapy and functional re-education have proved useful in flexible deformity by enhancing motor control, walking, and lowering the early surgical intervention requirement [6].

Surgery Surgical treatment Surgical alternatives such as tendon transfers, especially the split tibialis posterior tendon transfer, are widely used in the management of spastic equinovarus. These are procedures that attempt to rebalance dynamic forces yet there is always a chance of recurrence when the underlying spasticity is present [2,3]. They are most useful as an adjunct to posterior release and not as a stand-alone intervention.

Motor neurectomies and selective nerve blocks have become the potential supplements. By treating hyperirritable tibial nerve branches, these strategies treat the neurological causes of deformity. Improved outcomes have been reported when applied in conjunction with orthopedic correction especially in cerebral palsy children [10,14].

Relatively, although EPR cannot be ignored in inflexible and severe deformities, conservative and adjunctive measures are important in postponing, reducing, or augmenting surgical treatment. An orthopedic-physiotherapeutic-neurological solution seems to have the most effective long-term results in a wide range of patients.

There is an evidence that EPR is effective to restore a plantigrade foot and gait in children with equinus deformities. Nonetheless, inconsistency in the results in different etiologies such as cerebral palsy and idiopathic clubfoot is still a continuing problem. As an example, idiopathic cases tend to lead to sustained correction, but recurrence is more common in neuromuscular ailments [3,4].

There is one of the debates that persist in the decision between staged and a single large release. Those who believe in staged interventions advocate the theory that gradual correction results in fewer tissue trauma and complications, whereas those who believe in one-time comprehensive release believe that the long-term alignment is superior [7]. There is no evident evidence that favors one of the strategies, and the unique decision-making is required.

Multidisciplinary protocols are agreed upon in the world. The collaboration with orthopedic surgeons, physiotherapists, rehabilitation specialists and neurologists will provide the support of surgical intervention with rehabilitation and spasticity treatment. However, international guidelines are not well established with differences in practice across centers [12].

There are still considerable gaps in the literature. There are few large randomized controlled trials (RCTs) and multicenter long-term follow-up information is limited. This complicates the attempt to have standardized outcome measures and across population comparisons of techniques [4]. Moreover, radiographic or biomechanical outcomes are often reported in many studies but patient-reported quality-of-life outcomes are not taken into consideration, which is critical in children.

In the future, technological integration can be the future of equinus correction. The use of robotic-assisted surgery has been associated with more high accuracy and less tissue trauma, and AI-inspired surgical planning will potentially assist in the identification of recurrence vulnerability and tailor interventions. It is also crucial that rehabilitation technologies are improved (exoskeleton-assisted physiotherapy can improve functional recovery and decrease recurrence) [12].

To conclude, EPR is still a useful tool, although the optimal role should be taken into consideration in a wider care continuum. Controversies, bridging gaps in the evidence, and adoption of technological advances are some of the steps in enhancing results of this complex group of patients.

Conclusion

Extended posterior release (EPR) is a viable procedure offering short-term correction, which restores a plantigrade position and enhances the mobility of children with equinus deformities. The overall functional outcomes are positive, and gait efficiency, decreased energy expenditure, and social participation are improved.

The ability of EPR to be used over the long term is, however, limited by recurrence rates and delayed complications, including stiffness or overcorrection, especially in children with cerebral palsy. These difficulties underline the idea that surgical interventions are not enough to produce long-term results.

The better approach is through combining surgery with physiotherapy, orthotic support and neurological interventions. Such techniques as selective nerve blocks and Botox injections in addition to tendon transfers offer vital solutions in the reduction of recurrence and muscle balance.

Moreover, the need to introduce standard outcome tracking cannot be overestimated. A combination of objective measures of gait and patient-reported ones guarantees an integrated picture of advantages and shortcomings. This patient-based model not only emphasizes the mechanical repair of deformity but the overall

psychosocial effect on autonomy, involvement, and quality of life.

The future of managing equinus will be based on multidisciplinary care pathways, which include efficiency in surgical procedures, rehabilitation, and preventive measures. With technological creativity and patient outcome evaluations, clinicians are in a position to improve the child success rate and quality of life of children with equinus deformities.

Recommendations

Basing on the findings discussed in this paper, the management of equinus deformities can be optimized by making a number of recommendations in the use of endoscopic posterior release (EPR) and its adjuncts. The initial suggestion is that the decisions regarding the treatment must be extremely individual, and they should also consider the age, the underlying etiology, and the functional requirements of a particular patient. As an example, cerebral palsy in children can easily be complex and multi-joint involvement, and such a presentation may require long-term multidisciplinary treatment in addition to surgical release. In comparison, cases of idiopathic clubfoot can have good results through less invasive treatments when treated early. The evidence hence justifies the necessity of an early and organized assessment trackway with the standardized functional scoring systems, which would assist clinicians decide whether to use surgery, physiotherapy or both options in order to achieve the most lasting effects.

Second, the improved incorporation of postoperative rehabilitation into the regular surgical treatment has a solid argument. Although EPR is an effective correction in short-term, structured physiotherapy, gait training, and regular use of orthotics are crucial in the preservation of dorsiflexion gains and recurrence prevention. Rehabilitation is not to be regarded as a sideline treatment option but an in-focus part of the treatment mechanism. Close collaboration between orthopedic surgeons and physiotherapists and rehabilitation specialists is necessary to guarantee that there is a smooth postoperative transition process into functional reintegration. Also, patient-specific rehabilitation plans (according to age, severity, and neurological status) might optimize gains in gait efficiency and energy consumption, which would eventually enhance the quality of life of the patients and their families.

Third, one should focus on psychological, social, and economic aspects of treatment. Repeated surgeries although at times inevitable, are a great burden not only to the child but also to the caretakers. Including psychological support services, family counseling, and education in the treatment programs is necessary to cope with anxiety, frustration, and caregiver burnout. Economically, EPR and the associated procedures are resource-consuming as compared to conservative EPRs like the Ponseti technique or functional rehabilitation. Policymakers in healthcare are, thus, required to consider the long-term advantages of surgical repair compared to the cost of repeats of interventions. Early uptake of minimally invasive methods, growth in rehabilitation programs, and greater availability of conservative choices in resource constrained environments are some strategies that can assist in lowering overall treatment costs, and maintaining functional outcomes.

Fourth, the evidence suggests an urgent necessity of more rigorous and standardized research. Current literature is constrained by heterogeneity of reporting, absence of multicenter randomized controlled trials, and absence of long-term follow-up information. Internationally accepted outcome measures (such as: functional gait indices, patient-reported satisfaction, psychosocial wellbeing) would facilitate meaningful comparisons of research and clinical sites. The role of adjunctive treatments should also be examined by the future research to identify the value additive properties of adjunctive treatments, including tendons transfers, nerve blocks, and advanced orthotic devices, to maintain surgical outcomes.

Lastly, technological innovation and global collaboration will be more important in the future in managing the equinus deformity. Robotic-assisted surgical planning systems, artificial intelligence-driven predictive modeling, and tele-rehabilitation tools are becoming potent solutions that have the potential to make surgery more accurate, decrease the recurrence rate, and increase access to quality of care. The international guidelines, which have been formulated by consulting surgeons, physiotherapists, and rehabilitation specialists, will play a critical role in helping to make sure

that technological innovations provide a patient-centred, equitable care.

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