Physical Rehabilitation for Children with Erb's Palsy: A Systematic Review

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Abstract:

Introduction: Physical therapy intervention has a significant impact on improving the impairments and disabilities of Erb's Palsy patients. Proper assessments and management reduce physical complications and mental health problems, thus enhancing the child's opportunities to return to their maximal activity daily living. Aim: This study aimed to identify the physical therapy treatments for Erb's palsy children from infants until eighteen. **Method**: The search was conducted in August 2020 through seven databases based on eighteen keywords. The articles were evaluated based on predetermined inclusion and exclusion criteria. **Results**: Two hundred forty-five records were obtained and twenty-nine full text articles were included. Six eligible papers that met the inclusion criteria were further reviewed. The most implemented approach by the physical therapist was the conventional method, including stretching, strengthening, weight-bearing, positioning and active exercises. Using advanced techniques such as Virtual reality or plyometric also showed benefits in regaining the arm function in Erb's palsy children. **Conclusion**: The treatment appears more effective in improving the hand properties when conventional physical therapy treatments are combined with advanced exercise consisting of plyometric or virtual reality (VR). Hopefully, this study provides the idea for physical therapists in Malaysia to design the treatments for Erb's Palsy patients.

Keywords: Erb's palsy, physical therapy, conventional treatment, advanced exercise, virtual reality, plyometric

Introduction:

Obstetric Brachial Plexus Injury (OBPI) occurs in 0.5-3.0 cases per 1000 live during the delivery process caused by trauma to the brachial plexus nerve roots, C1 to C8. Excessive traction of the infant's head during the delivery increases the angle between shoulder and neck, resulting in an overstretching brachial plexus upper nerve root (Pondaag et al., 2004; Vekris et al., 2019). Mothers with gestational diabetes, multiparity and obese are believed to be at risk for Erb's palsy (EP) (Al-Qattan, 2004). The most common injury affecting the brachial plexus nerve is EP (46%), which appeared as the waiter's tip position. This injury is usually presented with shoulder abduction, medially rotated arm, extended elbow, pronated forearm and wrist flexion (Tortora & Derrickson, 2006; Vekris et al., 2019).

Children may experience several complications, including muscle and joint problems or neck torticollis on the affected site (Olama, 2011). In severe cases, children with EP might experience a sensation deficit on the affected area, leading to arm amputation (Al-Qattan, 1999). These complications might lead to lifetime disability to the child if not treated immediately.

Physical therapy treatments have been shown to improve disabilities in children with EP significantly. Management given by the physical therapists would enhance the child's opportunities to regain arm movements and prevent secondary musculoskeletal disorders (Duff & DeMatteo, 2015). Most birth palsy children recover spontaneously with physical rehabilitation treatment but may suffer chronic impairment if not treated properly (Hale et al., 2010; Vekris et al., 2009).

Physical therapy treatments such as strengthening, stretching, sensory stimulation and play therapy have been widely used among physical therapists worldwide and showed remarkably improved children's quality of life (Afzal & Asma, 2017; Rahat et al., 2019; Vata et al., 2016). Besides, the emergence of interactive technologies nowadays appears to improve the physical function of children with disabilities (Calderita et al., 2014; Zviel-Girshin et al., 2020). By looking at this, various techniques have been developed worldwide in EP rehabilitation across the country and times. Therefore, it would be great to gain an aerial overview of the physical therapy treatments for EP, to help Malaysian physical therapists to design the treatment.

Materials and Methods:

Search strategy

This study performed a systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (Liberati et al., 2009). The search of articles for physical therapy treatment for children with EP was conducted in August 2020 using several electronic databases; Scopus, Science Direct, PubMed, CINAHL, Web of Sciences (WOS), Physiotherapy Evidence Database (PEDro), Google Scholar and the Clinical Trials following the PICOS tool; Population (P), Intervention (I), Comparator ©, Outcome (O) and Study design (S). The articles were searched using a Boolean operator with the following keywords: (physiotherapy OR "physical therapy") AND (rehabilitation OR therapy OR treatment OR intervention) AND (child* OR pediatric OR paediatric OR infant OR kids OR neonat* OR newborn) AND ("erb's palsy" OR "brachial plexus birth palsy" OR "obstetric brachial plexus" OR "peripheral nerve injury" OR "birth-related brachial plexus injury"). This review did not have a year limit to avoid the missing of beneficial articles.

Eligibility

Articles fulfilled the following criteria were included: (1) children with EP aged 0-18 years old; (2) consisted of physical therapy treatment; (3) published in the English language; (4) Randomized control trials study design (RCTs) and (5) Full-text article.

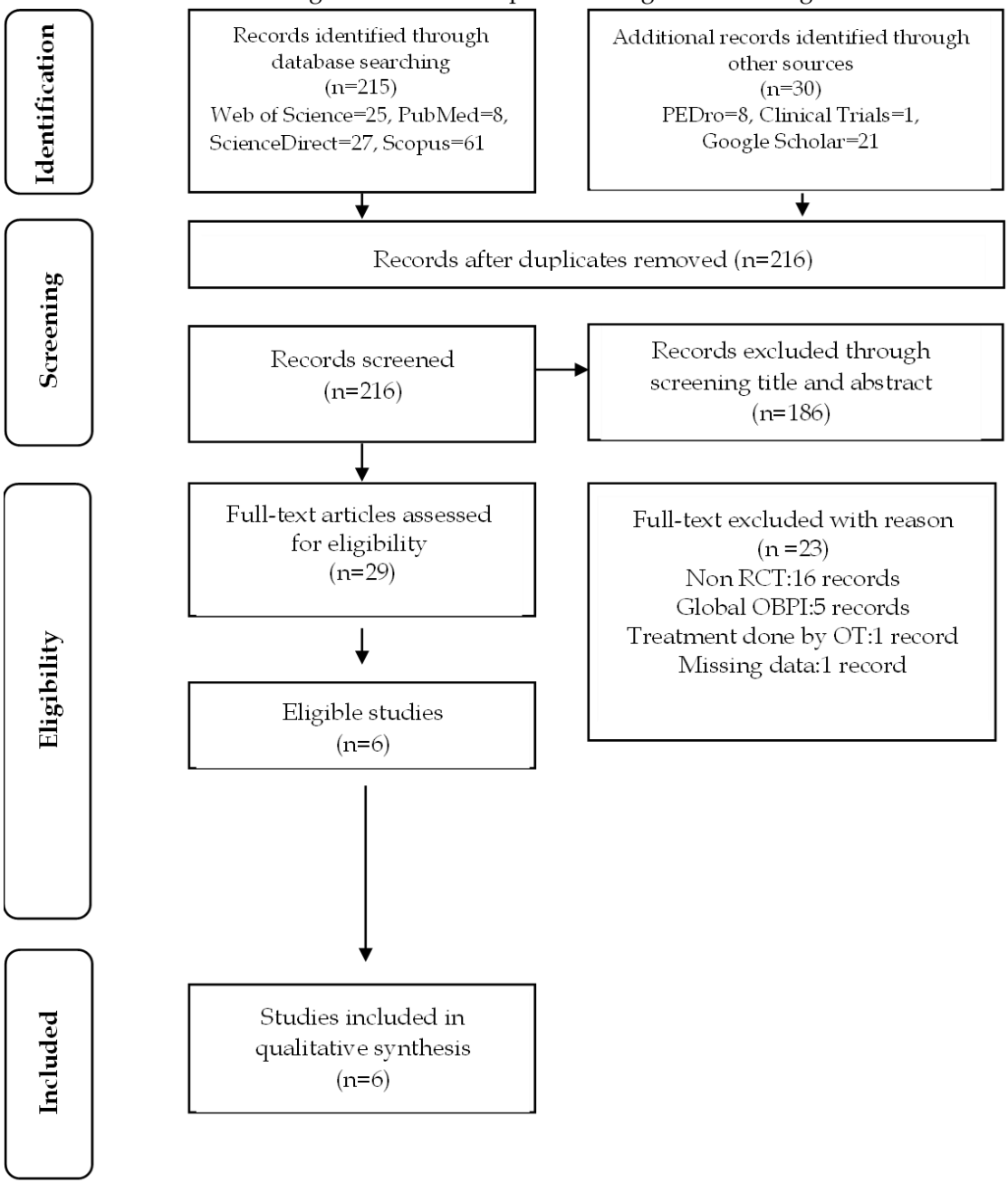
Data extraction and analysis

One author identified the articles that met the criteria and exported them into Mendeley®. The duplicate papers were then removed and the title and abstract of the remaining article were further screened. Three reviewers independently checked the relevant articles for the study. Articles agreed by the reviewers were included in the study, while the disagreement was resolved through discussions. For the missing or incomplete data, the corresponding authors were contacted through email. The data was presented in Table 1. to identify, examine, and evaluate the patterns of physical therapy treatment on EP children.

Result:

The search strategy from all different databases yielded 245 records. A total of 216 duplicate articles were excluded at the beginning of the screening process. After the title and abstract were examined, 29 articles were assessed for their eligibility. After screening the articles' eligibility, 23 full-text articles were omitted for not fulfilling the inclusion criteria.

Figure 1: The search process using the PRISMA guideline



The reasons for the excluded study were non-RCTs study design *(n=16)*, not explicitly mentioned about EP children *(n=5)*, exercises conducted by the Occupational Therapist (OT) *(n=1)*, and missing data *(n=1)*. For the missing data, the corresponding author was contacted through email. Figure 1 describes the result from the searching process using the PRISMA guideline.

Study characteristic

The study involved 233 EP children with 112 boys and 109 girls, ranging from 6 months to 10 years old. This current review included only RCTs as a study design that had either two groups (Abdel-kafy et al., 2013; Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016; Sarhan et al., 2013) or three groups (Ibrahim et al., 2011) in their interventions and were published in the English language.

Quality assessment of study

The articles studied were evaluated using the Cochrane risk-of-bias tool for randomized trials (RoB 2) suggested by The Cochrane Collaboration (Sterne et al., 2019). The following items were assessed for each article: (1) Random sequence generation; (2) Allocation concealment; (3) Blinding of participant/personnel; (4) Blinding outcome assessors; (5) Incomplete outcome data; (6) Selective outcome reporting and (7) Other bias.

Range of motion (ROM)

Four studies (Abdel-kafy et al., 2013; Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016) reported an increase in ROM on the affected upper extremity muscles when comparing pre and post-treatment values.

Muscle strength

Positive changes in muscles strength were found in the three studies. However, each research measured a variety of types of shoulder muscles. Sarhan et al. (2013) focused on the deltoid, external rotators, biceps brachii, supinators and wrist extensors; meanwhile, El-Shamy & Alsharif (2017) concentrated on abduction and external rotators and Al-Wahab et al. (2016) targeted shoulder flexor and external rotator.

Bone Mineral Density (BMD)

One study (Ibrahim et al., 2011) discovered the positive effect of WBEP on the BMD value in radius and ulna bones; meanwhile, Elnaggar (2016) found an increase of BMD value in the humerus bone in the study groups.

Forearm length and girth

Significant gains were observed in forearm length and girth in the study group for pre and post value (Sarhan et al., 2013). The findings of the included studies are presented in Table 1.

Table 1. Characteristic of the included study

Study (author, year)	Study design Risk of bias	Participant(s)	Affected Side (per case)	Intervention(s)	Study duration (week)	Result(s)
Al-Wahab et al., 2016	RCT *Risk of bias* Low	40 children 3-6 years old Subject loss: 6 Boys (n=16) Girls (n=18)	Left: 13 Right: 21	CG: Physical therapy program *(Stretching, strengthening, joint approximation weight-bearing positioning)* SG: Plyometric and Physical therapy program	6	Significant improvement found for pre and post treatment on all variables for both groups ($p<0.05$), except for ROM in shoulder external rotation in CG ($p=0.078$)
El-Shamy & Alsharif, 2017	RCT *Risk of bias* Low	40 children 5-8 years old Subject loss: - Boys (n=27) Girls (n=13)	Left: 15 Right: 25	CG: Physical therapy program *(Weight-bearing, joint approximation, PNF, scapulothoracic mobilization, strengthening, active hand exercise and stretching)* SG: VR	12	There was a significant difference in pre and post value for muscle strength, shoulder abduction and external rotation in both groups ($p<0.05$), but more remarkable in SG.
Elnaggar, 2016	RCT *Risk of bias* Low	42 children 3-5 years old Subject loss: - Boys (n=16) Girls (n=26)	Left: 20 Right: 22	CG: Physical therapy program *(Weight-bearing, joint approximation, PNF, strengthening, active hand exercise, stretching, scapula mobilization and posture correction)*	12	The BMD marked a significant difference for pre and post CG values ($p=0.034$) and SG ($p=0.003$).

				SG: NMES and Physical therapy program		
Ibrahim et al., 2011	RCT *Risk of bias* Low	51 children 3-10 years old Subject loss: 6 Boys (n=26) Girls (n=19)	Left: 20 Right: 25	CG: TEP *(Massage, active-passive exercise, Sensory stimulation, strengthening, coordination, PNF, stretching, play therapy and functional activities exercises)* CG: No specific exercise program (exercise that is regularly prescribed to EP children) SG: WBEP	24	The BMD improved significantly ($p<0.05$) in all groups but was favoured in WBEP
Abdel-Kafy et al., 2012	RCT *Risk of bias* Low	30 children 3-5 years old Subject loss: - Boys (n=11) Girls (n=19)	Left: 7 Right: 23	CG: Hand exercise program *(Arm reaching exercise, Arm-hand exercise, Postural reaction exercise, hand self-dependent activities exercise)* SG: MCIMT and Hand exercise program	12	The ROM for shoulder abduction and external rotation in SG improved significantly than in CG ($p<0.05$)
Sarhan et al., 2013	RCT *Risk of bias* Some concern	30 children 6-12 months Subject loss: - Boys (n=16) Girls (n=14)	Left: 11 Right: 19	CG: Physical therapy program *(Positioning, sensory, strengthening, stretching, scapular mobilization, manipulative exercise, splinting)* SG: PEMFT and Physical therapy program	12	The forearm length, girth, strength and ROM were improved in SG ($p<0.05$) after the interventions in comparison with CG

CG=Control group; SG=Study group; PNF=Proprioceptive neuromuscular facilitation; ROM=Range of motion; RCT=Randomized control trial; VR=Virtual reality; BMD=Bone mineral density; NMES=Neuromuscular electrical stimulation; TEP=Traditional exercise program; WBEP=Weight-bearing exercise program; MCIMT=Modified Constrained Induced Movement Therapy; PEMFT=Pulsed electromagnetic field therapy

Discussion:

This review focused on RCT studies, providing more substantial evidence to support clinical decision-making in rehabilitation. The review aimed to identify the available physical rehabilitation for children with EP. This study performed only a systematic review where no meta-analysis was involved. The review discovered that the conservative physical therapy treatments for EP children include stretching, strengthening, range of motion exercise, positioning, joint mobilization, splinting, weight-bearing exercise, joint approximation, massage and postural reaction exercises (Abdel-kafy et al., 2013; Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016; Ibrahim et al., 2011; Sarhan et al., 2013). Meanwhile, non-conservative treatments used included plyometric, VR and MCIMT (Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016).

Based on this review, the most common approach was the stretching technique focused on tight muscles, including internal rotators, subscapularis, forearm pronators, and wrist and fingers flexor. This technique showed benefit to the EP children in improving the range of motion of the whole arm (Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016).

Nevertheless, none of the writers specified how to conduct this stretching technique, including the starting position of the therapist and patient and the hand placement on the particular muscles that need to be stretched. Besides, to improve the arm range of motion, the authors applied this stretching exercise with other techniques such as fine motor exercises, postural reaction, weight-bearing, joint approximation, strengthening and splinting (Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016). Further investigations should be undertaken to explore the effects of each intervention on improving the hand range of movement. One study done by Abdel-kafy et al. (2013) did not include a stretching technique to increase the ROM instead focused only on the active movement exercise such as fine and gross motor activities through MCIMT. They successfully demonstrated that the ROM could be improved by concentrating only on the repetitive movement exercise using the MCIMT technique without implementing the stretch technique.

The physical therapy treatment to improve the arm strength among EP children was also reviewed. Even though all three reviews targeted different groups of muscles, all of the authors included the external rotators muscle in their interventions (Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Sarhan et al., 2013). These muscles were the most affected as the hand presented internal rotation for its deformity (Tortora & Derrickson, 2006). Like ROM intervention, the researchers prescribed almost all the conventional exercises, including strengthening, weight-bearing, PNF, joint approximation, joint mobilization, and stretching to improve muscle strength. All showed a positive effect on muscles strength for pre and post value. We found that all the conservative treatments must be applied together to give a better result in enhancing muscle power.

Nevertheless, it is not clear which treatment in the conventional approach is superior to others in improving the arm strength. Only one study has been reported by Al-Wahab et al. (2016) measured the effect of advanced exercise (plyometric) on arm strength. The author added plyometric on top of the conventional practice. However, we viewed that additional study warranted to measure the long-term effect on children compliances as this plyometric exercise took about 30 to 40 minutes with the number of intense workouts.

In the study done by Elnaggar (2016) and Ibrahim et al. (2011), a favourable effect was observed on BMD of the affected arm in EP children pre and post-treatment. Ibrahim et al. (2011) introduced the greater weight loading during weight-bearing exercise on the forearm (the common bone for osteoporosis among EP children) meanwhile, Elnaggar (2016) added an NMES machine during weight-bearing activity. Both exercises must be conducted by a qualified physical therapist. However, these studies might not be long enough to monitor the BMD value for children as the bone grows in the child age. Previously Sarhan et al. (2013) observed the effect of physical therapy exercises on muscle length and girth. The outcome suggested the positive impact of PEMFT in combination with conventional physiotherapy treatment in muscle length and girth.

Adapting the current technology, virtual reality (VR), gives a more remarkable result than the conventional method in increasing the range of motion and muscle strength in children with EP (El-Shamy & Alsharif, 2017). This outcome is consistent with the study done by Yeves-Lite et al. (2020), which showed that VR also improved the hand grasp in EP children. VR seems to provide a new medium for relearning motor programs in pediatric rehabilitation. However, the researcher lack delivering in-depth details on the safety component of when operating VR. We recommend using objective measures on this matter. Meanwhile, despite the increased studies investigating VR in pediatric rehabilitation, there are

still limited studies exploring this technology's role in the upper function, specifically on EP children.

Although the current review showed an encouraging result on both conventional and advanced methods, all the studies have not standardized the type of conventional training implemented. Furthermore, limited information is given on how these exercises were carried out for EP children. Only several studies reported the amount of the treatment, intensity, frequency and duration of the exercises conducted (Abdel-kafy et al., 2013; Al-Wahab et al., 2016; El-Shamy & Alsharif, 2017; Elnaggar, 2016). Therefore, all these suggest the need for future studies in physical therapy rehabilitation for EP children.

Conclusion:

In this review, we identified the physical rehabilitation treatments that help the children improve their arm function. It is clear that the combined advanced interventions include plyometric or VR, seem to have superior effects compared to conventional alone, enhancing the overall quality of life among EP patients. Hopefully, the outcomes from this review will help our physical therapists in designing an effective rehabilitation program for EP children.

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