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Functional Outcome of Vojta Therapy as A Postoperative Protocol for Surgically Treated Patients with Cerebral Palsy

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Purpose: To evaluate the efficacy of postoperative Vojta therapy in children with cerebral palsy (CP) who have undergone orthopedic surgical interventions for lower limb deformities.
Methods: We conducted a prospective case series on children with ambulatory CP aged 3 to 15, indicated for orthopedic surgical interventions (contracture release and deformity correction) between January 2020 and December 2022. One month following these interventions, all patients were scheduled for Vojta therapy sessions. Ambulation capability was evaluated using video gait analysis, an expanded timed get-up-and-go (ETGUG) test, and a 6-minute walk test (6MWT) at 2, 4, and 6 months postoperatively. A multivariable multilevel linear regression analysis was employed to demonstrate the adjusted effect of Vojta therapy during the postoperative period.
Results: A total of eleven eligible children with CP were included. Of these, seven were boys (63.6%) with a mean age of 6.3 ± 3.1. The majority of patients were classified as gross motor function classification system (GMFCS) level I (45.4%). We observed a significant improvement in ETGUG (-14.1 sec, $p = 0.011$), 6MWT (6.3 m, $p = 0.014$), cadence (2.1 step/min, $p = 0.033$), and stride time (-0.1 sec, $p = 0.027$) after being adjusted by baseline function, age, and GMFCS level during the follow-up period. Sub-group analyses revealed no significant difference between patients with GMFCS I and those with GMFCS II to III.
Conclusions: This study demonstrated a significant ambulation capability improvement in surgically treated patients with CP who underwent postoperative Vojta therapy.

Keywords: cerebral palsy, orthopedic surgical intervention, Vojta therapy, 6MWT, ETGUG, gait analysis

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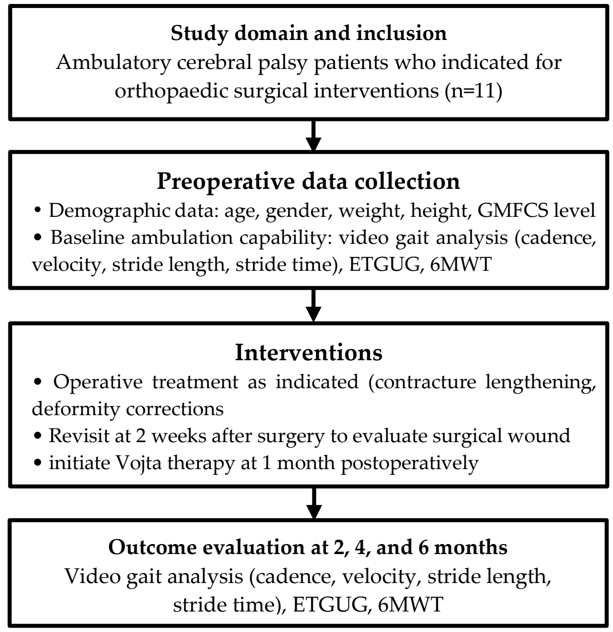
Cerebral palsy (CP) is a nonprogressive brain pathology in an immature brain, resulting in developmental musculoskeletal disorders, such as abnormal muscle tone, articular contracture, and movement imbalances.(1) This disease often requires surgical treatment as a multidisciplinary treatment plan that aims to improve the affected child's movement level according to their maximal ambulatory capability.(2) Orthopedic surgical intervention is a multidisciplinary treatment modality for children with CP that can be categorized into soft-tissue procedure, skeletal reconstruction, and salvage procedure.[3] In addition to operative treatment, a proper physical therapy program with or without orthosis is necessary as an initial conservative treatment or postoperative maintenance procedure.[4]

Vojta therapy is a dynamic neuromuscular physical therapy method that relies on developmental kinesiology and reflex locomotion.[5] Theoretically, the philosophy is based on a thorough kinesiological examination of the newborn. According to Vojta principles, the lack of coordination in the muscles of children with CP results from delayed postural development. Vojta's theory posits that the movement patterns are inherently stored in the central nervous system (CNS) and can be re-called with proper stimulation[6] Consequently, the reflex locomotion pattern of Vojta therapy offers an opportunity to activate dormant motor functions within the CNS. This method can be applied to patients with central nervous and musculoskeletal disorders such as CP, infantile postural asymmetry, and stroke.[7] Several studies have demonstrated the capacity of Vojta therapy to enhance motor function and improve gait patterns.[5,6,8]

However, patients with limb deformities, such as those with CP who have multiple joint contractures, might not fully benefit from Vojta therapy due to bone and joint abnormalities.[5] Their problems consist of structural deformities and movement disorders that must be addressed and require both operative treatment and proper physical therapy. Accordingly, this study aimed to elucidate the functional outcome of post-operative Vojta therapy in surgical patients with CP.

MATERIALS AND METHODS

We conducted a prospective case series of consecutive patients with CP and lower limb deformities between January 2020 and December 2022. The hospital ethics committee approved the study protocol. We included ambulatory patients with CP aged 3–15 y who had lower limb deformities and were indicated for orthopedic surgical procedures. All included patients and their caregivers were allowed to communicate and underwent functional outcome assessments. Patients with severe comorbidities, e.g., uncontrolled seizure, heart disease, severe osteopenia, and bleeding disorder, were excluded (Figure 1).



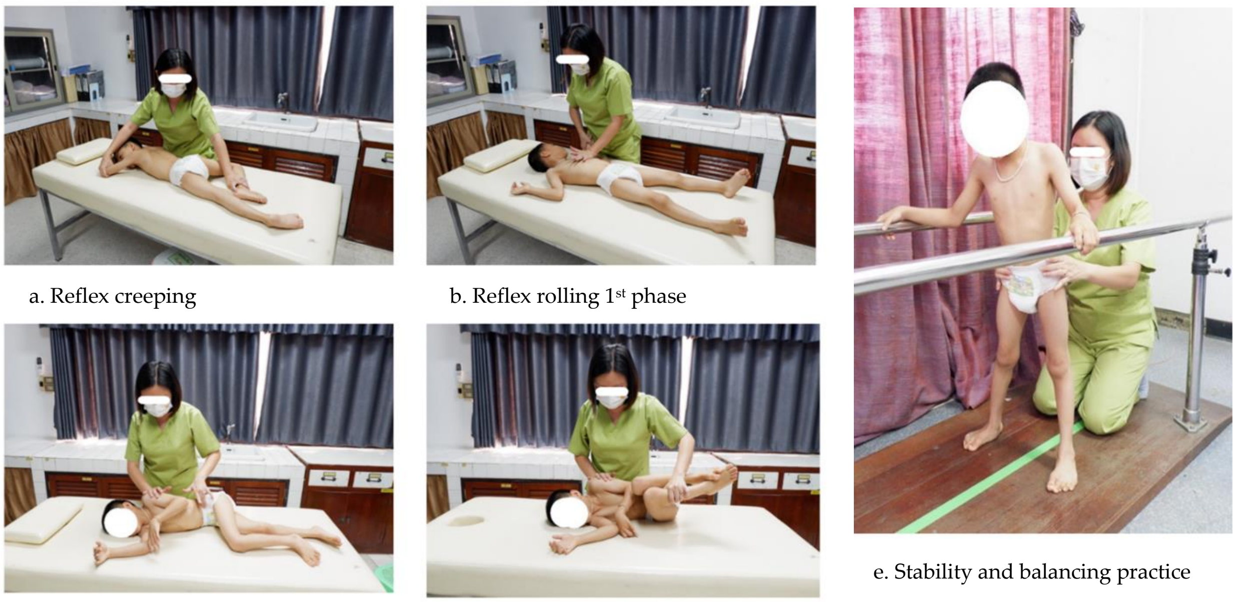
*ETGUG, Expanded get-up-and-go-test; 6MWT, 6 minutes walk test

Fig. 1. Study flow diagram of eligible patients.

After obtaining informed consent, patient demographic data including age, sex, diagnosis, gross motor function classification system (GMFCS) level, and specific deformities were collected at the first visit. In addition, preoperative video gait analysis was recorded. All patients underwent single-event multilevel (SEML) surgeries as required (soft-tissue and skeletal reconstruction). The surgical site was reevaluated for surgical wound pain, cast time, and fracture union. Vojta therapy protocol was prescribed for all patients one month after surgery. Follow-up visits were scheduled for treatment outcome assessment at 2, 4, and 6 months postoperatively.

Video gait analysis

Video gait analysis, walking distance cadence, speed, stride length, stride time, expanded timed get-up-and-go test (ETGUG),[9] and six-minute walk test (6MWT)[10] were evaluated at the initial and follow-up visits. In this study, we used a lengthy 20-meter walking path to record patient motion and measure various parameters. The recording setup included two cameras: a digital camera mounted on a tripod at the final walkway and a mobile camera moving horizontally alongside the patient to capture close-up views of their steps for subsequent re-evaluation. These videos were recorded to ensure measurement accuracy. We used the recorded videos to validate distance, walk duration, and step count. It was noted that some patients, particularly those classified as GMFCS 3, required walking assistance such as a roller walker or cane due to their pathology and pre-surgery deformities, making independent walking a challenge.



a. Reflex creeping

b. Reflex rolling 1st phase

c. Reflex rolling 2nd phase

d. Reflex rolling 3rd phase

e. Stability and balancing practice

Fig. 2. Vojta therapy and standing balance practice protocol. a) Reflex creeping, b) reflex rolling (1st phase), c), reflex rolling (2nd phase), d) reflex rolling (3rd phase), and e) stability and balancing practice**.**

Vojta therapy protocol

Vojta therapy protocol is a 40-minute physical therapy session that involves reflex creeping and reflex rolling stimulation (Figure 2a-e). Specific areas of the patient’s skin were targeted for locomotion reflex stimulation. The techniques included reflex creeping (hip maximal flexion and overhanging) and reflex rolling (1st, 2nd, 3rd phase position), tailored to individual patients’ deformities.[11] Subsequently, we assessed the patient's motor function and movement readiness.[11] The protocol was repeated twice a day and 1–2 days a week as appropriate. Patients without surgical complications or pain, and those capable of movement, were encouraged to engage in early ambulation.

Statistical analysis

All statistical analyses were performed using STATA 16 (StataCorp LLC, College Station, TX). Statistical significance was set at $p < 0.05$. Data distribution was assessed using the Shapiro-Wilk test. Normally distributed continuous parameters were expressed as mean ± SD while non-normally distributed continuous parameters were presented as median and interquartile range (IQR). Categorical data were represented by counts and percentages. Repeated outcome measurements were analyzed using multivariable multilevel linear regression analysis that considers the correlation between each follow-up information and individual patient baseline (random intercept). In addition, we compared the differences in combined Vojta therapy and surgical interventions between patients with GMFCS I and others.

Table 1 Individual demographic data of each patient.

Patient No.	Age (years)	Weight (kg)	Height (cm)	Sex	Baseline [a]GMFCS	Involvement	Pathology	Surgical procedure	Vojta therapy session per week	Vojta therapy session at 2, 4, and 6 months (hours)
1[b]	3	10	87	Male	3	Quadriplegia	• Hip adductor contracture • Knee flexion contracture • Equinus deformity	• Hip adductor release • Hamstring release • Gastrocnemius recession	4	(30 h/31 h/29 h)
2[b]	8	34	116	Male	3	Hemiplegia	• Motor weakness • Equinovarus deformity	• Tibialis posterior transfer • Percutaneous TAL • Gastrocnemius recession	4	(32 h/30 h/28 h)
3[b]	4	13	91	Female	2	Spastic diplegia	• Knee flexion contracture • Equinus deformity	• Gastrocnemius recession	4	(32 h/29 h/28 h)
4	7	32	127	Male	1	Monoplegia	• Knee flexion contracture • Equinus deformity	• Hamstring release • Gastrocnemius recession	2	(30 h/31 h/29 h)
5	6	15	100	Male	1	Spastic diplegia	• Hip adductor contracture • Knee flexion contracture • Equinus deformity	• Hip adductor tenotomy • Hamstring release • TAL	2	(16 h/14 h/14 h)
6	4	15	109	Female	1	Hemiplegia	• Equinovarus deformity	• Spilt tibialis anterior transfer • Plantar fascia release • Gastrocnemius recession	2	(16 h/14 h/14 h)
7[b]	11	26	138	Male	3	Quadriplegia	• Hip adductor contracture • Knee flexion contracture • Pes planus deformity	• Hip adductor release • Hamstring release • percutaneous TAL • Calcaneocuboid distraction	2	(16 h/15 h/15 h)
8[b]	8	20	105	Female	3	Paraplegia	• Excessive femoral anteversion • Pes planus deformity	• Femoral derotation osteotomy • Lateral calcaneal lengthening	4	(32 h/32 h/32 h)
9[b]	4	14	91	Male	2	Spastic diplegia	• Hip adductor contracture • Knee flexion contracture • Equinus deformity	• Hip adductor release • Hamstring release • Gastrocnemius recession	2	(15 h/14 h/13 h)
10	13	42	141	Female	1	Hemiplegia	• Knee flexion contracture • Equinus deformity	• Percutaneous TAL • Gastrocnemius recession	1	(8 h/6 h/6 h)
11	8	20	126	Male	1	Spastic diplegia	• Equinus deformity	• Gastrocnemius recession	2	(16 h/15 h/14 h)

[a]GMFCS: Gross motor function classification system, [b]Patients using gait aids

RESULTS

Eleven patients with CP were enrolled in the study. The demographic information of each participant is provided in Table 1 and summarized in Table 2. The median age with IQR of the included patients was 6.5(4–8) years. There was no postoperative surgical complication in any patient.

We observed an improvement in 6MWT, ETGUG, cadence, velocity, stride length, and stride time at six months postoperatively. There was a gradual improvement in 6MWT, ETGUG, speed, and cadence at four months and six months following corrective musculoskeletal surgery and postoperative Vojta therapy (Figure 3). After being adjusted by baseline gait parameters, age, and GMFCS level, multivariable multilevel linear regression analysis demonstrated that all outcome measurements significantly improved during the postoperative six months (Table 3).

Table 2 Demographic summary of included patients.

Demographic information	
Age (years) [Median (IQR)]	6.5 (4–8)
Weight (kg) [Median (IQR)]	20 (14–32)
Height (cm) [Median (IQR)]	109 (91–127)
Sex [n (%)]	
Male	7 (63.6)
Female	4 (36.4)
GMFCS[a] level [n (%)]	
I	5 (45.4)
II	2 (18.2)
III	4 (36.4)

Table 3 Differential effects of combined Vojta therapy and orthopedic surgical interventions on outcome measurements at each increasing postoperative month (adjusted for preoperative function, age, and aGMFCS level).

Outcome measurement	**change in outcome (per month)**	**standard error**	**95% confident interval**	***p*-value**
[b]6MWT (m)	6.3	2.6	1.2 – 11.3	0.014
[c]ETGUG (sec)	-14.1	5.5	-24.9 – -3.2	0.011
Cadence (step/min)	2.1	1.0	0.2 – 4.0	0.033
Velocity (m/sec)	0.02	0.007	0.003 – 0.03	0.016
[d]SL (m)	0.006	0.003	0.0003 – 0.01	0.040
[e]ST (sec)	-0.1	0.03	-0.13 – -0.008	0.027

[a]GMFCS: Gross motor function classification system, [b]6MWT: six-minute walk test, [c]ETGUG: expanded timed get-up-and-go test, [d]SL: Stride length, [e]ST: Stride time

Table 4 Outcome difference in the combined effects of Vojta therapy and orthopedic surgical interventions on outcome measurements between children with CP and GMFCS level I, II, or III.

Outcome measurement	**Mean differences**	**standard error**	**95% confident interval**	***p*-value**
[b]6MWT (m)	4.3	3.7	-3 – 11.6	0.249
[c]ETGUG (sec)	-0.8	7.7	-15.9 – 14.4	0.919
Cadence (step/min)	0.5	1.1	-1.7 – 2.6	0.676
Velocity (m/sec)	0.01	0.01	-0.0 – 0.03	0.257
[d]SL (m)	0.004	<0.1	-0.004 – 0.13	0.348
[e]ST (sec)	-0.001	0.03	-0.07 – 0.06	0.961

[a]6MWT: six-minute walk test, [b]ETGUG: expanded timed get-up-and-go test, [c]SL: Stride length, [d]ST: Stride time

Table 5 Outcome difference in the combined effects of Vojta therapy and orthopedic surgical interventions on outcome measurements between the 2nd and 4th months.

Outcome measurement	Mean differences	standard error	95% confident interval	*p*-value
[b]6MWT (m)	22.3	5.1	1.2 – 32.5	0.000
[c]ETGUG (sec)	-49.5	21.1	-90.8 – -8.2	0.019
Cadence (step/min)	5.2	2.6	0.13 – 10.3	0.044
Velocity (m/sec)	0.06	0.015	0.032 – 0.09	0.000
[d]SL (m)	0.032	0.009	0.013 – 0.05	0.001
[e]ST (sec)	-0.12	0.06	-0.24 – -0.01	0.031

[a]6MWT: six-minute walk test, [b]ETGUG: expanded timed get-up-and-go test, [c]SL: Stride length, [d]ST: Stride time

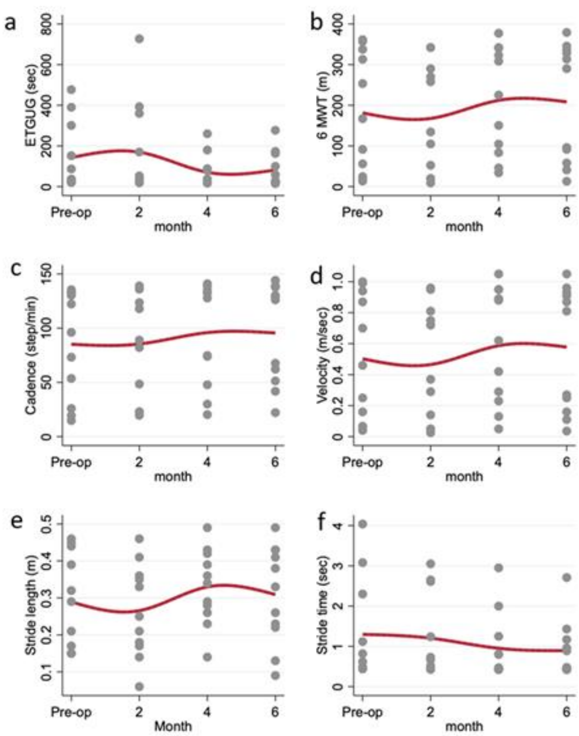


Fig. 3. Mean and standard deviation of ambulation capability in preoperative measurement and during the postoperative period, encompassing a) expanded timed get-up-and-go test (ETGUG), b) six-minute walk test (6MWT), c) cadence, d) velocity, e) stride length, and f) stride time.

In addition, when comparing patients classified as GMFCS level I and higher, no statistically significant differences were found in all interesting outcomes (Table 4). We postulated that the 1st and 2nd months post-surgery represented a period of improvement due to the corrective effects of the surgical procedure. Consequently, we compared the results between the 2nd and 4th months, speculating that the effectiveness of Vojta therapy might manifest during this period. Notably, all parameters showed significant improvement during this period (Table 5).

DISCUSSION

In CP cases, muscle or joint contracture are common deformities that hinder movement and can lead to disuse muscle atrophy. These deformities may progress, resulting in fixed conditions such as hip dislocation.

Surgical musculoskeletal procedures can improve skeletal alignment, joint motion, and joint stability in patients with CP. These improvements effect ambulation capability and physical function, thereby improving the GMFCS level.[12-17] Besides surgical treatment, patients with CP might present with various clinical conditions that require multimodal approaches to enhance their functional capacity, including physiotherapy. Muscle weakness and spasticity in patients with CP contribute to restricted gait function. Physiotherapy aims to improve optimal gait performance by increasing muscle strength. In addition to traditional physical therapy protocol, Vojta therapy aims to restimulate the alternative movement programs embedded in the brains of children with CP. Consequently, the neurophysiological programming from Vojta therapy could improve automatic coordination of the body's position, with a change in the position of the center of gravity, as is common with each movement.[18] Thus, Vojta therapy is a physical therapy specifically designed for CP, which could improve the functional outcome of this condition.[7]

Various physiotherapy methods highlight the benefits of physical therapy in addressing infantile postural asymmetry. Concordant with previous studies, our findings emphasize the benefits of Vojta therapy in operatively treated children with CP. Several studies have demonstrated that Vojta physiotherapy can significantly improve a child's daily functional motor skills, gait pattern, GMFM-88, and locomotor stage.[5,8,19,20] We believe that applying Vojta principles, which involve repetitive reflex locomotion and reflex creeping to activate the stored "normal movement" in the brain, could contribute to functional recovery and improved movement in patients with CP.

In this study, we observed a significant improvement in all parameters of instrumental gait analysis, including velocity, cadence, stride length, and stride time. It is worth noting that these parameters initially showed a decline in the first two months after surgery. This can be attributed to the fact that most patients started postoperative physiotherapy after immobilization. As a result, prolonged immobilization time often caused disuse muscle atrophy. Therefore, besides correcting deformities, it is essential to incorporate muscle-strengthening exercises and Vojta therapy post-surgery.

Furthermore, patients' functional outcomes, as assessed by the 6MWT and ETGUG, gradually improved during the follow-up period. The findings from the 6MWT and ETGUG revealed that patients with CP who received surgical treatment and underwent Vojta therapy exhibited improved ambulation abilities, as demonstrated by greater distances covered in shorter periods. Additionally, there was a slight but noticeable enhancement in patients' stride length and duration with each gait cycle. Although these improvements may seem minimal, they can become significantly more pronounced when multiplied by the patient's increased cadence and speed. A more extended follow-up period might elucidate the cumulative benefits of Vojta therapy. Moreover, our findings also demonstrate similar benefits between those with mild severity (GMFCS I) and moderate severity (GMFCS II and III). As a result, the combination of operative treatment and Vojta therapy could improve the functional level in both mild and moderate-severity patients with CP.

This study has several strengths. To the best of our knowledge, it is the first prospective study to evaluate the efficacy of postoperative Vojta therapy on gait analysis and functional outcome in surgical patients with CP. The therapy was performed by two Vojta therapy-certified practitioners. Furthermore, the use of comprehensive outcome measures, including video gait analysis, expanded timed get-up-and-go test (ETGUG), and 6-minute walk test (6MWT), offers a thorough evaluation of ambulation capabilities.

However, our study also had some limitations. First, the sample size was small. Second, this study could not determine the efficacy of intervention due to the lack of a control group. Finally, we could not differentiate the effect of Vojta therapy from surgical treatment since only one patient group underwent both interventions. Nevertheless, it is one of the few studies demonstrating the results of Vojta therapy on patients with CP; therefore, our findings remain relevant to the field. Future studies may incorporate a larger sample size and multicenter trials, an appropriate control group with propensity score matching, proper differentiation between intervention effects, and longitudinal follow-up to determine long-term effects.

CONCLUSIONS

While recognizing the aforementioned limitations, this study provides evidence of noteworthy improvements in ambulation capabilities among surgically treated patients with CP after postoperative Vojta therapy. Our findings underscore the potential of Vojta therapy as a valuable alternative to postoperative physical therapy in individuals with CP, enhancing ambulation and overall functional outcomes in this patient population.

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