The Rehabilitation Outcome of Spinal Meningioma Induced Proprioception Deficit

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Chronic non-traumatic myelopathy developed in a woman who presented symptoms of gait ataxia, right leg motor weakness, dysesthesia and urinary difficulty. Clinical evaluation revealed right leg weakness and global anesthesia as well as temperature, vibratory and proprioception sensation loss below the T-9 level and deep tendon hyperreflexia over the lower extremities. Magnetic resonance imaging showed an extra-intramedullary meningioma at the T-9 level. Following microscopic subtotal excision of the tumor, the patient underwent satisfactory rehabilitation programs with outstanding outcomes presented using the neurological scoring system, functional balance grade, postural analysis of Baropodometry screen and single leg standing time. *(Chang Gung Med J 2005;28:730-4)*

Key words: spinal meningioma, posterior column lesion, proprioception deficit, balance analysis.

It has been well established that spinal meningiomas generally carry excellent prognoses.[1-5] Even the rare case of extra-intramedullary meningioma in this study with serious pre- and post-operative neurological deficits produced excellent outcomes through satisfactory rehabilitation programs. Some evaluative methods for supporting the good rehabilitation results are described in this study including a score system for specific manifestations[6] (Table 1), a subjective functional balance grade[7] (Table 2), objective postural assessment of Baropodometry screen[8] and single leg standing time.

CASE REPORT

A 51-year-old woman had history of paresthesia over bilateral lower limbs for 18 months. Frequent headaches, dizziness, palpitations and urinary habit alterations in frequency and urgency were also experienced. Although she underwent some neurological evaluations at the Kaohsiung Chang Gung Memorial Hospital, only mixed cervical and lumbosacral radiculopathies were discovered during the electromyography study.

Progressive ataxic gait, right lower limb weakness and urinary difficulty led to her visiting the neurological department of the Kaohsiung Chang Gung Memorial Hospital again. More thorough surveys revealed the following: reduced muscle power of right hip flexor with mild increase in muscle tone of bilateral lower limbs; sensory disturbance below the T-9 level including global anesthesia, tight touch, cold, and vibratory sensation loss as well as impaired proprioception, decreased two point discrimination, and increased deep tendon reflex over bilateral lower limbs. Myelopathy over the posterior column was considered and Magnetic resonance imaging (MRI) was arranged, which demonstrated an extra-intramedullary mass that was isointense to the spinal cord on T1WI and hypointense on T2WI at the T-9 level. Hyperintensity alteration of the spinal cord at T8~10 levels was also observed and post-contrast evaluation indicated intense enhancement of the

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Table 1. Neurological Scoring System

Score	Sensory eeeicits, pain, dysesthesias	Motor weakness	Gait ataxia	Bladder Function	Bowe L function
5	No Symptoms	Full Power	Normal	Normal	Normal
4	Present, Not Significant	Movement Against Resistance	Unsteady No Aid	Slight Dist., No Catheter	Slight Dist., Full Control
3	Significant, Function Not Restricted	Movement Against Gravity	Mobile With Aid	Residual, No Cath.	Laxatives, Full Control
2	Some Restriction Of Function	Movement Without Gravity	Few Steps With Aid	Sometimes Catheter	Sometimes Loss Of Control
1	Severe Restriction Of Function	Contraction Without	Standing With Aid	Often Catheter	Often Loss Of Control
0	Incapacitated	Plegia	Wheel Chair	Permanent Catheter	No Control

Abbreviations: Dist.: disturbance; Cath.: catheter.
(From Klekamp J, M. Introduction of a score system for the clinical evaluation of patients with spinal processes. Acta Neurochir 1993[6])

Table 2. Functional Balance Grades

Normal	Patient is able to maintain balance without support Accepts maximal challenge and can shift weight in all directions
Good	Patient is able to maintain balance without support Accepts moderate challenge and can shift weight, although limitations are evident
Fair	Patient is able to maintain balance without support Cannot tolerate challenge. Cannot maintain balance while shifting weight
Poor	Patient requires support to maintain balance
Zero	Patient requires maximal assistance to maintain balance

From Leahy, P. Motor control assessment. In: Montometry P, Connolly B, eds. Motor Control and Physical Therapy: Theoretical Framework and Practical Applications. Chattanooga Group, Hixson, TN, 1991: 75 [7]

lesions (Figs 1 and 2).

An operation was arranged immediately and the intra-operative findings were as follows. The tumor was a hard consistency, ovoid shaped, extramedullary and intramedullary tumor projecting from the dorsal aspect and tightly attached to the spinal cord. Microscopic subtotal excision was executed smoothly. Following the operation, this patient subjectively experienced minor improvement in the right leg muscle power and voiding condition but ataxic gait with proprioception deficit still bothered her. She still had a strong tendency to fall and required a walker for ambulation.

The patient was transferred to the rehabilitation department for the sequelae and underwent appropriate rehabilitation programs of lower limb muscle strengthening, coordination training, balance training, closed kinetic chain exercises, perturbation exercise, weight-shifting exercise and functional training. She could ambulate well independently within 1 month and even run, allowing her returning to her original employment of teaching kindergarten students.

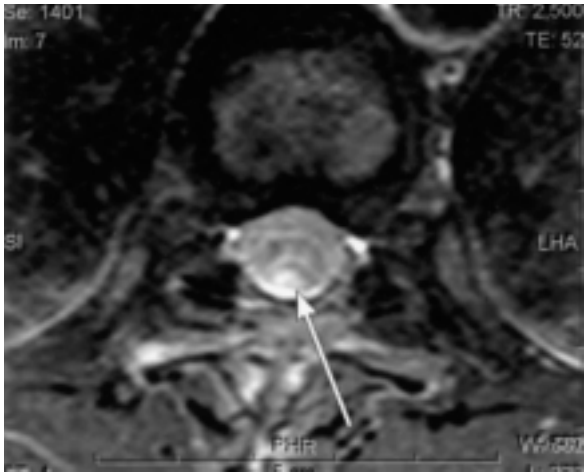

Fig. 1 Extra-intramedullary mass with isointense to spinal cord on T1WI and hypointense on T2WI at T-9 level. The post-contrast picture shows intense enhancement of the lesions.

Fig. 2 Hyperintensity changes of the spinal cord at T8~10 levels.

Four means were employed to plot the rehabilitation outcomes. First, the clinical course was documented using the neurological scoring system[6] (Table 1). For each of the following symptoms and signs, a score between 0 and 5 was given: sensory deficits, dysesthesia, pain, motor weakness, gait, and bladder and bowel functions. The scores tracked levels of functional significance:

5 - Full function
4 - Slightly compromised function
3 - Severely compromised but preserved function
2 - Disabled function
1 - Severely disabled function
0 - No function

In general, scores between 3 and 5 depicted satisfactory function levels and scores between 0 and 2 indicated unsatisfactory or incapacitated functions. Only the worse side of the body and limbs corresponding to the spinal level of the lesion were evaluated.

Second, a functional balance grade[7] was utilized for subjectively grading the dynamic balance (Table 2). Third, computerized baropodometry examined posture sway in the following four conditions "double leg standing with eyes open", "left leg standing with eyes open", "right leg standing with eyes open", and "double leg standing with eyes closed".[8] The patient was tested both at the time when she could stand independently and at the end of the rehabilitation. The patient was well prepared before clicking on the record button in every situation. Responding to patient tolerance, the recording time was set at 15 seconds for single leg standing or close eye situation and 30 seconds for double legs standing. The computer recording the evolution of the posture assessment was viewed at 20 frames per screen with changes of the dots signifying the center of gravity and extended as lines tracing the movement. Direction and consistency of the patient's sway were displayed finally as a graph. The surface of the ellipse containing 90% of the movements recorded during the posture examination and the X and Y chord lengths were finally measured. Average data were recorded after three examinations in each condition. Finally, another quantitative data was recorded via single leg standing time bilaterally integrating the enhancement of lower limb muscle strength and whole body stability.

The following neurological scores were recorded. Sensory deficits, pain, and dysesthesias changed from 2 to 4, motor weakness improved from 3 to 5, gait ataxia recovered from 1 to 5, while bladder and bowel function improved from 3 to 5 (Table 3). These scores indicated that this patient recovered from the level of incapacity for particular functions to the level of preserved functions according to this score system. The functional balance grade also advanced from poor to good, meaning that the patient could hold her balance without support, accept moderate challenges, and finally shift weight.

The improved balance and posture control during the middle to late rehabilitation period were demonstrated using Baropodometry with the decreasing surface of the ellipse and X-, Y- cord lengths resulting from the swaying center of gravity during all situations (Table 4) and prolonged bilateral single leg standing time (Table 5).

Table 3. Results of Neurological Scoring System

Score	Before rehabilitation	After rehabilitation
Sensory deeicits, pain, dysesthesias	2	4
Motor weakness	3	5
Gait ataxia	1	5
Bladder function	3	5
Bowel function	3	5

Table 4. Results of Baropodometry Evaluation

Baropodometry parameter		Measure situation	Measure time period middle rehab	Late rehab
Center coordinate (cm)	X	EO + DL	1.2	0.6
		EO + RL	2.4	2.1
		EO + LL	2.4	1.0
		EC + DL	7.3	2.2
	Y	EO + DL	1.7	0.6
		EO + RL	2.7	2.2
		EO + LL	1.7	1.4
		EC + DL	10.1	2.1
Ellipse surface (cm2)		EO + DL	1.6	0.28
		EO + RL	5.1	3.62
		EO + LL	3.2	1.55
		EC + DL	57.9	3.62

Abbreviations: EO: eye open; EC: eye close; DL: double legs standing; RL: only right standing; LL: only left leg standing.

Table 5. Results of Single Leg Standing Time

	Single leg standing	Measure time period middle rehab	Late rehab
Time (sec)	Right leg	26	35
	Left leg	48	75

DISCUSSION

The clinical features of this patient may resemble those of other patients with spinal cord diseases including posterior spinal artery infarct, infectious myelitis, myelitis due to collagen disease, and multiple sclerosis, that could initiate posterior column deficits and lead to symptoms such as lower limbs muscle weakness, posture instability, proprioception deficit or dyssynchrony of reciprocally innervated leg muscles during movement. We found no report about the means of effectively challenging the proprioceptive system when the posterior column is damaged. Therefore, our rehabilitation team modified previously described programs for this patient to develop ways of effectively challenging the dynamic and reflexive aspects of proprioception in the lower extremities following sports injury. For example, balancing on foam helped reduce the usefulness of somatosensory inputs of the ankles for managing balance, thereby challenging visual and vestibular inputs for compensatory balance control. Closed kinetic chain exercises (e.g., alternative kneeling exercise), functional training (e.g., figure eight cuts, single leg hops), and perturbation exercises were intended to enhance the proprioception and stability limits.

Rehabilitation efficacy was measured using four methods that were easily applied and interpreted without requiring time consuming batteries of tests. The Neurological Score System was organized by Klekamp to facilitate statistical analysis of the clinical course of patients with spinal lesions. Compared with other scores such as the Barthel Index (Manoney and Barthel, 1965) and the Frankel Index (Frankel and Hancock, 1969), this scoring system evaluated all symptoms with identical scores for particular functional levels. In this way, scores could be translated into a clinical picture allowing statistical analysis of the clinical course of patients both retrospectively and prospectively. This scoring system produced good reproducibility and validity results in previous studies. The functional balance grades were also described by Leahy as giving a more precise scale to interpret the dynamic balance improvement subjectively. Even the force platform assessment of balance was the main outcome measure to demonstrate an improvement in postural stability for static standing balance only. It was a reasonably safe consideration for patients with poor stability to accept more dynamic assessment of reactive balance control even though that it may focus on the patient's somatosensory deficit.[9,10] Because there were rare discussions regarding the efficacy of rehabilitation for patients with posterior column deficits, we suggest these easy and safe methods for applying and interpreting the results that may be valuable gathering more databases for further statistical analysis in the future.

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脊椎腦膜瘤術後之本體感覺缺損復健預後

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脊髓腦膜瘤多爲生長於硬膜內髓鞘外 (intradural extramedullary) 且生長緩慢的良性腫瘤。若能早期診斷，手術徹底移除腫瘤防止再發且術後積極復健治療，一般的預後均不錯。此個案因持續惡化之雙下肢麻木，僵硬無力，平衡失調，雙足著地漂浮感及頻尿而就醫。神經學檢查發現其右髖關節屈曲之肌力下降爲四分；雙側下肢深肌腱反射增強；輕觸覺，冷覺自第九節胸椎皮節之下減低，雙下肢兩點辨別，震動感及關節位置感異常及陽性Romberg's test。核磁共振攝影檢查顯示於第九節胸椎位置存在一T2WI 下低強度之腫瘤。手術中發現此腫瘤乃由背側硬膜長出，並緊密沾黏至脊髓 (intra-extra medullary tumor)，腫瘤部分灼燒切除後，病理報告爲纖維性腦膜瘤。術後病患右下肢肌力及頻尿情形稍許改善但站立及步行之平衡仍甚不佳。因此我們安排於本體感覺及穩定、平衡力強化訓練前後，以四種方式評量病患復健成效：包含神經學計分系統，功能性平衡力分級，氣壓式足底壓力測量儀 (Baropodometry)，及單足站立時間等。結果爲該病患經復健治療後平衡及步行能力均有明顯改善。提出的四種簡易又安全評量方式亦可供爲日後相似病例統計預後之用。(長庚醫誌 2005;28:730-4)

關鍵字：脊髓腦膜瘤，後椎體路徑病變，本體感覺缺損。

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