

Function of the Hand in Patient with Posttraumatic Tetraplegia

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Summary

Function of the hand, even not precise, but useful in everyday- life activities is extremely important for the patients with quadriplegia. At high grade it is deciding about quality of life. Properly undertaken treatment, early rehabilitation, functional hand therapy in many cases allow recovering its function, assuring self - service. The results of transmitting active but usually weakened muscles tendons - into paralyzed ones (sometimes taken in such cases) are uncertain. This refers particularly to spastic hand, when the operational indications should be stated very cautiously. The biggest problem makes patients, who in spite of therapeutic efforts have got totally functionally useless hand. In such cases there are different trials performed to improve functioning of quadriplegic hand, but results of such procedures usually are not fully satisfactory.

Keywords: Functional Electrical Stimulation; Functions of the Tetraplegic Hand; Restoration of Tetraplegics Hand Function; The Relation Between Cord Injury Level and Function of the Hand

Introduction

Quadriplegia (tetraplegia) as a result of severe cervical spinal cord injury belongs to the most profound dysfunction of the locomotor system. Similar cord injuries on lower level, in spite of paralysis of both legs and trunk - don't cause severe grade of disability. They left over the chances for quite good performed everyday - life activity, self- service and ability to use the wheelchair. The degree of disability is dependent from the degree of hand insufficiency. Function of the hand for patient with cord injury in the cervical spine has got very important role. Such person spends most of the day - time in bad or on the wheelchair, is lacking of performing any, even simplest every - day activities, is totally dependent from surrounding society, which is usually unable to secure persistent, full - time care. The importance of hand functioning for such patients is stressed in clinical material taken from Hanson and Franklin [1]. They have been checking in anonymous questionnaire what human function seems to be the most important. About 76% of hole randomized group pointed out function of the hand. That's why analysis of functional abilities of the hand so performed [2-4] and undertaking every possible method directed to regain and enhance hand functioning [5-9] has

got so important meaning in treatment of patients after cervical cord lesions.

Materials and Methods

The material of 285 clinical cases has been analysed. All of them were treated after cervical cord injuries and were admitted to hospital (Metropolitan Rehabilitation Centre in Konstancin, near Warsaw) with symptoms of quadriplegia. In (Table 1) is visualized the relation between neurologic deficit and level of spine injury. The level of damaged spine has been determined using standard X-ray and in doubtful cases CT or MRJ examination. The level of neurologic deficit has been defined accordingly to evaluation of superficial feeling loss level. Spine injure in most cases, dealt with spaces C5 - C6 and C6 - C7 (totally over 43% of all cases), and all together injuries between C5 - C7 made 80% of analysed group. Neurologic deficit mostly dealt with C6 segment (38%). Usually, it is accepted, that cervical cord lesion is one segment lower than the level of spine damage. In analysed material we usually found neurologic deficit on the level of bony metamere lesion or little above (65% of cases). This is probably because of fact, that primary examination was performed early - after couple or several hours after the accident had happened, when the posttraumatic oedema of the cord could cause certain elevation of neurologic deficit level. Important is the fact though, that neurologic deficit level seems to be higher

in intervertebral damage, connected with luxation of vertebral bodies, not in vertebral body fracture, where the level of spinal cord compression is relatively lower.

The Level of superficial feelings loss						
Level of spine injure	C5	C6	C7	C8	D1	All together
C4-C5	38	7	-	-	-	45
C5	11	26	4	-	-	41
C5-C6	17	33	6	1	-	57
C6	4	12	18	5	-	39
C6-C7	1	27	28	10	1	67
C7	-	3	9	13	3	28
C7-D1	-	-	3	3	2	8
All together	71	108	68	32	6	285

Table 1: The relation between the level of spine injure and neurological deficit.

The Relation Between Cord Injury and Function of the Hand

Many factors have influence on the range of hand function in patients after cervical spine injury. They are: severity of cord lesion, mechanism and force of trauma, duration of cord compression, undertaken treatment, age of patient, cooperation with the patient during rehabilitation process and others. The most important factor though, seems to be the level and degree of the

cord lesion [2,3,8]. This is clearly illustrated in the (Table 2), where we can see the relation between upper extremity function notified in primary examination and the level of cord injury. As an active muscle complex has been assumed dynamic group of muscles with strength of more than 2 according to Lovett scale. Primarily - at the admission it has been notified just the activity of elbow flexors (41% of cases), with accompanying activity of deltoid muscles only. A smaller was group of better prognosis, with additionally active extensors of the wrist (28% of cases).

Active muscle complexes of upper limb					
level of cord injure	None	Elbow flexors	Wrist flexors	Finger flexors, extensors	All together
C5	62	8	1	-	71
C6	3	103	2	-	108
C7	-	7	57	4	68
C8	-	-	17	15	32
D1	-	-	2	4	6
All together	65	118	79	23	285

Table 2: The relation between the level of cord injury and function of upper limb dynamic complexes.

There was numerous though group of patients with total plegia of the upper extremity (23% of cases). The level of cord injury is in high correlation with dynamic complexes of upper limb, which work quite properly. The cord lesion on the level of C5 is usually accompanied with functional paralysis of the limb (87% of cases). The symptoms of lesion on the C6 level is the peripheral paralysis of extremity with left preserved activity of elbow flexors (96%). The lesion on the C7 level secures fair activity of flexors and extensors of the wrist (85% of cases). This creates the chance to regain at least the simple hand - grip activity

by the use of “trick” mechanism (this means that active, strong extension of fingers in the way of tensed finger flexors tendons). At the group of patients with lower cervical cord injuries we meet sometimes individuals with good fingers activity, though with the level of C8 lesion more common is group of patients with active only wrist extensors (56%).

Function of the Hand after Hospital Treatment

During treatment, the area of oedema and blood supply abnormalities got diminished, what usually decreases the level of

neurological deficit and sometimes regains activity in primarily muscles [4,6]. Early undertaken of hand rehabilitation process and functional hand therapy in many cases allow full or at least partial recovery of hand function. In (Table 3) it has been presented handgrip abilities regained in final stage of hospital treatment in correlation with activity of main dynamic complexes extremity notified during admission to the hospital. Overall, in 58% of analysed group different level of hand functioning has been regained. Of course, regarding primary neurological and functional state in analysed group of patients - regaining precise and accurate hand function we have met relatively rarely (only about 10% of cases) and usually during low level of cord injury (C8 - D1).

Function of hand (After treatment)					
Active dynamic complexes (Primary examination)	None	Tubby function	Function in everyday-live activity	Precise function	All together
None	57	6	2	-	65
Elbow flexors	63	41	14	-	118
Wrist flexors	1	27	43	8	79
Finger flexors, extensors	-	-	4	20	23
All together	121	74	62	28	285

Table 3: The relation between handgrip abilities and activity of dynamic muscle complexes (after treatment).

Unfortunately, quite large group of treated patients (42%) didn't regain functional activity of hand, and quite numerous is also group of patients, who be able to use the hand only into specific everyday - life situations, minding limited hand - grip functioning ("Trick Grip"). The relation between hand function and the balance of upper extremity dynamic complexes, notified during primary examination is clear. If the paralysis of the extremity during primary examination is total, the hand usually stays functionally useless (88% of patients). Also in the group, where we had primarily preserved only activity of elbow flexors - the hand often stays functionally useless (53%), and in none case from that group we didn't regain precise function of the hand. Definitely better results have been noted in patients with active, during primary examination, extensors of the wrist. In most patients (55%) hand has been useful during every day - life activities, and in 10% of treated individuals good, precise function of the hand was regained. When during primary examination, flexors and extensors of finger were present - nearly in all of patients (87%) precise efficiency was recovered.

Conclusion

Based on the facts set out above, function of the hand, even not precise, but useful in everyday - life activities are extremely important for the patients with quadriplegia. At high grade it is deciding about quality of life. Properly undertaken treatment,

early rehabilitation process, functional hand therapy in many cases allow recovering its function - assuring self - service. In the group of patients treated restoration of the hand functioning, in different level has been regained in 58%. Precisely performed manoeuvres was however rare (about 10% cases), and quite numerous (26%) where the hand function was very weak, enabling only simple tasks. In such cases it is worth consider special orthopaedic equipment to use, what could improve functioning of the hand [6-8] or on the way of surgical procedures [9-11]. But the indication into surgical procedures are not stated too often.

The results of transmitting active tendons, but usually weakened muscles into paralyzed ones are uncertain. This refers particularly to spastic hand, when the operational indications should be stated very cautiously. The biggest problem makes patients who in spite of therapeutic efforts have got totally functionally useless hand (42% of analysed group). There are different trials performed to improve functioning of the quadriplegic around the word, using special systems of robot - manipulators [8], functional electrostimulation of nerves, muscles (Figure 1) [12-14] and preferred in our Centre transmitting of musculo- cutaneous nerve into median nerve (Figure 2) [6,15,16]. The results of such procedures are not fully satisfactory, but even regaining simple hand - grip allows the patient to grab big thing like apple, sandwich, cutlery with bold handle, enables limited independent activity, self - service and improves positive thinking.



Figure 1: A patient with hybrid orthosis (using nerve stimulation) - enabling the function of the paralyzed tetraplegic hand.

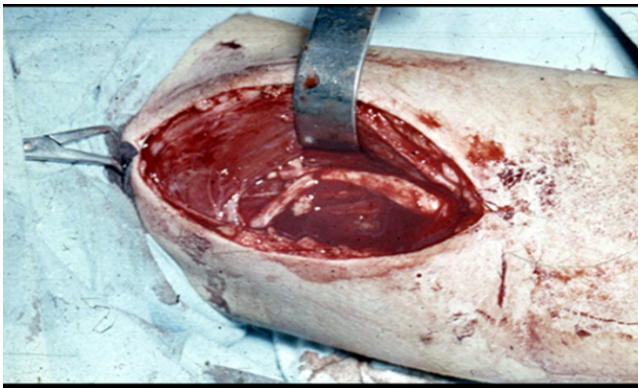


Figure 2: Connection of the median nerve and the musculocutaneous nerve to restore simple function of the paralyzed hand.

References

1. Hanson RW, Franklin WR (1986) Sexual loss in relation to other functional losses for spinal cord injury males. *Arch Phys Med Rehab* 57: 291-298.
2. Kiwerski J (2005) Cervical Spine Injury. In: *Medical Rehabilitation*. Kiwerski J (Editor). PZWL, Warszawa 2005.
3. Harvey LA, Batty I, Jones R, Crosby J (2001) Hand function of C6 and C7 tetraplegics 1 - 16 years following injury. *Spinal Cord* 39: 37-41.
4. Fattel C (2004) Motor capacities of upper limbs in tetraplegics. *Spinal Cord* 42: 80-84.
5. Kloosterman MGM, Sneek GJ, Jannink MJA (2009) Systematic review of the effects of exercise therapy on the upper extremity of patients with spinal cord injury. *Spinal Cord* 47: 196- 201.
6. Kiwerski J, Krasuski M, Ogonowski A, Dziewulski M (2000) The possibility of restoring or improving the hand function of the tetraplegic patient. *Ortop Traumatol Rehabil* 2: 28 -34.
7. Snoek GJ, Ijzerman MJ, Hermens HJ, Maxwell D, Biering-Sorensen F (2004) Survey of needs of patients with Spinal cord injury impact and priority for improvement in hand function in tetraplegics. *Spinal Cord* 42: 526- 532.
8. Pańniczek R, Kiwerski J (2004) Supporting of the loss function of the human extremities by functional electrical stimulation and orthosis. *Pol J Phys Eng* 10: 43-49.
9. Moberg E (1978) *The upper limb in tetraplegia: a new approach to surgical rehabilitation*. Stuttgart. Georg Thieme 1978.
10. Fomer-Cordero J, Mudarra-García J, Forner-Valero JV, Vilar-de-la-Peña R (2003) The role of upper limb surgery in tetraplegia. *Spinal Cord* 41: 96-102.
11. Harvey LA, Lin C, Glinsky JV (2009) The effectiveness of physical interventions for people with spinal cord injury: a systematic review. *Spinal Cord* 47: 187-191.
12. Peckham PH, Thrope GB, Buckett JR, Freehafer AA, Keith MW (1982) Coordinated two mode grasp in the quadriplegic initiated by functional neuromuscular stimulation. *IFAC Proceedings Volumes* 15: 29-33.
13. Kiwerski J, Pańniczek R (1984) An apparatus making possible restoration of simple functions of the tetraplegics hand. *Paraplegia* 22: 316-319.
14. Kiwerski J, Krasuski M, Dziewulski M, Barcińska I (2001) Czynność ręki chorego z tetraplegią pourazową (tetraplegic hand function). *Postępy Rehabilitacji* 15: 43-47.
15. Kiwerski J (1982) Recovery of simple hand function following transfer of the musculo- cutaneous nerve into the median nerve. *Paraplegia* 20: 212-217.
16. Krasuski M, Kiwerski J (1991) An analysis of the results of transferring the musculo- cutaneous nerve on the median nerve in tetraplegics. *Arch Orthop Trauma Surg* 111: 31-33.