



Functional hand development in tetraplegia

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The development of the 'functional hand' in tetraplegics has been historically facilitated through specialized hand positioning schemes. However, clinical experience at the University Hospital Heidelberg demonstrates no direct relationship between various hand positioning techniques and the probability of functional hand development. The aim of this study was to document the various methods of hand positioning and the resulting functional outcome. In a multi-center study, the paralysed thumb and finger positioning of 64 tetraplegics and the resultant functional outcome was evaluated with a specially developed survey form. Results indicated that the functional outcome of the tetraplegic hand was highly dependent on the level of the spinal cord injury and only to a minor degree dependent upon the different methods of hand positioning employed. The conclusion drawn is that remaining neurologic function after injury determines the final functional outcome of the tetraplegic hand.

Keywords: tetraplegic hand function; hand positioning; neurologic situation; level of lesion; physiotherapeutical measures

Introduction

Therapeutic strategies which aim at the development of a functional hand in newly injured tetraplegics are a key component of the rehabilitation program. Experience shows that the post rehabilitation independence level of tetraplegics is strongly dependent upon, *inter alia*, dealing with the remaining neurological and vegetative function of hands and fingers. (Figure 1).¹

The commonly applied concept used in rehabilitative settings is the use of various hand positioning techniques which supposedly favor the development of a functional hand shape.^{1,2} Clinical experience and observations of this concept in the Rehabilitation Center of the Orthopaedic University Hospital Heidelberg have shown widely varying results. Patients receiving the same type of hand positioning experienced results ranging from well developed to completely insufficient functional hand development.

These varying results led to the following study question: Can the development of a tetraplegic functional hand be influenced by a particular hand positioning scheme?

Subjects and method

Patients

The questioning was carried out in 64 patients with complete or incomplete tetraplegia. The average age

was 34.8 years, ranging from 13–73 years. The classification of the patients ($n=60$) according to the level of paralysis is shown in Figure 2. Four patients with an incomplete paralysis (tetraparesis) were excluded from the study, because they could not be assigned to a homogenous group. Only patients with a complete paralysis from C 2/3–C 7/8 were included in the study.

Exclusion criteria

Exclusion criteria were:

- additional neurologic diseases, e.g. traumatic brain injury or tumors.
- operations performed at the upper extremity to improve hand function.
- fractures in the hand area.
- children under the age of 12, because of the inability to answer survey questions.

Positioning group

Forty-four patients received rehabilitative hand positioning. Eighteen were from the Orthopaedic University Hospital Heidelberg, and 26 from other hospitals. Hands were considered positioned:

1. If hand positioning was begun at the beginning of rehabilitation.
2. If hands were positioned with an aid (e.g. positioning-glove, Figure 3) for at least 12 h per day or night for 3 months.^{1,2}



Figure 1 Independence in activities of daily life

Level of lesion n = 64

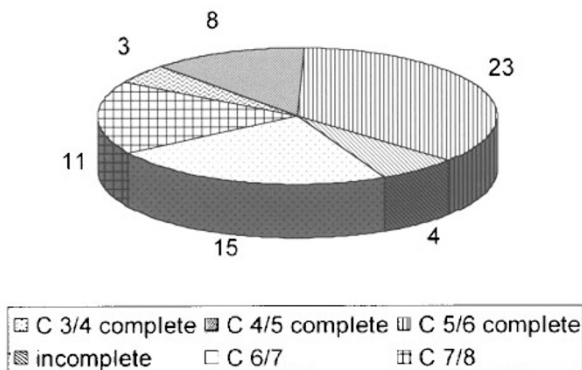


Figure 2 Levels of neurologic lesions



Figure 3 Positioning glove for a tetraplegic hand

Types of positioning

Classical

Thirty-four patients were positioned in the classical functional hand position. By this we understand dorsal extension of the wrist with flexion of the MP and PIP joints. Of this group, 19 patients were positioned with a positioning glove, ten with palmar rolls, and five patients used a palmar splint for positioning.

Other positioning techniques

Ten patients were positioned in 0 degree wrist extension with fully extended finger joints. Ten patients had a wrist extension splint, and two patients received additionally an arm splint immobilising the elbow joint in an extended position.

Non-positioning group

Sixteen patients obtained no hand positioning.

Survey implementation

The hand positioning technique and the subsequent development of a functional hand for 64 tetraplegics were documented using a survey form. The patients

Hand Evaluation Scheme

Name

Date of birth

date of injury

kind of injury

fracture (spine)

level of paralysis initially

level of paralysis now

primary treatment

further treatment

surgery at spine

surgery at arm / forearm / hand

concomitant injuries

Hand positioning

beginning

way of positioning

duration and intensity

Spasticity (upper extremities)

kind of spasticity

beginning of spasticity

Figure 4 Hand evaluation scheme

Table 1 Results of patients without functional hand positioning

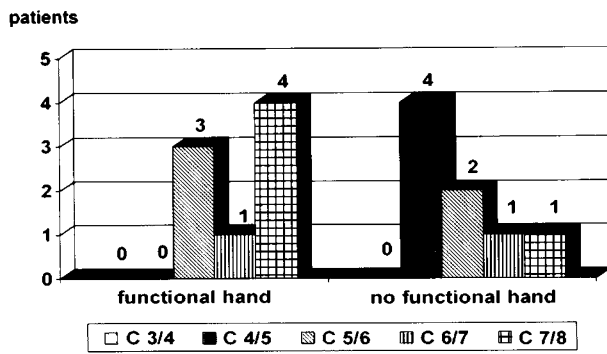
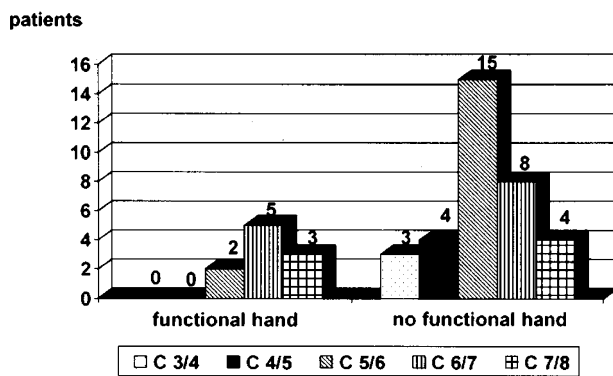


Figure 7 Ideal positioning of a tetraplegic hand

Table 2 Results of patients with functional hand positioning



Functional hand development and neurological lesion level

The hands were also classified according to the different neurological lesion levels. Tables 1 and 2 show that the probability of functional hand development is higher with lower lesions.

Discussion

Our results demonstrate that for the development of a tetraplegic functional hand, particular hand positioning is not absolutely necessary. Furthermore, consistent hand positioning does not necessarily lead to the development of a functional hand. Thus, a tetraplegic hand kept in its natural position with slight dorsal wrist extension and moderate finger flexion (a result of active dorsal extension), and a positioning of the shoulders in slight external rotation would be sufficient for the development of a tetraplegic functional hand without particular hand positioning (Figure 7).

It is our impression that the neurological situation of the patient, the innervation and especially the spasticity determines the functional outcome and quality of movement associated with the tetraplegic functional hand.

A future goal of the clinical team should be to look for other possible rehabilitation schemes which favour the development of a functional hand. In any human being, tetraplegic or other, the development of the hand as a supporting and grasping organ is dependent on the upright mechanism of the whole body. In the case of neurological lesions, therapists should attempt to achieve the best possible coordinated movement of the muscles by neurophysiologically based therapies such as Vojta, PNF, or Bobath.

In order to maximize this functional ability, the anatomical and functional condition of the normally innervated hand should be taken into consideration as well as muscle tone and positioning of the whole body.

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