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Prehension

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Summary

The important function of prehension is explored in differents points, including its development, which helps the baby in the learning process. Because of the multiple degrees of freedom, the hand can be molded in many meaningfull ways. These patterns are presented according to the literature evolution. Motor prehension control shows how the central nervous leads wiht the several prehension conditions. Also, its evaluation can help in many diagnosis processes. Related disorders with some physical interventions are presented in the next section.

Definition and function of prehension

The human hand is a complex instrument, that has multiple aims. In a physiologic view, the hand represents the efector extremity of the arm, as it can be in the most favorable position to execute specific functions (Lehmkuhl; Smith 1989). The functional capacities of the hand as a perfect locomotor system organ have great influence in the social and criative efficiency of humans. Only the hand is capable of making minucious distinctions about external caracteristicas because it combines strength and accuracy (Catovic et al 1991).
Using the independent movements of the several segments of fingers and hand we can hold, maintain, release, take the hand to objects or handle them and move them in all directions. In all these actions there is: 1) the independence of thumb movements and indicator among themselves and in relation to the other fingers, 2) the fact that all fingers movements and wrist run independently of the arm segments positions, 3) independent movements of the interphalangeal and metacarpophalangeal joints (Brandão 1984).

Although the hand has multiple functions, the essential function is prehension. Such capacity appears from the tweezers lobster to the hand of the monkey, but in humans prehension reached its highest degree of functionality. This is due to a particular provision of thumb, which may object to all other fingers (Kapandji 1980).

Human manipulative tasks are carried out by hand movements, that frequently involve forceful movements and prehension. According to Putz-Andersson (1988) the movement of the thumb causes the hand to be aligned with the forearm, resulting in a slight ulnar deviation of the wrist.

Prehension development

The maturity of the differents parts of the central nervous and musculosqueletal systems are associated with the madure patterns of prehension acquired in the first years of the life (Cook; Woollacott 1995). As sensory-motor coordination develops, the adult characteristics of prehension are also imprinted in the motor memory of the child. (Brandão 1984). Hand-eye coordination helps in eye fixation, which means a good eye stabilization, and it is also presented during the movement of a movel target. Like the motor components, the sensorial contributions to prehension are essentials to a good and accurate performance (Cook; Woollacott 1995).

Babies use their hand to learn and explore the environment and indirectly they develop the concepts of spatial dimentions of objects and other physical properties, like shape and texture (Imrhan 1989). After infancy, the hand assumes more specific roles, and can be used to access and shape the environment.

Prehension patterns and behaviour

Prehension patterns have not been clearly defined. According to Bendz (1974) there is much confusion generated by inadequate sinonymy. The following are some classifications of prehension patterns in the chronological order in which they were presented in the literature.

The beginning

Schlesinger in 1919 (apud Jain, Hennedy and Carus 1985) related six basic patterns of prehension: cylindrical, in point, on hook, palm, spherical and lateral. Later in 1947, of the University of Berkeley, Califórnia (Jain, Hennedy and Carus 1985), a study using kinematography identified three basic patterns of the six previous: palm, in point and lateral. Such studies were added to others (Griffths 1943; Napier 1956; Taylor; Schwarzs 1955 (apud Lehmkuhl; Smith 1989) Rash; Burke 1977 (apud Maluf 1986) and Lehmkuhl; Smith (1989) which used the shape of the object as the parameter to the classification.

Criteria for functional classification

Classification based on action

Alongside the classifications described, Napier 1956 (apud Maluf 1986) found that the movements of prehension should not be determined, only by the shape of the object, but also by the purpose of the action. Based on this finding a dynamic and functional aspect of prehension was described, with two basic factors: strength and precision. In the strength prehension, the object is pressed against the palm of the hand for the generation of force by the fingers and thumb. In the precision prehension, the object is manipulated between the thumb and the fingertips in a fine movement without the involviment of the palm.

In 1974, Bendz completed the system of Napier (apud Maluf 1986), proposed in 1956, including the flexor and extensor prehension.

Classification based on the contact area: hand-object

In 1980 Kapandji, taking into account the areas of contact between the object and the fingers and/or the hand, described the following types of grip: opposition terminal prehension, opposition subterminal prehension, opposition subtermino-lateral prehension, palm prehension in “full hand”, palm-digit prehension, interdigit lateral prehension.

Again Kapandji in 1987 (apud Pachioni, Loureiro and Fonseca 1992), improved the classification and grouped prehension in this way: 1) digitals, bidigitals and pluridigitals; 2) palm; 3) centrated. In another group, the prehensions with weight and actions prehensions were included.

Although there have been changes over time, there is still much confusion in the ranks. There is also some overlap between the patterns of the different classifications. Moreover, there seems to be a trend in the current literature to standardize and group the prehensions again in three forms already recommended by the study of Berkeley University in 1947 (apud Jain, Hennedy and Carus, 1985) and by Taylor; Schwatz 1955 (apud Lehmkuhl; Smith 1989). That is, although the systems have become increasingly complex and detailed, the forms most studied, probably because they are the most used, are the three basic forms of grip, namely: lateral, palm and pulp or edge (mainly between thumb and second finger)(Ager, Olivett and Johnson 1984; Mahiowetz 1985; Imrhan 1989; Imrhan 1992; Fernandez et al 1992; Imrhan; Rahman 1995).

Motor control of prehension

Cole and Abbs (1988) and Flanagan and Wing (1995) identified a parallel modulation of prehensile strength and strength to lift objects, independant of surface texture and frequency of movement. In the same way, Westling and Johansson (1988) described motor commands which varied with the load being handled. In this way it is believed that daily practice can lead to an adaptation of these commands, a phenomenon described as adaptive memory. Thus each time the weight is altered, the command is corrected (Sangole; Levin 2007).

It is believed that the perception of muscular contraction can be codified in the memory by two mechanisms: one from the pressure of the reaction occurring at the surface of the palm and fingers, which stimulates the mechanoreceptors of the region, and the other a kinesthetic model, generated from the muscular tension of the phalanx flexor muscles (Lowe, 1995). Thus, the sensory inputs reveal important functions in the control of movements, such as the modulation of the output of the muscles, optimizing the strength to be used (Cook; Woollacott, 1995).

Various individual factors have been recognized as capable of affecting prehensile strength in normal individuals, including age (Mathiowetz et al 1985; Imrhan 1989), sex and body posture (Catovic et al 1991; Fernandez et al 1992; Lamoreaux; Hoffer 1995). Other factors such as hand size and arm length, have also been associated with prehensile strength, although they are more controversial.

Also the posture used during prehension must be considered. The orthostatic position compared with seat and supine postures seems to facilitate higher strength levels be achieved in the prehension movement (Su et al 1994; Catovic et al 1989; 1991).

Evaluation of hand grip strength

Pereira et al (2001) said that grip strength can be used as an indicator of coordination development and helping in the diagnosis of neurological disfunctions related to the motor learning and to perception and also in the identification of arm, forearm and hand pathology, in the control of the reabilitation process and in the determination of suportable patterns in the aplicattion or sustentation of loads.

Evaluating prehension strength in children of 7 to 14 years, Esteves et al (2005) reported that several factors can influence strength production: age, laterality, practice in different physical activities, size of the grip, sex, height and body mass. These authors also enphazised that the values of prehension strength are maximal in the adult phase, about 25-35 years. After this period, there is a gradual decline.

In the same way, Barbosa et al (2006) exploring the relation between strength prehension and the nutritional state in elderly persons, concluded that there is a positive correlation between them. There are modifications in the nutritional state and muscle strength with the advance of age; the effects of the nutritional state on the muscle strength are specific to the nutritional indicator, to the sex and to the age group.

Some authors identified reduction in maximum strength and prehensile capacity in the presence of pain and musculoskeletal disorders (Smith; Benge 1985; Janda et al 1987; Niebuhr; Marion 1987).

Musculoskeletal disorders related to prehension

According to Putz-Andersson (1988) non-neutral postures of the wrist combined with forceful and repetitive movements are important risk factors for triggering upper limb work-related musculoskeletal disorders (WRMDs).

Muscle, tendon and nerve respond to dynamically varying local forces. The stresses generated under these situations were reviewed by Hagberg et al (1995). According to this review, both external (force exertion) and internal forces (from stretching or compression of the median nerve at the wrist) are hypothesized to be part of the mechanisms leading to WRMDs. Chronic disorders usually present more structural tissue damage. A decrease in the capacity to exert strength is one of the outcomes of tissue damage. Therefore, measurements of the hand grip strength are used as an indicator of impairment of the hand function.

Basic rehabilitation interventions

In abnormal neuromotor development we can find children without the adequate and necessary sensoriomotor experiences due to abnormal primitive reflexes and abnormal muscle tone. Consequently, in a special treatment, using recreational activities, including the handling of various types of toys (textures, shapes, weights, sizes), we must inhibit these reflexes to facilitate normal muscle tone. Moreover, to prepare the ground for the coordination of grip and precise handling, techniques of facilitation should be employed within the sequential development process (Duff; Charles 2004).

Similarly, when an adult suffers brain damage, the grip can also be damaged. The use of compensatory strategies for prehension may be related to the degree of motor impairment: severely to moderately impaired subjects recruited new degrees of freedom to compensate for motor deficits, while mildly impaired subjects tended to employ healthy movement patterns (Cirstea; Levin 2000). Through physiotherapy these patients may have an improvement in its grip with exercises that include strength, elongation, facilitation of weak and little active muscles and also the use of mental practice. In addition, placements and adequate incentives for the intense use of common prehensions in activities of daily living can be introduced. There is also the so-called Constraint induced therapy, which is based on restriction of the less affected arm allowing concentrated facilitation of the more-affected arm (Wolf et al 2008).

Diseases or injuries affecting the spinal cord, peripheral nerves or even the osteomyoarticular system can also compromise the use of prehensions. Again, several classes of exercises and even the use of functional electrical stimulation can result in improvement in the strength and accuracy of the various forms of grip. Some novel interventions can also be suggested: massed practice (repetitive activity-based training) and somatosensory stimulation (prolonged peripheral nerve electrical stimulation at submotor threshold intensity)(Beekhuizen 2005).

As commented before, a great number of lesions are related to the work, so many modifications have to be considered: repetition of the same task must be avoided, a rest period must be respected, the exercises practiced, specially elongations must be intense. In some cases the subjects have to change their work activity and also be submitted to a surgery with a long rehabilitation period. (Spielholz et al 2001).

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