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Evaluation of posttraumatic hand impairment and disability

Ocena pourazowej dysfunkcji i kalectwa ręki

Hand injuries are the most common body injuries. Despite management, permanent post traumatic hand impairment continues frequently. The aim of the study was to evaluate the permanent post traumatic hand impairment and disability. This study included 1287 patients treated due to hand injuries in the period of fifteen years. Severity of injuries was evaluated according to the Hand Injury Severity Score (HISS) by Campbell and Kay. Permanent hand impairment was estimated with the use of Swanson's examination protocol, quality of performing everyday activities - on the basis of an originally developed questionnaire Hand Disability Score (HDS). Strong correlations ($p < 0.001$) between severity of hand injuries, extent of permanent impairment and quality of performing everyday activities were found. Concluding, Swanson's examination protocol still constitutes a valuable tool for evaluation of post traumatic hand impairment. The presented HDS can be used for assessment of quality of daily activities in patients after hand injuries. Repeated examination with use of HDS can also be used for estimation the progress of rehabilitation.

Introduction

Hand injuries constitute a very important position in traumatology. They are very common injuries with an incidence among other injuries reaching 28% [1]. For this reason they are considered one of the most common types of body injuries [2,3]. Despite proper management of hand injuries severity of permanent impairment or disability can result, making return to previous occupation impossible and even impeding routine daily activities [4,5]. According to some authors, permanent post traumatic hand disability is more common and more severe as compared to other types of injuries [4].

Development of a protocol for evaluation of severity of permanent post traumatic hand impairment, introduction of an original method of assessment of quality of everyday activities performed following hand injuries as well as the clinical

value of those estimations were the aims of the study. Evaluation of a correlation between severity of hand injury, degree of post traumatic disability and quality of everyday activities was also intended by study.

Urazy rąk stanowią znaczącą część wszystkich urazów. Pomimo leczenia, ich częstym następstwem jest kalectwo pourazowe. Celem pracy była ocena kalectwa pourazowego i ograniczenia funkcji rąk w wyniku ich urazów. Badaniem objęto grupę 1287 chorych z obrażeniami rąk leczonych w okresie piętnastu lat. Ciężkość obrażeń ręki określono na podstawie Skali Ciężkości Urazów Ręki (Hand Injury Severity Score -HISS) Campbella i Kay'a. Rozmiar trwałego kalectwa pourazowego oceniono według metodyki opisananej przez Swansona. W oparciu o oryginalnie opracowaną metodę Hand Disability Score (HDS) dokonano oceny jakości wykonywania czynności codziennych przez tych chorych. Wykazano ścisły związek ($p < 0,001$) pomiędzy ciężkością obrażenia, rozmiarem trwałego kalectwa pourazowego oraz jakością wykonywania wybranych czynności codziennych. Opracowana przez Swansona metoda pozostaje nadal wartościowym sposobem oceny stopnia ograniczenia funkcji ręki pourazowej zaś HDS może być pewnym wykładnikiem jakości wykonywania czynności codziennych u chorych po obrażeniach rąk. Okresowe badanie HDS po zakończeniu leczenia chirurgicznego może być również wykładnikiem postępu leczenia usprawniającego.

Materials and methods

This study included 1287 patients treated due to hand injuries in the period of fifteen years. All patients were treated as emergency cases. The attempt of primary reconstruction of all injured tissue structures constituted the standard approach of treatment. Severity of injuries was assessed according to the Hand Injury Severity Score (HISS) by Campbell and Kay [6]. Long-term follow-up examinations were performed at least 18 months after completion of full course of treatment (including rehabilitation) assuming that this period was sufficient for total sta-

bilization of the function of the injured hand.

Evaluation of impairment of hand function was based on the widely used Swanson's examination protocol [7,8] with a few modifications. To facilitate calculation it was adopted that 1% of motor or sensory function of the hand equals 1 point. Thus maximal score for healthy hand was 100 points. To simplify scoring adduction and abduction of II-V fingers was omitted in evaluation, as in Swanson's study. Difference between maximal possible scoring (i.e. 100) and number of points obtained during follow-up examination constituted the basis for calculation of degree of hand impairment. Results were presented as a percentage of a norm (1 point equals 1%).

The thumb is responsible for 40% of hand value, index and 3rd finger for 20% each while 4th and 5th fingers for only 10% each. One half of hand function is represented by motion in metacarpophalangeal plus interphalangeal joints and one half by tactile sensation of fingertips. Therefore motor function of fingers constitutes half of their value. For the thumb this amounts to 20%, for the index and 3rd finger - 10% each, while 4th and 5th fingers - 5% each. Motor function of fingers 2-5 was evaluated using TAM test (Total Active Motion) assuming - according to work by American Society for Surgery of the Hand [9] - that full range (100%) of active motion of those fingers equals 2600. Total range of active motion (TAM) of particular fingers was calculated as a percentage of a norm and was presented as an appropriate number of points. Evaluation of motor function of the thumb was different. The most important motion of the thumb is opposition i.e. ability to turn back against the other four fingers. According to Swanson opposition determines 60% of motor value of the thumb. The remaining 40% of motor value is defined halfway by adduction and halfway by the movement in metacarpophalangeal plus interphalangeal joints. Thus, if motion of thumb constitutes 20% of hand function, and opposition equals 60% of this 20%, therefore opposition is 12% of hand function (meaning 12 points). Range of opposition was evaluated according to Swanson's examination protocol using measurement (in centimeters) of distance from the flexion crease of the thumb's interphalangeal joint on the palmar surface to the distal palmar crease of the third metacarpophalangeal joint. Assuming the distance of 8 cm equals 100%,

		aMP	aPIP	aDIP	TAM	%	pts		cm	pts
thumb	flexion							opposition		
	extension deficit							adduction		
2 nd finger	flexion							TAM 20% 40% 60% 80% 100%		
	extension deficit							thumb 0 1 2 3 4		
3 rd finger	flexion							2 nd -3 rd 2 4 6 8 10		
	extension deficit							4 th -5 th 1 2 3 4 5		
4 th finger	flexion							opposition:		
	extension deficit							0-2-4-6-8 cm		
5 th finger	flexion							0-3-6-9-12 pts		
	extension deficit							adduction:		
								8-6-4-2-0 cm		
								0-1-2-3-4 pts		

	Points (norm)	Normal sensation TPD < 6mm	Defective sensation TPD > 6mm	Anesthesia	Points
thumb	radial side	8			
	ulnar side	12			
2 nd finger	radial side	6			
	ulnar side	4			
3 rd finger	radial side	6			
	ulnar side	4			
4 th finger	radial side	3			
	ulnar side	2			
5 th finger	radial side	2			
	ulnar side	3			

Value of particular fingers after amputations	aDIP	aIP, aPIP	aMP
thumb		20 pts	0 pts
2 nd finger	9 pts	4 pts	0 pts
3 rd finger	9 pts	4 pts	0 pts
4 th finger	5 pts	2 pts	0 pts
5 th finger	5 pts	2 pts	0 pts

Motoric function:	Sensory function:	Together:
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Figure 1
Chart of clinical evaluation of post traumatic hand impairment.

Table I
Age and gender of examination patients group.

Gender	Together		M		F	
	n	(%)	n	(%)	n	(%)
	1287	100	1035	80,42	252	19,58
Age	x ± SD [min - max]		x ± SD [min - max]		x ± SD [min - max]	
	37 ± 15.8 [14 - 97]		37 ± 15.4 [14 - 97]		38 ± 17.4 [14 - 89]	

results of examination were presented as a appropriate number of points: from 0 (in cases of lack of opposition) to 12 points (in cases of full range of opposition). The method of evaluation of adduction of thumb was similar.

According to formerly presented calculations, thumb adduction determines 4% of hand function. The range of this motion was also evaluated according to Swanson's examination protocol as a distance from the palmar crease of the interphalangeal joint to the distal palmar crease of fifth metacarpophalangeal joint. Distance of 8 cm was assumed to be

0% of adduction while 0 cm - 100% (inversely to the opposition), thus equaling 4 points. Remaining 20% of motor function of thumb was determined by the motion in metacarpophalangeal plus interphalangeal joints. The range of such movement was assessed in a healthy hand in 50 patients who visited our outpatient department. The average range of this motion reached 1400 and this value was used as a norm for further study. Numerical points from 1 to 4 were assigned to appropriate percentage of range of this motion.

Sensor function of fingertips was qu-

	I've always performed this activity with the use of the other hand	If a dominant hand has been injured (i.e. right for righthanded and left for lefthanded)		
		Skilful performance	Performance with some difficulty	Necessity to use the other hand for performance
washing				
toothbrushing				
shaving/make-up				
turning on and off the faucet				
use of aerosols				
use of fastener				
use of cutlery – spoon, fork				
cutting with the knife				
pouring water				
holding a glass				
picking up a coin				
handwriting				
hand stitching				
leafing through a book, newspaper, magazine				
using scissors				
plugging into socket				
locking and unlocking with a key				
carrying shopping bag, briefcase, suitcase				
	Skilful performance	Performance with some difficulty	Inability to perform	
putting on socks, stockings				
buttoning and unbuttoning				
tying shoelaces				
peeling potatoes				
unwrapping or lighting a match				
wringing out the washcloth				
typing				

Figure 2
Chart of evaluation of quality of hand in daily activities - Hand Disability Score.

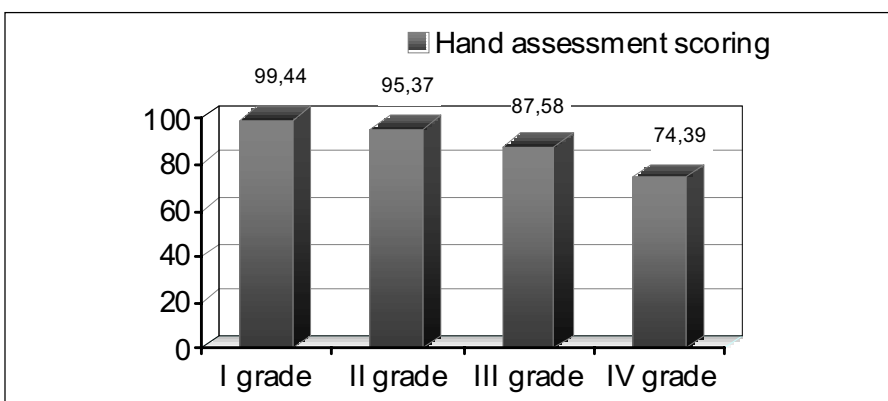


Figure 3
Correlation between severity of injuries and assessment of hand function.

alified according to Swanson's examination protocol. It was evaluated using a simplified two-point discrimination test (TPD), with only three values: normal sensation (TPD<6 mm), defective sensation/handicapped sensation (TPD>6 mm)

and anesthesia. Defective sensation scored half of number of points attributed to normal sensation.

In cases of amputation assessment of value of particular fingers after different levels of amputation followed precisely

Swanson's examination protocol with only one exception. Cases of peripheral amputation with preserved motion of distal interphalangeal joint of the stump scored half of the number of points attributed to amputation of whole phalanx. These patients did not require additional assessments.

Total number of points obtained from evaluation of all motor and sensory functions was subtracted from 100, thus resulting in a number reflecting severity of impairment of hand function.

The chart for clinical evaluation of posttraumatic hand impairment is presented in figure 1.

Quality of performing everyday activities was evaluated on the basis of an originally developed questionnaire (fig. 2), named Hand Disability Score (HDS) [10]. It included 25 different daily activities performed with one or both hands and requiring basic hand holds. The questionnaire was specially designed to make the patients decide which one hand to use, since some activities may be performed using hands interchangeably [11]. As time passed from injury, patients adapt to some degree of impairment and some activities impossible to be completed during convalescence become performable with adaptation to altered conditions. It was assumed that after 18 months from a completion of a full course of treatment some difficulties in the use of hands become permanent.

Activities performed skillfully and those performed always using the other, healthy hand scored 4 points. Activities performed using injured hand but with some difficulty scored 2 points. Necessity to use the other hand for some activities scored 1 point, because the activity was performed but with use of non-dominant hand. Proficient performance of two-handed activity scored 4 points, while its performance with some difficulty scored 2 points. Inability to perform two-handed activity did not score. Maximal possible score was 100 points [10]. Collected data was subjected to statistical analysis.

Results

There were 1035 male (80.42%) and 252 female (19.58%) patients in the study group of 1287 patients. Mean age was 37 ± 15.8 years and ranged from 14 to 97 years. Mean age of women was slightly higher (38.4 years) than men (36.6 years) (table I) [12].

There were 587 patients (45.61%)

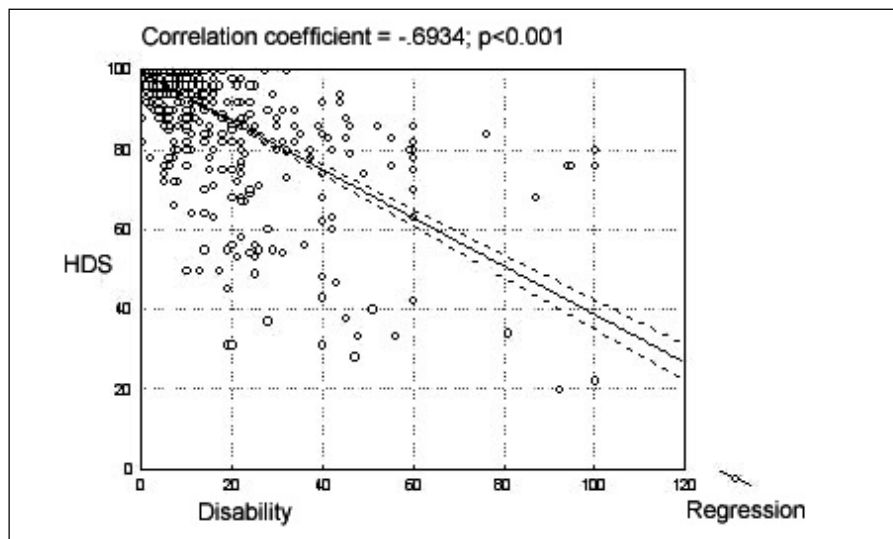


Figure 4
Extent of permanent disability and points scored by patients in the evaluation of function of hand in daily activities (HDS).

Table II
Severity of injuries of examination patients group.

Severity of injuries	Number of patients	Percentage
I (slight)	587	45.61%
II (moderate)	384	29.84%
III (medium to severe)	220	17.09%
IV (severe)	96	7.46%
Together	1287	100%

Table III
Confluence of severity of hand injuries to assessment of hand function on HDS scale.

Severity of injuries	I	II	III	IV
Number of patients: 1071	528	302	165	76
Assessment of hand function (/100 points)	99.44	95.37	87.58	74.39
Univariate analysis: F = 162.05; p < 0.001				

with injuries assessed as slight injuries (1st grade) in the study group. There were 384 patients (29.84%) suffering from moderate injuries (2nd grade), 220 patients (17.09%) with medium to severe injuries (3rd grade) and 96 patients (7.46%) with severe injuries (4th grade) included in the study (table II).

Long-term follow-up was performed on 1071 patients (83.22% of all treated). Evaluation of motor and sensor hand function was performed in every patient according to the Swanson's examination protocol with a few local, previously mentioned modifications. Functional motor, sensor and both motor and sensor impairment of different degree was found in 626 patients (58.45% of examined). The level of hand impairment ranged between 1% and 100% (on the average 13.6%) [13].

The study confirmed formerly demonstrated statistically significant association between severity of injury, localization

and the level of permanent post traumatic disability ($p < 0.001$). Post traumatic impairment in the form of permanent limitation of hand function had strong influence on return to preinjury activity or profession ($p < 0.001$) [5,12].

Results of scale (HDS) evaluating function of hands in daily activities were compared with severity of injuries. Statistically significant ($p < 0.001$) correlation was found between severity of injuries and quality of daily activities performance regardless of which hand (dominant or non-dominant) became injured. Patients with slight injuries (1st grade) showed skillful performance of daily activities without difficulties and limitations (mean score 99.44 points). Patients suffering from moderate injuries (2nd grade) scored on the average 95.37 points. Patients with medium to severe injuries (3rd grade) were able to perform daily activities with some difficulty (mean score 87.58 points), while patients suffering from se-

vere injuries (4th grade) scored only on the average 74.39 points (table III, figure 3).

Comparative analysis of extent of permanent disability and points scored by patients in the evaluation of function of hand in daily activities (HDS) was performed. Statistically significant correlation between the level of impairment and quality of performance of daily activities was found - the more severe impairment, the worse function of hand in everyday activity was found ($p < 0.001$) (fig. 4) [10].

Discussion

Swanson's examination protocol [7,8] was used for objective evaluation of motor and sensor function of the hand. It was partially modified in order to obtain a more precise assessment of limitation of those functions and ability to sum up particular deficits. Though Swanson's examination protocol was published 25 years ago it still constitutes in our opinion a valuable tool for evaluation of post traumatic function of the hand.

Strong correlation was found between severity of hand injury and the level of permanent post traumatic impairment, allowing prediction of extent of disability from the time of initial management right after definitive assessment of severity of injury [5]. Similar conclusions were found by Mink van der Molen in a study evaluating usefulness of HISS scale by Campbell and Kay [14]. This can be important in qualifying patients for early psychotherapy preparing them gradually for the problem of permanent impairment of injured hand after completed treatment. On the other hand this can be useful in selection of suitable occupational therapy for training in different activities or a new profession.

A questionnaire for assessment of quality of daily activities performed with one or both hands (HDS) was designed to address different hand functions with the use of all basic hand holds - including those usually performed with the use of both hands. Impairment of dominant and non-dominant hand was assessed together, for some activities are performed by different patients with the use of one or the other hand [11]. E.g. left-handed people sometimes use right hand for writing or for other activities. An individual, who is left-handed, writes using right hand (thus injury of left hand wouldn't impair his writing), while he draws only with the left hand. For this purpose there is a section: "I've always performed this activity with the use of the other hand" in

our questionnaire. With time passing from injury and after adaptation to altered conditions, a healthy hand can take over some activities performed formerly with the injured hand. Moreover, a dominant hand is not always used for the most precise activities - e.g. hammering the nail is usually performed with non-dominant hand holding the nail, while the dominant hand is used to hammer. Due to above mentioned possibilities Absoud and Harrop stated that the significance of whether an injury affected a dominant or non-dominant hand should not be the only prognostic factor of extent of hand impairment in daily activities [15]. Therefore examination using HDS questionnaire assesses function of both hands.

Selection of particular daily activities was to a certain degree based on evaluation of hand function performed by Jebesen [16]. Yet time necessary to perform those activities was not a part of examination because precise determination of a norm is technically difficult, for different people spend different time performing them. Moreover the most important factor of quality assessment is the subjective judgment of the patient and not the examining physician. Some included daily activities were formerly used in different questionnaires assessing quality of life [17,18, 19]. A number of selected activities were determined only in order to facilitate calculations. Maximal possible score was 100 points with normal function of both hands. Our questionnaire was developed independent of The Hand Function Scoring System (HFS) publi-

shed in 1998 by Watts et al. created for assessment of progress in rehabilitation [20].

According to Rondinelli there is no precise correlation between post traumatic impairment of hands and quality of activities performed with their use [21]. Probably this results from different abilities of adaptation to altered (limited) physical efficiency/fitness presented by different patients. Our statistical analysis - demonstrating a strong correlation between HDS score and both severity of injury and extent of post traumatic impairment - substantiates our recommendation for the use of HDS in assessment of quality of post traumatic hand function. Repeated examination with use of HDS can also be used in monitoring of progress of rehabilitation.

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