

THE DIFFERENCES IN ACTIVATION OF CHOSEN MUSCLES DURING BREAST STROKE SWIMMING STYLE BY HANDICAPPED SWIMMERS A2

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Abstract

In the report we focus on comparison of each case studies of analysis of breast stroke swimming style by handicapped swimmers with over-knee amputation. The aim was to find out the stability of performance of each step, cycle (drive) by breast stroke swimming style and then to describe involving of chosen muscles by performance of each cycle at chosen group. Monitoring of kineziological contents of movement of chosen muscles was done by comparing analysis with help of qualitative analysis of video recording and on the base of quantitative comparison of intensity of electric possibility of chosen muscles.

Monitored unit contained four swimmers, two men and two women, at age of 22 – 30. In the time of the research only these swimmers attended swimming races of disabled people in the Czech Republic in category A2. Results show asymmetrical activity of chosen muscles (m. pectoralis major, m. trapesius a m. obliques). Monitored people show stable performance of skills in individual comparison. Electric activity of chosen muscles is similar in comparison of each attempt.

Keywords: handicap, swimming, breast stroke swimming style, EMG, A2

Introduction

Movement activity belongs to an important means of support and stabilization of health, socialization and enrichment of quality of human life. All movement activities in water area bring undisputedly big contribution not only for healthy population, but also for disabled people. In professional literature, especially in foreign languages, we can read about distinctions of learning swimming of disabled people (Lockett and Keyes, 1994), but only small part concerns realization of movement activities in water area by people after amputation of legs.

The need of movement is one of the most important needs of either healthy or disabled people. Therefore it is very important to search and support activities of interest. Sport activity provides big opportunities in this area, of course.

Integration of disabled people into society is a long time and exacting process. It depends on creation of suitable conditions from a part of society, it means „require of a complex care“. Movement activities influence positively involvement of disabled person into society, they

help overcome loneliness, reserve, shyness. Sport activity, performed on any level, is for this point of view one of few possibilities how to overcome psychical, social and physical problems of disabled person.

It is clear, that regular sport activity helps with general development of body and intellectual abilities of person and it is not decisive if the person is healthy or somehow handicapped. We think, that just swimming and all movement in water area, which brings a big range of movement activities, can offer sport joy even to the most disabled people, if the ways are modified correctly. Modified didactic ways taken from methodology of non-handicapped, suitably adjusted and dosed, can work as part cure.

Generally, swimming training of handicapped people can be considered as positive especially for its increase of movement scale, stretching of shorten muscles, increasing of muscle power, improvement of movement coordination and area orientation in water area. People after amputation of leg or legs must learn to adapt to change of centre of gravity, which is caused by losing of leg and it leads to asymmetry of body.

By losing one leg, the centre of gravity moves to the healthy part and over. The change of the centre of gravity causes overturning, which is necessary to balance by own effort, which can be seen by managing of basic swimming skills, especially swimming positions and swimming locomotion.

In time-space solution of duration of swimming cycle of a swimmer with a leg amputation there exist bordered time phases, where main movement activities are performed. Optimum of time and space solution influence performance in a race. We suppose, that the best time will be reached by those racers who have higher percentage of phases, which are important for effectiveness of pull in technical solution of swimming cycle (position of body, pull of arms, pull of legs).

In this work we will show by EMG, to variability in swimming mode of disabled swimmers with over-knee amputation at the same classification group A2 according to IPC-SAEC/SW (International Paralympic Committee – Sport Assembly Executive Committee- Swimming).

Researches with using of electro-myograph in swimming showed big improvement in last century, by using surface electrodes dealt by Ikai. In 1964 they informed about involvement of surface muscles at swimming by crawl. They focused on the phase of pull, where the main pulling power comes from, which is the most important for swimming performance (Ikai, Ishii, Miashyta, 1964). T. Okamoto and S. L. Wolf (1979) show methods of measuring EMG in water area by hung systems, where appear problems with arte-facts, coming from faults on leading between the surface of electrode and scanner. They describe the ways of connection and fixing of electrodes to the body of swimmer. Their researches rather lead to watching of crawl kick and comparing of crawl legs with movement figure of walking. Deschold, Rouard (1999) concerned the relative replacement of shoulder, elbow and wrist joint. Their studies were based on Counsilman and Maglich, but they mostly took care of trajectory of movement of mentioned joints at swimming by crawl. The research did not take too much care about direct involvement of muscles during the movement. G. Piette and J.P. Claris (1979) watched izometric and dynamic contraction of chosen muscles at swimming by crawl. The research was dealt on top swimmers and on average swimmers. BY analysis of quantity and quality they acknowledged figure of movement at swimming by crawl. The results showed big differences in watched sample. Muscle activity of rotators of shoulder joint did not show the best figure of movement. Also Hamilton, Luttgenser (Čechovská 2003) concerned about analysis of muscle activity by EMG, connection and rate of muscle activity in technique of swimming ways, each phase and its length. Pánek and Pavlů (2010) point at methodology of recording EMG at present by portable EMG.

1 Swimming style breast stroke

1.1 Critical places in swimming style breast stroke

Critical place I

We define as a moment when head and shoulders raise up the water surface as much as possible. It is the end of pulling phase, where is consecutive flexion in elbow joint, whereas arms pull athwart down. Pulling places are palms and inner parts of forearm. Flexion of elbow joint is changed during pulling phase. The biggest is 90 –100 degrees. At the moment, when arms reach the level of elbows, swimmer draws quickly bended arms under chest. Elbows nearly touch each other at this time.

Critical place II

We define as a moment when head goes down under the water surface. It is beginning of stretching phase and it is characteristic by rapid pulling out of arms ahead and dipping of head under the surface.

1.2 Some specifics of monitored locomotive activities

Pull of swimming style breast stroke: at swimming style breast stroke we pull by palms and forearms of both arms. By catching the support, which is made by palms in water area, the pull is made to place of support by arm. Palms and forearms make punctum fixum at this moment, the swimmer – makes punctum mobile. PF is only virtual, in water area it is not possible to formulate properly. Acral parts of land vertebrates have only small area, which is enough for support on firm surface. Important: in forward direction arms move against contradiction of water area in phase of transfer. M. trapezius cooperates at the beginning of pull on centration of blade bone with m. serratus anterior, pars medialis, massive activation in second half responses to pushing blade bone forward in phase of transfer of arm against contradiction. This phase can be seen as completely different from other kinds of locomotion realised by shoulder braid, just because of contradiction at transfer of arms forward. Also m. pectoralis major shows by its activation to work of slant muscle chain on front part of trunk. Second wave of activation m. pectoralis major appears in time, when arm makes transfer in shoulder for next pull. M. trapezius, pars medialis shows enormous increase of activity in final phase of drawing of arm to the palce of support, when the blade bone is involved in locomotion work of whole shoulder braid. M. obliques Mm. Obliqui abdomini - Symmetrical locomotion movement in water area is an alternative human locomotion, in which is ot realised crossed locomotion pattern if the right technique is applied. Mm. Obliguui work in function to fix the trunk, connection of trunk with pelvis and at balancing of locomotion work mm. Latissimi dorsi. Through mm. Obliguui is transmitted locomotion work of shoulder braid to pelvis. At racing swimming style of breast stroke it participates on retro-reflexion of pelvis at defect (limited by rules) dolphin waving.

2 Type of research

It is description of movement stereotype of pulling arms at swimming style breast stroke by measuring EMG at chosen probands. By quality analysis (Knudson and Morisson 1997) we define in each cause critical places and their description of using each muscle by EMG. The measurement was done at swimming style breast stroke. The length of measured part was 25 metres. The part was swum by middle intensity.

2.1 Monitored people

Four handicapped swimmers of group A2 (over knee amputation) took part in this research. Their characteristic is mentioned in tab 1

Tab. 1 *Monitored set*

| | | | | |
|------------|------|------|-------|-------|
| gender | man | man | woman | woman |
| Age | 37 | 31 | 20 | 21 |
| Weight | 107 | 75 | 43 | 50 |
| amputation | left | left | right | right |

2.2 Methods

The basic method was measuring of electro-myographic signal (EMG) by surface electromyography (SEMG). Consequently there was made synchronized video record for evaluation of movement by quality analysis of movement skills. Measurement was done at those muscle groups providing arms by swimming style breast stroke. There was used portable measuring device with 7 channels for scanning EMG potentials, 1 working channel for synchronizing of video-recording. The weight with batteries and sport bag was 1.4 kg. Regulation of sensitivity 0.05 – 2 mV, adjustable length of measurement in interval of 5 sec – 4 min 50 sec.

2.3 Monitored variability

There was a search of muscle chain with following muscles - m. trapezius pars medialis dx., m. trapezius pars medialis sin., m. pectoralis major dx. pars sternalis, m. pectoralis major sin. pars sternalis, m. obliquus abdominis externus sin., m. obliquus abdominis externus dx.,

2.4 Time analysis

Based on defined beginning and end of units of analysis (establishing of critical places) we made rough estimation of the length of lasting each step by time analysis of video-recording.

Synchronisation of EMG recording with video-recording

After establishing of comparing unit (attempt) we established synchronised beginning of unit of analysis by auto-correlation (Konrad, 2009). Based on choice of highest possible correlation between the result of comparing unit and chosen unit of analysis we established the beginning of EMG recording.

Normalization of data

According to the fact, that units of analysis had various time lengths, it was necessary to normalize data by conversion to percentage time axis (Konrad, 2009). The conversion of units into percentage was done by averaging of data in interval response to one percent in each analysed unit of analysis. By this we got an opportunity to compare quantitatively recordings of EMG in each unit of analysis.

3 Results and discussion

In first part we show chosen results, which approve stability of attempts in each step. In tab 2 there are average correlations of the same muscles at various measurements. As it is seen from average correlation, various correlation coefficients reach high values. However

coefficient of determination is better characteristic for evaluating interact relation, which is shown in tab. 3.

Tab. 2 Coefficient of autocorrelation between steps

| Coefficient of autocorrelation between steps | | | | | | | | |
|----------------------------------------------|---------|-------|---------|-------|---------|-------|---------|-------|
| Muscles | A | | B | | C | | D | |
| | average | SD | average | SD | average | SD | average | SD |
| Lat.dx | 0,771 | 0,177 | 0,853 | 0,069 | 0,890 | 0,063 | 0,806 | 0,069 |
| Lat sin | 0,371 | 0,328 | 0,888 | 0,090 | 0,899 | 0,045 | 0,716 | 0,114 |
| obliq dx | 0,444 | 0,275 | 0,508 | 0,209 | 0,877 | 0,093 | 0,674 | 0,167 |
| obliq sin | 0,737 | 0,121 | 0,396 | 0,271 | 0,761 | 0,112 | 0,561 | 0,161 |
| pect dx | 0,629 | 0,272 | 0,424 | 0,180 | 0,843 | 0,096 | 0,716 | 0,093 |
| pect sin | 0,415 | 0,272 | 0,615 | 0,127 | 0,826 | 0,124 | 0,895 | 0,033 |

Tab. 3 Coefficient of determination at all monitored swimmers

| Muscles | A | B | C | D |
|-----------|----------|-----------------|-----------------|----------------|
| | average | average | Average | average |
| Lat dx | 0,59436 | 0,727357 | 0,791667 | 0,650342 |
| Lat sin | 0,137823 | 0,789263 | 0,807629 | 0,51226 |
| obliq dx | 0,197403 | 0,258088 | 0,769176 | 0,453904 |
| obliq sin | 0,542544 | 0,156438 | 0,579522 | 0,315012 |
| pect dx | 0,396118 | 0,180081 | 0,710529 | 0,512767 |
| pect sin | 0,172139 | 0,378676 | 0,68253 | 0,80127 |

Coefficient of determination practically shows, what percentage from results B it is possible to estimate from results A. The results show big stability of performance especially at swimmers B and C. At swimmer it also corresponds to the results of kineziologic analysis, which is mentioned below. As review we show only normed chart of electric activity m. pectoralis major sin. (Fig. 1), where the curve in the middle is the average, and the upper and lower curves are plus, minus decisive variation from this average. In Picture 1 just for review we show duration of coefficient of variability and duration of electric activity at all monitored attempts of swimmer D by m. pectoralis major sin.

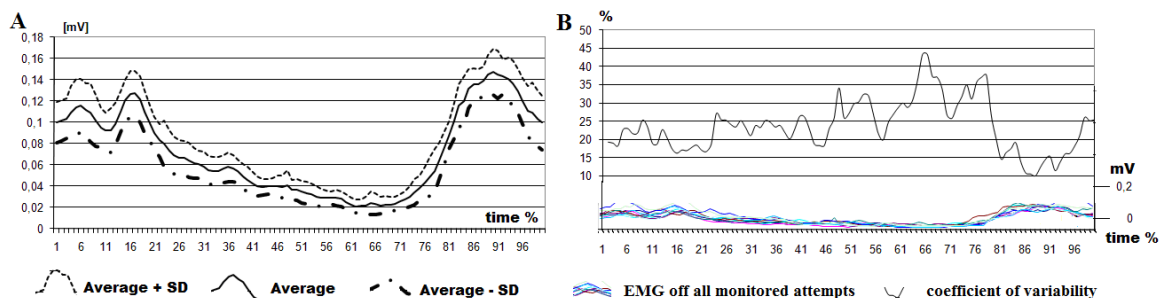


Fig. 1 Chart of average EMG curve m. pectoralis major sin. and duration of coefficient of variability

For entirety and comparison of size of effect we show coefficient of variability in chart 3, which was counted from all attempts of monitored swimmers.

Tab. 4 Coefficient of variability at all monitored swimmers

| Muscles | Coefficient of variability | | | | | | | |
|------------|----------------------------|------|---------|------|---------|------|---------|------|
| | A | | B | | C | | D | |
| | average | SD | average | SD | average | SD | average | SD |
| Lat dx. | 41,9 | 18,6 | 27,4 | 9,6 | 16,3 | 5,8 | 21,5 | 7,3 |
| Lat sin. | 29,5 | 8,2 | 23,8 | 4,9 | 17,8 | 5,1 | 51,1 | 17,8 |
| obliq dx. | 32,9 | 9,2 | 31,5 | 13,6 | 23,2 | 7,5 | 28,1 | 6,3 |
| obliq sin. | 27,9 | 5,8 | 32,8 | 11,4 | 24,8 | 5,8 | 30,1 | 7,8 |
| pect dx. | 32,6 | 14,7 | 25,5 | 9,1 | 25,3 | 8,5 | 24,5 | 8,9 |
| pect sin. | 37,6 | 10,9 | 31,8 | 8,4 | 27,7 | 12,8 | 23,6 | 7,1 |

Results achieved by correlative coefficient (coefficient of determination) show the relation between two results in total performance. On the contrary the results of coefficient of variation show the size of changes in each measurement. It is relation between the average of measurement in given time moment and decisive variation of these measurements. It shows percentage portion of decisive variation to average of measurement in given time moment. These result (Tab. 4) show relatively same involvement of chosen muscle groups, which responds to choice of monitored people.

In second part of results we show in form of charts results of description of burden of chosen muscles by EMG. For considering of swimming style breast stroke based on electric activity of chosen muscles we show complete results in form of charts, where there is shown duration of average EMG at pair of symetrically marked muscles in each chart. Full line always shows duration of right muscle and intercepted curve shows duration of muscle in left side of body.

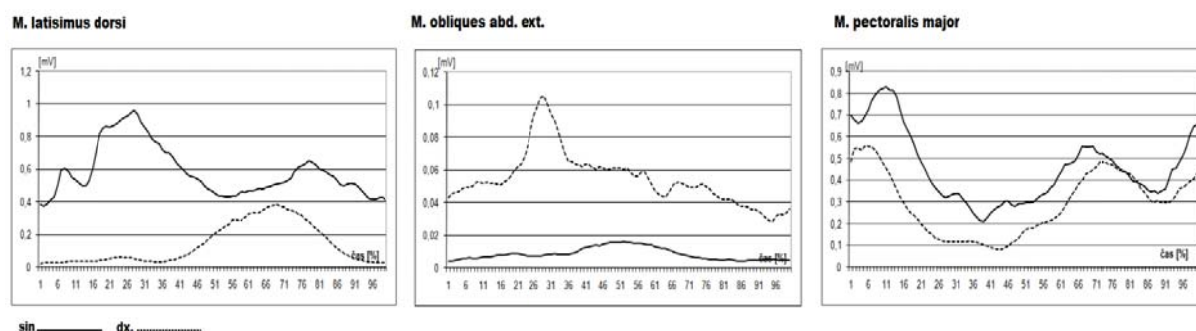


Fig. 2 Graphical demonstration of duration EMG at monitored pairs of swimmer A

Amputation of left leg causes polarizatin of propulsive work of important propulsive muscles in advantage to homolateral muscle m. latissimus dorsi sin. Significantly asymetrical work of mm. Latissimi dorsi is caused by diagonalizatin of upper part of swimmer's body to the left side of the body, the side of missing leg. Mm. Obliqui are activated reciprocally for balancing of asymetry of body on haemal side of trunk. M. obliquus abdominis sin shows lower part of involvement, does not connect complete part of moving set. Mm. Pectorali work in symetrical regime with phase movement responding to bevel lengthways axis of the body towards to result trajectory of locomotion. Contraction of huge inner rotators of right shoulder joint (m. latissimus dorsi dx a m. pectoralis major dx) in second part of average working cycle causes inner rotation in shoulder joint, which cannot be prevented because of weak outside rotators m. infraspinatus a m. teres minor.

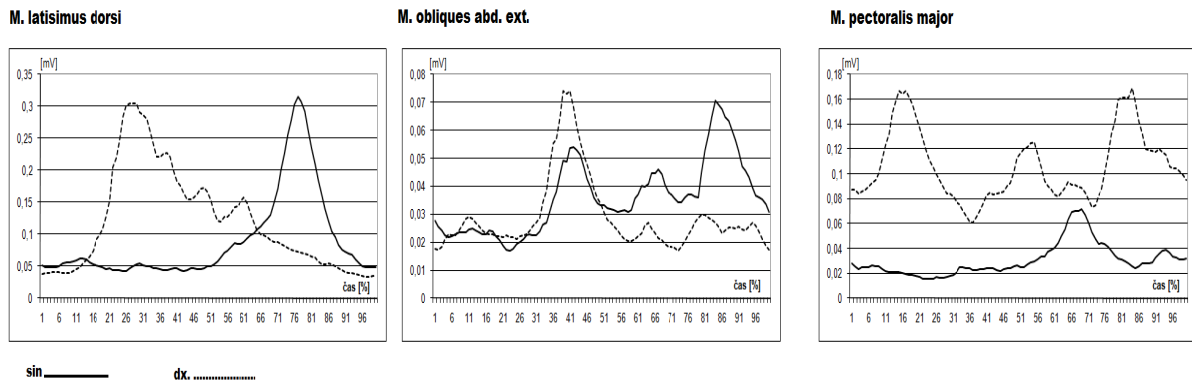


Fig. 3 Graphical demonstration of duration EMG at monitored pairs of swimmer B

Amputation of left leg causes opposite phenomenon in comparison with previous proband by timing mm. Latissimi dorsi. M. latissimus dorsi dx makes propulsive power for whole part of the body (without amputation), swimmer's lengthways axis is not misaligned so much from result locomotion trajectory. So in phase of pull of arms contra lateral m. latissimus dorsi dx is actively silent. This condition responds to the absence of same side muscle on haemal part of the trunk m. pectoralis major sin. This dominant trend of same side actin is added by contraction m. latissimus dorsi dx and homolateral m. obliquus abdominis externus dx in phase of movement of arms. After balancing of affect of these two muscles in their local maximum, we can find the action of contra-lateral m. obliquus abdominis externus dx. First same local maximum mm. Obliqui follows to propulsive action of arms, again on non-limited part of the body we can find bigger increase in amplitude EMG signal.

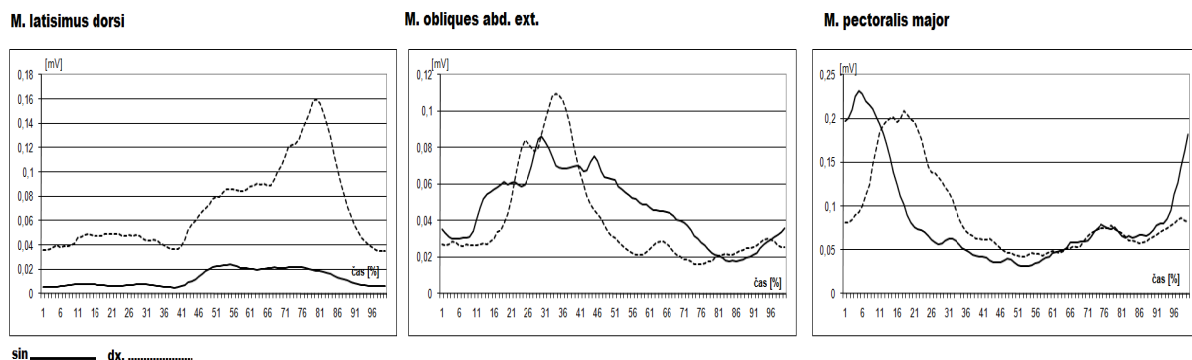


Fig. 4 Graphical demonstration of duration EMG at monitored pairs of swimmer C

At proband with amputated right leg we can find relative lateral symmetry of activation of monitored muscles. In phase of pull of arms mm. Latissimi dorsi are not activated on both sides. Propulsive work is done by adductors on haemal side of the trunk, which is followed by activation of mm. Obliqui abdomini, in the same order of start of main muscle activation. It means left first, then right side. Because of this there is misalignment of lengthways axis of the body regarding to trajectory of locomotion to right side. Creativity of propulsive power on haemal side of the trunk means, that pull is led more under the body, where is weaker possibility to use mm. Latissimi dorsi. These dorzale muscles are activated in phase of movement of arms and therefore they draw pelvis and trunk to future part of support. So postural characteristics will rather tend to hyper-extension, (dorzale flexion or backward bend) of the trunk.

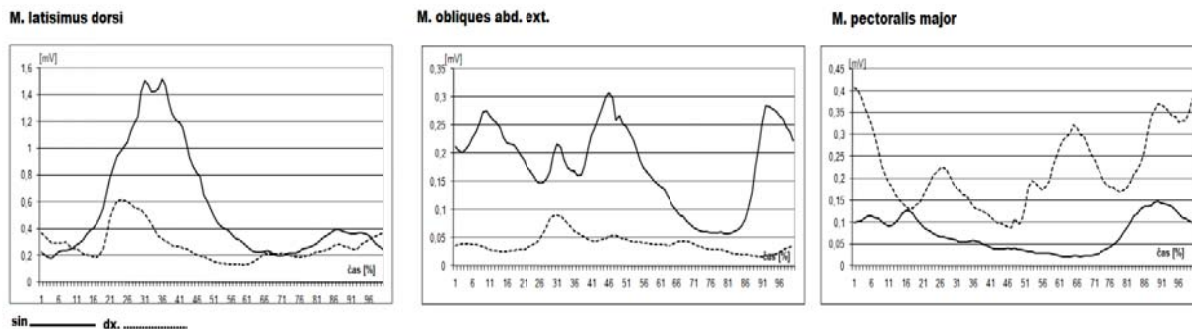


Fig. 5 Graphical demonstration of duration EMG at monitored pairs of swimmer D

At next proband with amputated right leg we find very dynamic balancing of post-operated asymmetry of movement set. It is rather a type of pull with dominated side, where leg is, as it comes from EMG curve of muscles m. latissimus dorsi sin a m. obliquus abdominis externus sin. Both side actions of locomotion muscles of shoulder braid, mm. Latissimi dorsi is apparent in phase of pull of arms. This action is balanced by activation of contra-lateral m. pectoralis major dx, where proband keeps movement set in direction of locomotion. Asymmetry of movement set is shown in timing of mm. Obliqui abdomini. From comparison of levels of amplitude of local maximums and local minimums of these muscles it is clear lower activity of right side, that side, where the amputated limb is missing. There are similar results in work of mm. Pectorali majori.

Conclusion

Probands with significant asymmetry of movement set, given by amputation of one limb solves the situation for keeping the direction of locomotion in two basic ways. Either it burdens whole movement set more on unbroken side of body with keeping of length-ways (in standing – vertical axle of body in direction of locomotion or in contrary it diagonalizes the upper part of body to the side of the amputated limb.

Phenomenon of missing activation of decisive muscle for propulsive show at locomotion through shoulder braid – muscle m. latissimus dorsi is considered as general and does not have to concern only people with healthy disability. It goes together with transmission of locomotion function from dorzale into haemal part of trunk and with position of trunk in area of pectoral and lumbar backbone bearing semi-flexion – extension – hyperextension.

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ROZDÍLY V AKTIVACI VYBRANÝCH SVALŮ V PRŮBĚHU PLAVECKÉHO ZPŮSOBU PRSA U HANDICAPOVANÝCH PLAVCŮ SKUPINY A2

V příspěvku se zabýváme porovnáváním jednotlivých případových studií analýzy plaveckého způsobu prsa u handicapovaných plavců s nadkolenní amputací. Cílem bylo zjistit stabilitu provedení jednotlivých cyklů (záběrů) u plaveckého způsobu prsa a dále popsat zapojení vybraných svalů při provedení jednotlivého cyklu u vybrané skupiny. Sledování kineziologického obsahu pohybu vybraných svalů se uskutečnilo formou srovnávací analýzy pomocí kvalitativního rozboru videozáznamu a na základě kvantitativního porovnání intenzity elektrického potenciálu vybraných svalů. Sledovaný soubor tvořili čtyři plavci, z toho dva muži a dvě ženy, ve věku 22 – 30 let. V době výzkumu se pouze tyto plavci zúčastňovali závodů v plavání tělesně postižených v ČR v kategorii A2. Výsledky ukazují na nesymetrickou aktivitu vybraných svalů (m. pectoralis major, m. trapesius a m. obliques). V intraindividuálním porovnání vykazují sledované osoby stabilní provedení dovedností. Elektrická aktivita vybraných svalů je při porovnání mezi jednotlivými pokusy podobná.

UNTERSCHIEDE BEI DER AKTIVIERUNG VON AUSGEWÄHLTEN MUSKELN IM VERLAUF DES BRUSTSCHWIMMENS BEI BEHINDERTEN SCHWIMMERN DER GRUPPE A2

In dem Beitrag beschäftigen wir uns aufgrund eines Vergleichs einzelner Fallstudien mit Analysen des Brustschwimmens bei behinderten Schwimmern mit Oberschenkelamputation. Das Ziel war es, die Stabilität der Durchführung der einzelnen Zyklen (Schwimmzüge) beim Brustschwimmen festzustellen und weiterhin das Einsetzen der ausgewählten Muskeln bei der Durchführung eines einzelnen Zyklus bei der ausgewählten Gruppe zu beschreiben. Die Beobachtung des kinesiologischen Inhalts der Bewegung der ausgewählten Muskeln wurde in Form einer Vergleichsanalyse mit Hilfe der qualitativen Analyse einer Videoaufnahme und auf der Grundlage eines quantitativen Vergleichs der Intensität des elektrischen Potentials der ausgewählten Muskeln durchgeführt. Die Versuchsgruppe bestand aus vier Schwimmern, zwei Männern und zwei Frauen im Alter von 22-30 Jahren. Im Untersuchungszeitraum nahmen nur diese Schwimmer an den Schwimmwettbewerben für Menschen mit Behinderungen in der Kategorie A2 in der Tschechischen Republik teil.

RÓŻNICE W PRACY WYBRANYCH MIĘŚNI W TRAKCIE PŁYWANIA ŻABKĄ U OSÓB NIEPEŁNOSPRAWNYCH Z GRUPY A2

Artykuł dotyczy jednego studia przypadków obejmującego analizę porównawczą pływania żabką u osób niepełnosprawnych z amputacją nogi powyżej kolana. Celem było sprawdzenie stabilności wykonania poszczególnych cykli stylu "żabka" oraz opisanie udziału wybranych mięśni w wykonaniu danego cyklu w wybranej grupie osób. Obserwacje kinezyologicznego zakresu ruchu wybranych mięśni prowadzono w formie analizy porównawczej przy pomocy jakościowej analizy zapisów wideo oraz na podstawie ilościowego porównania natężenia potencjału elektrycznego wybranych mięśni. Badania prowadzono na grupie czterech osób, dwóch mężczyzn i dwóch kobiet w wieku 22-30 lat. W czasie badań osoby te uczestniczyły w zawodach pływackich osób niepełnosprawnych w Czechach w kategorii A2. Wyniki wskazują na niesymetryczną pracę wybranych mięśni (m. pectoralis major, m. trapesius a m. obliques). W porównaniu intraindywidualnym badane osoby wykazują trwałą poprawę umiejętności. Aktywność elektryczna wybranych mięśni była u porównywanych osób w poszczególnych próbach podobna.