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COMPARISON OF THE MUSCLE ACTIVITY DURING THE RUN WITH ONE OR BOTH STABILIZERS IN HANDICAPPED SKIERS OF THE GROUP LW2

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SUMMARY

The paper compares the EMG activity of selected muscles during skiing of the handicapped LW2 skiers in the run with one or both stabilizers. Results of the three case studies show that in selected muscles on the right lower limb (m. gluteus medius, m. tensor fasciae latae, m. adductor longus, m. tibialis anterior, m. gastrocnemius – cap. laterale and mediale, m. peroneus longus) there are significant differences in the EMG activity in the observed runs. The presumption of the significant difference in the intensity of muscle inclusion between the stated runs has been proved, with the exception to m. gluteus medius. There was a certain increase in the electrical potential during the run with one stabilizer. However, these differences are in both tested persons no significant. A significant difference has been measured in the third tested person. For the next similar research we suggest to combine the SEMG methods and kinematical analysis with measuring the strength, which the skier uses to influence the ski and also stabilizers.

Keywords: Skiing, handicap, EMG, stabilizers, LW2

BACKGROUND

Analyses of ski turns have been done by many authors. One of the first Czech experts who looked into this problem was Čepelák (1955–1957). In his steps carried on Novák (1967) and later Příbramský and Makovec (1976).

The Japanese theoretic Fukuoka (1971) first used the new knowledge and technical device equipment in the area of wireless transfer and used it for biomechanical analyses of skiing turns. Observation of reaction strengths between a ski and surface was also done by Mote and Hull (1978), and Kuo, Louie and Mote (1983).

Müller (1983, 1984) analysed with the help of kinematical and dynamic methods basic kinds of turns in alpine skiing. Kinematical analysis was focused mainly on the time parameters. Hellebrandt (1986) used the dynamographic method for observing the influence of upright ski forces on the surface during joined turns and kinematical analysis for determining the changes of direction ski angle and the course of individual body segments.

Nachbauer (1988) tried to determine reaction forces influencing the lower part of ski boots during competition skiing. Příbramský, Jelen and Broda (1987) were trying to clear up space characteristics of individual slalom turns and phasing motor activity during its course. They used the possibility of highly frequent cinematography for biomechanical analysis of the closed slalom turn.

Nachbauer and Rauch (1991) observed three basic aspects of competition alpine skiing technique: run distance, reaction forces and angle in the knee joint. Nachbauer et al. (1996) continued in the steps of Mossner, Kaps and Nachbauer (1995) and used video recording for gaining coordinates of individual body segments in alpine skiing.

Spitzenpfeil, Seifriz and Mester (1997) states that with the development of carving there is a higher risk of falls. They have used the kinematical and dynamographic method for observing the load on the inner and outer ski during realizing joined turns. Carving from the biomechanical point of view was also studied by Niessen and Müller (1999). In their paper they have focused on the use of highly carved skies in the context of the formed turn radius. Furthermore, they have studied the influence of boards under the binding on the ski behaviour in turns and on reducing vibrations. They have observed the connection between the board height and the probability of digging the ski edge with the followed possibility of a fall.

Nachbauer and Kaps (2000) realized with the help of the kinematical and dynamographic analysis a comparison of turns on carving skies and turns on classical skies. Pozzo et al. (2000) analyzed the starting phase during the slalom race. Žvan and Lešnik (2000) described on the basis of the 3D analysis the turn in giant slalom. They have divided it into three phases: starting phase, turning phase and finishing phase. The authors focused on observing two basic techniques: when controlling the skiing speed and increasing the skiing speed.

The comprehensive Czech book discussing the biomechanics of alpine skiing is the book by Jelen, Příbramský and Kohoutek (2001), who writes about the comprehensive knowledge from the area of alpine skiing biomechanics.

Vodičková et al. (2003) constructed a special recording device enabling to record forces influencing the surface during skiing. In their paper they describe the recording device which measures force effects in three axes of the Cartesian axes system and corresponding torsion moments around these axes. Furthermore, they discuss the dynamography of a carving turn (2005a; 2005b).

Supej et al. (2003) observed the movement of the body's centre of gravity and described the skiing turn during the training and the competition in giant slalom. They have compared two different techniques when starting the turn.

Supej, Kugovnik and Nemec (2005) developed methods for analysing skiing turns. They describe the method "Kinski", which synchronizes the course of selected parameters with a video record. That brings feedback information for competitors and coaches.

Pozzo et al. (2005) discusses on the basis of the 3D kinematical analysis the movement course of the body's centre of gravity during running through three gates in the giant slalom in the World Cup in Val Badia in 2002.

Ducret et al. (2005) analyzed with the help of kinematical analysis and the analysis of forces working against surface the course of the competitor's run in the downhill race.

Kugovnik, Supej and Nemec (2005) found two different techniques in slalom with the help of kinematical analysis.

Kračmar et al. (2007) characterized the muscles work of lower limbs during the downhill skiing as mainly postural and compared it with the work during the bipedal walking which is mainly the phase work.

Matošková, Zahálka and Süss (2003) defined with the 3D analysis the critical points during the ski turn in skiers with one side above the knee amputation.

The turn on the inner ski edge with the use of both stabilizers

The skier starts the turn with a slight forwarding the inner arm with the inner stabilizer and a slight bending the standing leg in knee joint in sagittal level together with a slight knee bending inside the turn.

The knee bend of the standing leg increases to the turn top in the sagittal level and also bends inside the turn. At the same time there is a significant trunk bend forward. The trunk bend inside the turn in the frontal level also increases to the turn top. The inner arm in shoulder joint moves backwards from the turn start to its top, that is to the skier's body in the sagittal level. In the frontal level the arm is either too close by the skier's body during the whole turn course or on contrary further from the skier's body. The arm significantly bends in the elbow joint to the turn top. From the turn top the standing leg starts to stretch in the knee joint, and knee and trunk return gradually over the ski. The trunk bend stays the same. The inner arm moves in the shoulder joint again slightly in front of the body, in the elbow joint it stays in the same position. The outer arm with the outer stabilizer copies the movement of the inner arm.

The turn on the outer ski edge with the use of both stabilizers

The skier's movement in the turn course is same as during the turn on the inner ski edge. There are only the following differences: there is greater trunks bend to the turn top, the inner arm with the inner stabilizer is moved more forward at the turn start and the arm in the shoulder joint in the frontal level is significantly closer to the body.

The turn on the inner ski edge with the use of inner stabilizer

The skier's movement during the turn course is same as the movement of the skier using both stabilizers. There is not such a significant knee bend of the standing leg to the turn top because the support is only with one stabilizer. The knee is on contrary more significantly bended inside the turn, because it holds more body weight, which is not supported by the stabilizer. There are greater body bends in the frontal level and there is not such a significant trunk bend. The inner arm in the shoulder joint moves in the frontal level further from the body. From the turn top there is a greater bend of the standing leg in the knee joint. The arm in the shoulder joint moves back to the body in the frontal level. The outer arm with the outer stabilizer is over the snow and its position is very individual during the whole turn course.

The turn on the outer ski edge with the use of inner stabilizer

The skier's movement is same during the turn course as during the turn on the inner ski edge. Only to the turn top there is a more significant trunk bend than in the turn on the inner ski edge.

The skier does not have such postural certainty on the outer ski edge as on the inner ski edge. That comes from the postural function of a leg. The ski loading in its frontal part enables using the side ski carve and lead the ski on the edge in the turn. The possible sweep would increase the degree of postural uncertainty, especially in higher speeds than in the turns on the inner ski edge. The three point model of a foot also enables to keep the side balance when standing on one leg without loading the heel, but loading the front part of the foot.

To understand the specific situation of a skier with an amputated leg it is important to mention that reasons causing the loss of a leg cannot significantly influence the structure of the healthy leg and probably nor its function. The outer part of a leg is then equipped mainly by abductors and the inner part by a strong adductor group. These muscles are evolutionally determined for different functions. That results in a different solution of the postural situation when skiing on one ski, which is during the turn on the inner and outer edge realized always in a different way and that is through the healthy leg but also the trunk and the whole movement system in fact.

METHODOLOGY

Aim

The aim of the paper is to show and compare the EMG activity of selected muscles during skiing of the handicapped skiers of the group LW2 when using one or both stabilizers.

Hypothesis

We suppose that there will be significant differences in the intensity of electric activity of observed muscles during the run using both stabilizers and the run using only one stabilizer.

Research methodology

The research was based on observing individual case studies analysing the specific locomotion – skiing in skiers with one side above knee amputation (group LW2).

Observed sample

The group of skiers with one side above knee amputation consisted of three skiers, two men and one woman aged between 22 and 30 years.

Used research methods

Electromyography record

EMG is according to the Schmidt (1991) a common method for recording movement, which measures involvement of muscles in the movement together with the timing of their work. The most common method which we have also used is the recording of electric activity connected with the contraction of certain muscles in the course of movement. The easiest way consists of fixing electrodes on the skin covering the included muscles, amplifying the signal and recording by the polygraphic recorder for the further analysis. The surface EMG (SEMG) in the area of kinesiology measures the muscle activation, co-activation of muscle groups in the course of complex and selected movement, influence of load on muscle function, can observe the process of a therapeutic process, and the effect of movement load.

The method of measuring the muscle activity by SEMG has its place in evaluating the moment and speed of the muscle activity start and its relative rate when evaluating the complex movement patterns. The suitability of this method is recognized for the kinesiology analysis of human movement including walking and posture (Rodová, Mayer and Janura, 2001). SEMG will be used in selected individuals to describe the inner timing of movement (time succession of selected muscles), then to compare co-activation of selected muscles and to compare "similarities" in individual turns.

We have used the portable measuring device working on the basis of EMG potentials, carried on the skier's body. It weighs 1.3 kg, its pattern frequency is 200 patterns a second, filters measures with the frequency 30–1200 Hz. The more concrete data about the device and the precise placing of electrodes are available by authors.

Observed variables

We have chosen the following muscles for observing differences between the run with one stabilizer and both stabilizers:

1. Musculus gluteus medius
2. Musculus tensor fasciae latae
3. Musculus adductor longus
4. Musculus tibialis anterior
5. Musculus gastrocnemius
   – Cap. laterale
   – Cap. mediale
6. Musculus peroneus longus

With regard to the fact that all skiers had amputated the left leg, all muscles were on the right side.

DATA ANALYSIS AND EVALUATION METHODS

Statistical methods

To compare individual attempts and to compare individual case studies we have used basic descriptive statistics.

To gain the real data it is necessary to adjust the measured data on the basis of the used sensitivity of the measuring device:

$$X_{real} = k * \mu * X_i$$

k = coefficient, multiplying the measured data. It was counted as dividing the value of diode's reference tension, which is a part of the device; by the maximal possible range of data 0–255.

$(V_{REF} = 2.484\ [V])\ k = V_{REF} / 255$
$k = 0.009741\ [V]$
μ = device sensitivity (0.05 mV; 0.1 mV; 0.2 mV; 0.5 mV; 1 mV or 2 mV)
X_i = measured value (rough scores)
X_{real} = real value of electric activity in the muscle

We have used the frequency analysis to analyze the significant changes of EMG potentials.

The classes in the histogram were created as intervals of 10% out of the overall measured variation range of values of EMG muscle potentials. Furthermore, we will use the percentile analysis of gained rough scores.

RESULTS

Table 1. Analysis of percentiles in EMG activity in the observed muscles

	m. gluteus medius dx.				**m. adductor longus dx.**				**m. tibialis anterior**			
percentiles	2 stabilizers		1 stabilizer		2 stabilizers		1 stabilizer		2 stabilizers		1 stabilizer	
	A 17	A 18	A 24	A 20	A 17	A 18	A 24	A 20	A 17	A 18	A 24	A 20
75%	36	38	65	61	30	35	68	74	74	86	129	124
50%	27	27	43	38	25	26	50	47	52	59	85	82
25%	22	21	29	25	21	21	37	32	25	17	45	43
	B 52	B 53	B 58	B 59	B 52	B 53	B 58	B 59	B 52	B 53	B 58	B 59
75%	34	34	44	39	59	67	98	108	52	54	108	97
50%	24	21	26	26	48	54	76	79	30	30	80	71
25%	17	14	17	16	40	43	57	53	11	15	53	42
	m. tensor fasciae latae				**m. gastrocnem cap. med.**				**m. gastrocnem. cap. lat.**			
	A 17	A 18	A 24	A 20	A 17	A 18	A 24	A 20	A 17	A 18	A 24	A 20
75%	38	40	80	77	30	28	49	67	50	49	59	81
50%	28	27	50	41	17	17	34	37	22	27	38	54
25%	21	19	33	24	9	9	24	24	13	13	26	33
	B 52	B 53	B 58	B 59	B 52	B 53	B 58	B 59	B 52	B 53	B 58	B 59
75%	73	74	119	100	42	26	39	50	52	47	54	81
50%	46	41	70	56	22	16	24	30	30	26	34	49
25%	27	25	40	34	11	11	17	19	15	13	24	24
	m. peroneus longus											
	A 17	A 18	A 24	A 20	B 52		B 53		B 58		B 59	
75%	81	83	104	113	69		46		90		86	
50%	64	61	86	88	51		35		69		66	
25%	49	49	70	69	32		26		40		49	

Table 2 shows the results from comparing the electrical activity of m. adductor longus dx. with the help of histograms with cumulative frequencies out of the measured data in randomly selected pairs of runs with one and both stabilizers. Due to the limits of this measurement we can only compare results in one person in situations when placement of electrodes having been changed.

Table 2. Electrical activity of m. adductor longus

m. adductor longus								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	1890	46.14%	1690	41.26%	265	6.47%	3069	74.93%
10–20%	1924	93.12%	1742	83.79%	2009	55.52%	942	97.92%
20–30%	252	99.27%	544	97.07%	1493	91.97%	84	99.98%
30–40%	30	100.00%	120	100.00%	286	98.95%	1	100.00%
40–50%	0		0		41	99.95%	0	
50–60%	0		0		2	100.00%	0	
60–100%	0		0		0		0	
Run with one stabilizer								
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	354	8.64%	364	8.89%	368	8.98%	1485	36.25%
10–20%	1280	39.89%	1281	40.16%	814	28.86%	1694	77.61%
20–30%	637	55.44%	1183	69.04%	972	52.59%	595	92.14%
30–40%	584	69.70%	746	87.26%	872	73.88%	112	94.87%
40–50%	549	83.11%	367	96.22%	528	86.77%	61	96.36%
50–60%	302	90.48%	72	97.97%	258	93.07%	30	97.09%
60–70%	238	96.29%	33	98.78%	122	96.04%	44	98.17%
70–80%	114	99.07%	21	99.29%	69	97.73%	40	99.15%
80–90%	33	99.88%	22	99.83%	37	98.63%	21	99.66%
90–100%	5	100.00%	7	100.00%	56	100.00%	14	100.00%

Table 3. Electrical activity of m. gluteus medius dx

m. gluteus medius dx.								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	1124	27.44%	1385	33.81%	459	11.21%	463	11.30%
10–20%	2129	79.42%	1688	75.02%	1378	44.85%	952	34.55%
20–30%	732	97.29%	661	91.16%	1045	70.36%	1316	66.67%
30–40%	107	99.90%	303	98.56%	699	87.43%	795	86.08%
40–50%	4	100.00%	59	100.00%	328	95.43%	364	94.97%
50–60%	0		0		129	98.58%	124	98.00%
60–70%	0		0		55	99.93%	53	99.29%
70–80%	0		0		2	99.98%	18	99.73%
80–90%	0		0		1	100.00%	7	99.90%
90–100%	0		0		0		4	100.00%
	Run with one stabilizer							
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	692	16.89%	537	13.11%	722	17.63%	395	9.64%
10–20%	1378	50.54%	1209	42.63%	1016	42.43%	1173	38.28%
20–30%	785	69.70%	884	64.21%	749	60.72%	1465	74.05%
30–40%	474	81.27%	617	79.27%	395	70.36%	468	85.47%
40–50%	251	87.40%	524	92.07%	454	81.45%	287	92.48%
50–60%	282	94.29%	214	97.29%	257	87.72%	161	96.41%
60–70%	133	97.53%	100	99.73%	200	92.60%	88	98.56%
70–80%	49	98.73%	11	100.00%	135	95.90%	37	99.46%
80–90%	37	99.63%	0		93	98.17%	15	99.83%
90–100%	15	100.00%	0		75	100.00%	7	100.00%

Table 4. Electrical activity of m. tensor fasciae latae

m. tensor fasciae latae								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	2667	65.11%	2617	63.89%	1098	26.81%	656	16.02%
10–20%	1078	91.43%	1202	93.24%	1297	58.47%	1093	42.70%
20–30%	205	96.44%	163	97.22%	815	78.37%	1230	72.73%
30–40%	59	97.88%	32	98.00%	425	88.75%	651	88.62%
40–50%	50	99.10%	42	99.02%	280	95.58%	268	95.17%
50–60%	33	99.90%	30	99.76%	115	98.39%	117	98.02%
60–70%	4	100.00%	10	100.00%	47	99.54%	46	99.15%
70–80%	0		0		13	99.85%	19	99.61%
80–90%	0		0		4	99.95%	6	99.76%
90–100%	0		0		2	100.00%	10	100.00%
Run with one stabilizer								
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	1641	40.06%	993	24.24%	408	9.96%	1206	29.44%
10–20%	964	63.60%	1435	59.28%	1134	37.65%	1014	54.20%
20–30%	626	78.88%	727	77.03%	743	55.79%	835	74.58%
30–40%	358	87.62%	461	88.28%	639	71.39%	385	83.98%
40–50%	147	91.21%	258	94.58%	260	77.73%	160	87.89%
50–60%	86	93.31%	166	98.63%	221	83.13%	112	90.63%
60–70%	42	94.34%	32	99.41%	158	86.99%	141	94.07%
70–80%	74	96.14%	22	99.95%	154	90.75%	145	97.61%
80–90%	99	98.56%	2	100.00%	118	93.63%	60	99.07%
90–100%	59	1	0		261	100.00%	38	100.00%

Table 5. Electrical activity of m. peroneus longus

m. peroneus longus								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul.	Frequency	Cumul. %
0–10%	603	14.72%	672	16.41%	884	21.58%	490	11.96%
10–20%	1433	49.71%	1502	53.08%	1870	67.24%	819	31.96%
20–30%	1150	77.78%	925	75.66%	1047	92.80%	949	55.13%
30–40%	608	92.63%	584	89.92%	225	98.29%	885	76.73%
40–50%	200	97.51%	303	97.31%	60	99.76%	534	89.77%
50–60%	57	98.90%	98	99.71%	10	100.00%	229	95.36%
60–70%	9	99.12%	12	100.00%	0		95	97.68%
70–80%	26	99.76%	0		0		52	98.95%
80–90%	9	99.98%	0		0		33	99.76%
90–100%	1	100%	0		0		10	100%
Run with one stabilizer								
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	278	6.79%	144	3.52%	403	9.84%	367	8.96%
10–20%	473	18.33%	515	16.09%	346	18.29%	584	23.22%
20–30%	1061	44.24%	1179	44.87%	953	41.55%	978	47.09%
30–40%	881	65.75%	1174	73.54%	1027	66.63%	762	65.70%
40–50%	724	83.42%	838	93.99%	757	85.11%	509	78.13%
50–60%	419	93.65%	218	99.32%	229	90.70%	357	86.84%
60–70%	204	98.63%	28	100.00%	147	94.29%	226	92.36%
70–80%	34	99.46%	0		104	96.83%	170	96.51%
80–90%	11	99.73%	0		84	98.88%	103	99.02%
90–100%	11	100.00%	0		46	100.00%	40	100.00%

Table 6. Electrical activity of m. tibialis anterior

m. tibialis anterior								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	1213	29.61%	1287	31.42%	1407	34.35%	2458	60.01%
10–20%	1110	56.71%	631	46.83%	939	57.28%	784	79.15%
20–30%	912	78.98%	1041	72.24%	730	75.10%	637	94.70%
30–40%	445	89.84%	553	85.74%	608	89.94%	140	98.12%
40–50%	331	97.92%	434	96.34%	336	98.14%	56	99.49%
50–60%	60	99.39%	140	99.76%	69	99.83%	15	99.85%
60–70%	25	100.00%	9	99.98%	7	100.00%	6	100.00%
70–100%	0		1	100.00%	0		0	
Run with one stabilizer								
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	662	16.16%	733	17.90%	449	10.96%	1470	35.89%
10–20%	737	34.16%	668	34.20%	218	16.28%	858	56.84%
20–30%	641	49.80%	558	47.83%	336	24.49%	830	77.10%
30–40%	641	65.45%	622	63.01%	569	38.38%	500	89.31%
40–50%	533	78.47%	573	77.00%	730	56.20%	232	94.97%
50–60%	323	86.35%	609	91.87%	568	70.07%	99	97.39%
60–70%	302	93.73%	252	98.02%	492	82.08%	62	98.90%
70–80%	168	97.83%	69	99.71%	382	91.41%	16	99.29%
80–90%	70	99.54%	12	100.00%	158	95.26%	10	99.54%
90–100%	19	100%	0		194	100.00%	19	100.00%

Table 7. Electrical activity of m. gastrocnemius cap. mediale

m. gastrocnemius cap. mediale								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	3185	77.76%	3276	79.98%	2546	62.16%	3267	79.76%
10–20%	682	94.41%	618	95.07%	948	85.30%	535	92.82%
20–30%	168	98.51%	179	99.44%	372	94.38%	228	98.39%
30–40%	50	99.73%	23	100.00%	190	99.02%	55	99.73%
40–50%	8	99.93%	0		38	99.95%	11	100.00%
50–60%	3	100.00%	0		2	100.00%	0	
60–100%	0		0		0		0	
Run with one stabilizer								
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	1625	39.67%	1795	43.82%	2553	62.33%	1939	47.34%
10–20%	1178	68.43%	1595	82.76%	1008	86.94%	1287	78.76%
20–30%	566	82.25%	575	96.80%	316	94.65%	483	90.55%
30–40%	351	90.82%	96	99.15%	143	98.14%	161	94.48%
40–50%	212	96.00%	35	100.00%	45	99.24%	102	96.97%
50–60%	100	98.44%	0		15	99.61%	47	98.12%
60–70%	31	99.19%	0		4	99.71%	49	99.32%
70–80%	19	99.66%	0		5	99.83%	18	99.76%
80–90%	4	99.76%	0		7	100.00%	6	99.90%
90–100%	10	100,00%	0		0		4	100,00%

Table 8. Electrical activity of m. gastrocnemius cap. laterale

m. gastrocnemius cap. Laterale								
	JADU				PAKU		DOJA	
	Run with both stabilizers							
	E17		E18		E53		E4	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	2231	%	1865	45.53%	1970	%	2254	55.03%
10–20%	655	70.46%	937	68.41%	1171	76.68%	989	79.17%
20–30%	397	80.15%	532	81.40%	558	90.31%	542	92.41%
30–40%	390	89.67%	400	91.16%	303	97.71%	246	98.41%
40–50%	273	96.34%	204	96.14%	93	99.98%	64	99.98%
50–60%	108	98.97%	128	99.27%	1	100.00%	1	100.00%
60–70%	30	99.71%	30	100.00%	0		0	
70–80%	9	99.93%	0		0		0	
80–90%	3	100.00%	0		0		0	
90–100%	0		0		0		0	
Run with one stabilizer								
	E20		E24		E59		E9	
Classes	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %	Frequency	Cumul. %
0–10%	541	13.21%	816	19.92%	1561	38.11%	1319	32.20%
10–20%	918	35.62%	1459	55.54%	1509	74.95%	936	55.05%
20–30%	715	53.08%	744	73.71%	474	86.52%	753	73.44%
30–40%	636	68.60%	476	85.33%	295	93.73%	647	89.23%
40–50%	598	83.20%	343	93.70%	174	97.97%	249	95.31%
50–60%	371	92.26%	151	97.39%	57	99.37%	117	98.17%
60–70%	192	96.95%	67	99.02%	23	99.93%	43	99.22%
70–80%	54	98.27%	18	99.46%	3	100.00%	21	99.73%
80–90%	48	99.44%	14	99.80%	0		3	99.80%
90–100%	23	100.00%	8	100.00%	0		8	100.00%

DISCUSSION

Musculus adductor longus

Results from the comparison of EMG electrical activity of muscles (Table 2) show that during the run with the use of one stabilizer there is a significantly higher EMG electrical activity of m. adductor longus dx. than during the run with both stabilizers. That also proves the analysis through percentiles, which is presented in Table 1.

M. adductor longus connects pelvis with femur and its main function is adduction of femur. Furthermore, it helps flection in hip. It is in the antagonist relationship to m. gluteus medius and m. tensor fasciae latae. It influences the freedom of movement in hip. It helps to stabilize stands and influences dynamic stabilization of walking (Véle, 2006).

On the basis of previous research dealing with the kinematical description of skiing with one side above knee amputation with the use of both stabilizers or with the use of one stabilizer, we have described the different bend of skier's body inside the turn (Matošková, Süss and Zahálka, 2008). It is probably the cause of a smaller activity of this muscle in the case of the run with both stabilizers. Thanks to the support of both stabilizers there is a greater support base during the run and the skier does not have to lose balance significantly and does not have to react with the higher EMG electric activity of muscles keeping the posture. In this way we can also explain the lower activity of m. adductor longus. During the both types of runs the highest frequency of electric activity results is between 10–30% of maximum. During the run with one stabilizer there are moments when the EMG electric activity of m. adductor longus reached 80–100%. We suppose that part of this high EMG muscle activity is in situations when the balance is disturbed.

M. gluteus medius dx.

Results stated in the Table 1 show significant differences in the intensity of EMG electric activity of m. gluteus medius dx. between the observed turns in the first tested person (JADU). That is also documented by the results in the analysis of cumulative frequencies stated in the Table 6. In the case of other observed persons (PAKU and DOJA) there was no significant difference proved. M. gluteus medius connects pelvis with femur. It main function is abduction in hip; the front part helps during pelvis ante version and inner rotation in hip joint; the back part helps during pelvis retroversion and outer rotation and extension in hip. At the same time it contributes to stabilize pelvis position in the frontal level mainly when walking (Véle, 2006).

Regarding to pelvis stabilization, on the basis of both stabilizers support, the lower EMG electric activity of this muscle is probable. The higher activity in the tested persons PAKU and DOJA can be explained by the fact that they use the stabilizer less then the JADU skier. M. gluteus medius also helps as another muscle during hip joint flexion. It is very important for pelvis stabilization when walking and keeping the balance of the standing body (Čihák, 2001). The higher activation of m. gluteus medius in the case of other two tested skiers can also be explained by the reaction to unbalanced states during a smaller support of stabilizers. This statement should be documented by another measuring the strength by a strain gage.

Musculus tensor fasciae latae

M. tensor fasciae latae belongs among double joint muscles – it connects pelvis and tibia. It is a muscle with a very similar function as m. gluteus medius. It realizes abduction, flection and inner rotation of hip; it stretches fascia latae and can participate on the knee extension when standing (Véle, 2006). It also participates on the final knee rotation (Čihák, 2001).

Analysis results show significant differences in the intensity of electric activity of m. tensor fasciae latae in all tested persons (Table 4).

M. tensor fasciae latae does next to hip flection extension in the knee joint. Even though there is no significant movement in the knee joint during turns of skiers with above knee amputation (Matošková, 2006), the results show greater load in this joint during turns with one stabilizer. The reason of lower intensity of m. tensor fasciae latae inclusion can be explained by the skier's weight distribution on stabilizers and the lower limb during turns with both stabilizers. To prove this statement it is necessary to connect measurement of muscle activity with the measurement by strain gage – measurement of strengths which the skier influences stabilizers during turns. This muscle does not have evolutionally and phylogenetically the function to keep lower limbs under body in its antigravity function. Therefore, its inclusion during the turn on the inner edge has to be different and it is obviously compensated by the position of the whole body.

Musculus peroneus longus

M. peroneus longus connects tibia and fibula with the foot shell. It does foot exersion and helps during plantar flexion and foot abduction (Véle, 2006).

Results of percentile analysis show significant differences in the intensity of electric activity of m. peroneus longus in all tested persons (Table 1). With the analysis in percents of muscle activation intensity (Table 5) we get similar results because it appears that during the run with both stabilizers skiers reach 90% frequencies of measured values up to 40–50% of intensity values and during the run with one stabilizer their reach this 90% frequency during the electric tension intensities up to 60% of maximum.

It appears that the run with one stabilizer puts higher demands on the "lean" of crus forward, and transferring body weight on the front part of foot. During the run with both stabilizers this intensity of muscle activity is replaced by the stabilizers support. This situation relates to the mentioned different postural function of abduction and adduction muscle group of the lower limb.

Musculus tibialis anterior

M. tibialis anterior belongs among long muscles of the front calf muscles group. It connects tibia with the foot shell. It does dorsal flection of talar joint (extension) and inversion (Véle, 2006).

The percentile analysis (Table 1) shows a significant difference between results from the measurement of the electric activity intensity of m. tibialis anterior. The intensity during the run with one stabilizer reaches almost the double intensity of electric activity than with the run with both stabilizers.

The table 6 shows the distribution of electric tension frequencies of m. tibialis anterior during both types of observed turns. The distribution according to cumulative percents of results appearance supports the more detailed analysis of muscle function.

Both analyses show a big difference in the intensity of electric potential between the run in individual types of turns. This difference is caused by a small support base during the run with one stabilizer on one leg, when the skier has to adjust all the time the crus

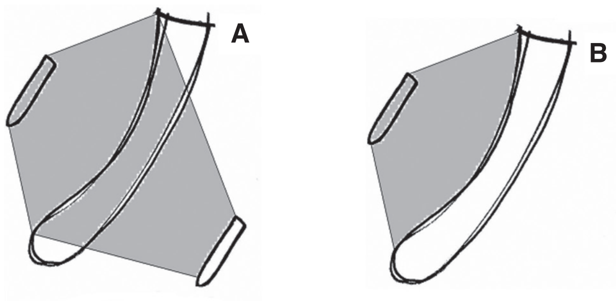

Figure 1. The support base when using both stabilizers and when using only the inner stabilizer

lean forward to the changing balance situation. In the run with both stabilizers the support base is bigger (Figure 1). At the same time with the bigger support of both stabilizers it is easier for the skier to keep the crus lean forward. M. tibialis anterior is in the antagonist relationship to m. peroneus longus and it is supported by the analysis of the electric activity intensity of both muscles.

Mm. gastrocnemii (mediale et laterale)

Mm. gastrocnemii (mediale et laterale) connects femur and tuber calcanei, they have double joint character, however, the effect on the knee joint is relatively small in comparison to the effect on the foot – unwinding of foot during walking – propulsion of walking (Véle, 2006).

The results of percentile analysis in the Table 1 show significant differences in the inclusion of these muscles. There is not such a significant flection in the knee joint in skiers with one side above knee amputation during skiing. However, the analysis of the run with one stabilizer found out a higher activity of mm. gastrocnemii, m. peroneus longus and m. tibialis anterior. These muscles also participate on the muscle loop constricting of m. tibialis anterior and m. peroneus longus (Véle, 2006), control the leg work. Therefore, the agreement in significant differences in including these muscles into the handicapped skier's work during different types of runs is not surprising.

CONCLUSION

We supposed that we would find significant differences in the intensity of EMG electric activity in the observed muscles during the run with both stabilizers and the run with one stabilizer.

Table 9 shows the survey of gained analyses results measured by the percentile analysis. When evaluating the significance of differences in the electric activity of muscles we proceeded from the effect size, where we have defined the significant difference 10 mV. We have come out the assumption of 10% rate from the variation difference of the electric potential intensity.

Table 9. Results of significant relationships

m. adduktor longus	+
m. gluteus medius	–
m. tibialis anterior	+
m. peroneus longus	+
m. tensor fasciae latae	+
m. gastrocnemius cap. mediale	+
m. gastrocnemius cap. laterale	+

Key: + means a significant difference, – no significant difference between the intensity of muscles inclusion was proved

The presumption of significant difference in the intensity of EMG electric activity of included muscles between the two runs of handicapped skiers has been proved, except for m. gluteus medius. This muscle also showed a certain increase in electric potential during the run with one stabilizer, but these differences are in two tested persons no significant. The third tested person showed a significant difference.

The study has objectified the idea that skiers with amputated leg appear in a different postural situation during the runs with one or both stabilizers. The validity is of course stated only for the three tested persons.

For the further research in skiing of skiers with one side above knee amputation we recommend to join the methods SEMG and kinematical analysis with measuring strength, which the skier influence the ski and stabilizers.

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KOMPARACE AKTIVITY ZAPOJENÝCH SVALŮ PŘI JÍZDĚ S JEDNÍM NEBO OBĚMA STABILIZÁTORY U HANDICAPOVANÝCH LYŽAŘŮ SKUPINY LW2

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SOUHRN

Příspěvek se zabývá porovnáním EMG aktivity vybraných svalů při lyžování handicapovaných lyžařů skupiny LW2 při jízdě s jedním nebo oběma stabilizátory. Výsledky tří případových studií ukazují, že u vybraných svalů na pravé dolní končetině (m. gluteus medius, m. tensor faciae latae, m. adductor longus, m. tibialis anterior, m. gastrocnemius – cap. laterále a mediale, m. peroneus longus) jsou významné rozdíly v EMG intenzitě ve sledovaných jízdách. Předpoklad významnosti rozdílů v intenzitě zapojování svalů mezi uvedenými typy jízd handicapovaných lyžařů se potvrdilo, s výjimkou svalu m. gluteus medius. I u tohoto svalu se jedná o určitý nárůst el. potenciálu při jízdě s jedním stabilizátorem, ale tyto rozdíly jsou u dvou probandů zanedbatelné. U třetího probanda se jedná o signifikantní rozdíl.

Pro další výzkum lyžování lyžařů s jednostrannou nadkolenní amputací doporučujeme spojit metody SEMG a kinematické analýzy s měřením síly, kterou působí lyžař na lyži a také na stabilizátory.

Klíčová slova: Lyžování, handicap, EMG, stabilizátory, LW2

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