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ONE POSSIBILITY OF GETTING UP FROM A CHAIR BY MODIFIED ABOVE – KNEE PROSTHESIS

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ABSTRACT
Disabled persons with above – knee prosthesis of any kind have problems with getting up from a chair. Using could significantly facilitate that very important movement for this population modified above – knee prosthesis with hydraulic linear actuator in knee and ankle of the prosthesis.
Keywords: above – knee prosthesis, hydraulic actuator, rising from a chair

1. INTRODUCTION
In order to fulfill his everyday activities for a man is important his ability to accomplish necessary movements which are repeat very often. The most usual movements can be divided into four groups:
- getting from a chair
- standing
- walking
- climbing upstairs

After researches [3] connected with climbing upstairs with modified above – knee prosthesis, in this paper will be considered getting up from a chair with this type of modified prosthesis.

2. MOVEMENT FROM SITTING POSITION TO GETTING UP
For detailed research of movement from sitting position to standing is best to divide that movement into sitting phase and getting phase. Time period for both phases is very different, but approximately t takes 1-3 seconds. Sitting phase takes 30% of total time and getting up phase takes approximately 20% + 50% (forward-thrust and extension) of total time.

2.1. Sitting phase
Usually when a person sits in relaxed way he leans against back of the chair and gravity centre is far behind person's feet (Fig. 1.). When the gravity centre would stay behind the feet it wouldn't be possible for the person to get up. Ideal initial position for getting up is with bent knees, with at least 90 , so in that way the feet lie directly under knee joint or with bent knees till 115, with placing the feet little backwards. The person can move the feet before body movement or at the same time the body have to learn beforehand in order to set a new gravity centre position circa 2 centimetres in front of ankle joint. This activity happens with bending of the hip and in the beginning there is minor activity

in bending of the hip in order to initiate the movement. Once, when this is achieved flexors stop with their activity and gravitation takes over the movement.
The sitting phase ends when getting up from a chair starts. There is also significant variation of bending angle of hip joint and shoulders joints during this phase and also in accurate head position. The speed of the movement also varies among the people depending on different circumstances, such as the high of the chair, length of the lower extremities, person's age, joint's mobility, and at the end strength of the muscles.

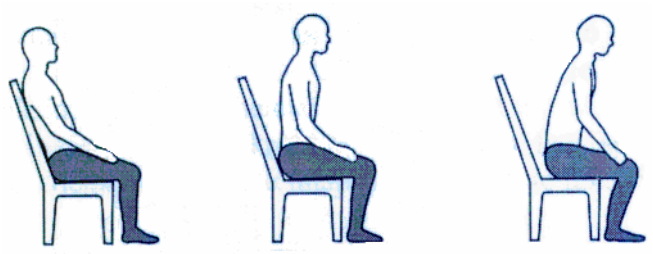

Figure 1. Sitting phase

2.2. Getting up phase
Getting up phase can be divided into forward – thrust phase and extension phase (Fig. 2).

2.2.1. Forward - thrust
This phase begins with getting up from the seat and it continues until the gravity centre doesn't come circa 7 centimetres in front of ankle joint, where it will stay until erected position isn't achieved.
Forward – thrust phase is short and it ends before a big hip and knee joint extension happens. The body and upper extremities continue the movement started in sitting phase and the moment realized in this sitting phase carries gravity centre beforehand referred to ankle joint. The forward – thrust phase is relatively short and it takes about 20% of total necessary time for getting up, but it is important for entire process, because the getting up isn't possible without forward – thrust of gravity centre through the feet.

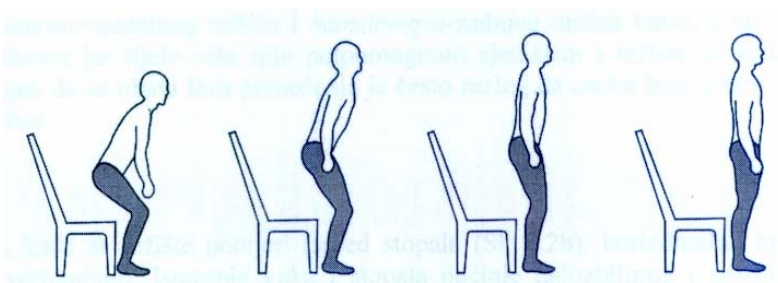

Figure 2. Getting up phase

2.2.2. Extension
Once when the gravity centre is moved underneath the feet horizontal movement is changed with vertical movement. Extension of the hip and ankle starts the most seriously and there is also plantar ankle joint bending. When the joints become progressively extended the body also starts to extend and neck spine part little by little starts to bend in order to keep the vertex in the highest position. Upper extremities go back to their usual relaxing position with help of eccentric muscle work.

3. CALCULATION OF LINEAR ANTHROPOMETRIES

Analysis of existing statistical anthropometrics in literature, which is available to us, they have many differences, so they cannot always be used for dynamic anthropometrics, because in most cases they refer to different dimensions of statistic positions.

For automatically calculation of mentioned linear anthropometrics [1] there is made a program in MATLAB. As an example, which is described with this method, there are results for male population.

Table 1. Anthrop measure of male population

VARIJABLA	POSTOCI				
Muškarci (N 120)	5 %	25 %	50 %	70 %	95 %
Visina tijela	1627	1691	1735	1769	1842
Raspon ruku	1630	1703	1754	1795	1879
Dužina nadlaktice	289	304	315	323	341
Dužina podlaktice	259	271	279	285	299
Dužina ruke	706	741	765	784	824
Dužina natkoljenice	487	513	531	545	575
Dužina potkoljenice	357	377	391	402	425
Dužina noge	906	956	991	1018	1076
Biakromijalni raspon	369	392	407	419	445
Širina zdjelice	272	292	305	316	338
Masa tijela (u kg)	58,4	68,4	75,5	81,0	92,6

4. CALCULATION OF MOMENT IN KNEE JOINT IN MOMENT OF GETTING UP

On the basis of the mentioned data we can calculate moments in point **A** of knee joint in moment when a person sits on a chair and starts getting up phase. (Fig. 3).

Moment in prosthesis joint **A** is calculated by expression:

$$M_A = \sum_{i=1}^{12} M_i = f(S, l)$$

Moments for point **A** (knee joint of prosthesis) will be separately calculated for all three groups of male population in the beginning of getting up phase.

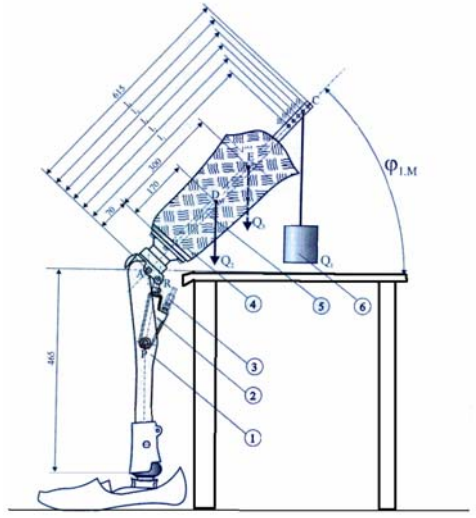

Figure 3. Above- knee prosthesis at the moment of getting up phase

After we have calculated the moments it is necessary to determine forces in linear actuator for all three groups of male population at the beginning of forward – thrust phase. The results of calculation is listed in table 2.

Table 2. Moments and forces in linear actuator

GROUPS OF MALE POPULATION	HEIGHT (cm)	MASS (kg)	MOMENT IN KNEE (Nm)	FORCE IN ACTUATOR (N)
I	**162,7**	**58,4**	**44,6**	**3722**
III	**173,5**	**75,7**	**54,9**	**4580**
V	**184,2**	**92,6**	**69,4**	**5789**

5. CONCLUSION

Linear actuator can realize forces, which occur in linear actuator in knee of above – knee prosthesis in getting up phases. They are bigger than forces, which occur during climbing upstairs.
From getting up from the chair and for climbing up stairs is possible to use same linear actuator.

6. REFERENCES

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