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ORIGINAL PAPER

Organism Encumbrance of Cardiac Surgeon During Surgery

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ABSTRACT

Introduction: Most everyday activities, performed over a long period leads to performance degradation of skeletal muscles as well as spinal column which is reflected in the reduction of maximum force, reduction of the speed of response, reducing control of the movement etc. Although until now many mathematical models of muscles are developed, very small number takes into account the fatigue, and those models that take into account changes in the characteristics of muscles for extended activities, generally considered tiring under certain conditions. Given that the current models of muscle fatigue under arbitrary conditions of activation and load are very limited, this article presents a new model that includes scale of muscles overload. **Material and Methods:** There are three female cardiac surgeons working performing these surgeries in operating rooms, and their average anthropometric measures for this population is: a) Weight: 62 kg; b) Height: 166 cm. Age: 45 taken in the calculation within the CATIA software, that entity is entitled to 50% of healthy female population that is able to execute these and similar jobs. During the surgery is investigated the two most common positions: position "1" and "2". We wish to emphasize that the experiment or surgical procedure lasted for two positions for five hours, with the position "1" lasted 0.5 hours, and position "2" lasted about 4.5 hours. The additional load arm during surgery is about 1.0 kg. **Results:** The analysis was done in three positions: "Operating position 1", "Operating position 2 ', and each of these positions will be considered in its characteristic segments. These segments are: when the body takes the correct position, but is not yet burdened with external load, then when the surgeon receives the load and the third position when the load is lifted at the end of the position. Calculation of internal energy used on the joints is carried out in the context of software analysis of this model using CATIA R5v19. The proposed model is based on CATIA software model, which consists of visual indicators of the burden on certain parts of the body as well as the forces acting in these parts of the body. **Conclusion:** Based on these indicators to define which muscles, as well as that part of the skeletal system is overloaded, what is the position and what needs to be done that specific load be within permitted limits.

Key words: cardiac surgery, biomechanics, CATIA software package, anthropology, occupational medicine.

1. INTRODUCTION

Coronary artery bypass is heart surgery which bypasses the narrowing of coronary blood vessels. In order to gain access to this surgery–coronary artery bypass arterial and venous grafts are used. Grafts are used to bridge constrictions in coronary blood vessel and thus, an adequate blood flow. In this way, the heart receives a sufficient amount of oxygen required for normal functioning. Number of bypass depends on the number of arteries that are stenosed, the quality of the blood vessel and the diameter of the artery.

Coronary artery bypass surgery on the heart should ensure for the patient the normal functioning in everyday life. Coronary artery bypass solves the pain from angina pectoris, prevents myocardial infarction, and in people who have already suffered myocardial infarction prevent further deterioration of myocardial function. Because of the prevalence of coronary artery disease is the most frequently performed surgery in the world. Blood vessels used for bypass are called grafts.

There are two basic types of grafts: venous and arterial. The most commonly used venous graft is great saphenous vein coronary artery bypass on

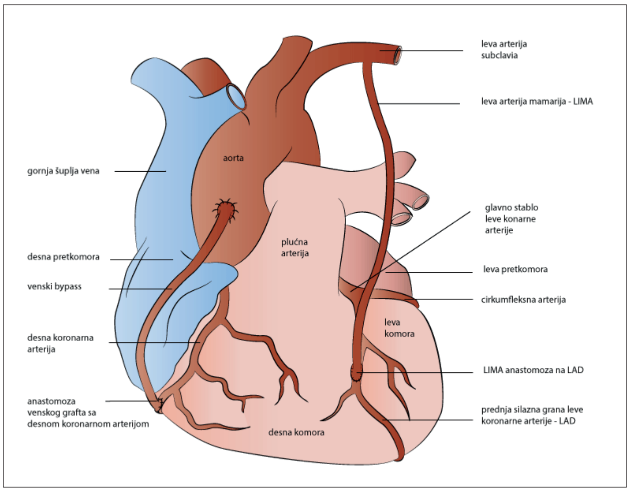

Figure 1. The anatomical structure of the heart

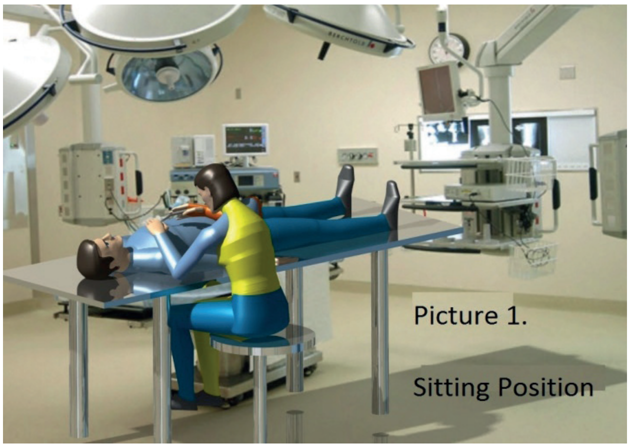

Figure 2. Cardiac surgeon in position 1 during surgery

Figure 3. Cardiac surgeon at the 2 position during surgery

the beating heart. Surgeries at the so-called, beating heart were performed in patients who need a smaller number of aortocoronary bypass or patients with porcelain aorta. The movements performed by the surgeon during the five-hour surgery represents besides mental also a physical effort.

This paper is to show the organism encumbrance of cardiac surgeon and how much energy is spent in the course of a surgical procedure.

2. MATERIAL AND METHODS

There are three female cardiac surgeons working performing these surgeries in operating rooms, and their average anthropometric measures for this population is: a) Weight: 62 kg; b) Height: 166 cm. Age: taken in the calculation within the CATIA software, that entity is entitled to 50% of healthy female population that is able to execute these and similar jobs. During the surgery is investigated the two most common positions: position “1” and “2”. We wish to emphasize that the experiment or surgical procedure lasted for two positions for five hours, with the position “1” lasted 0.5 hours, and position “2” lasted about 4.5 hours. The additional load arm during surgery is about 1.0 kg. The movement of the operator during the operation is unchanged. Movement of the surgeon during the surgery is unchanged. The respondent is in the static position.

3. RESULTS

Mathematical model of position 1 with organism load during surgery.

Mathematical model of the 2 with load of the body during surgery

3.1. Review of the health status of cardiac surgeon working on that workplace

This is the case of average respondents–heart surgeons, mostly middle-aged, who have problems with the locomotor system. They mainly complaint is the pain in the neck.

According to respondents, most said that they have pain in the cervical spine that spread to one or both shoulders and shoulder blades are followed with stiffness of the neck and

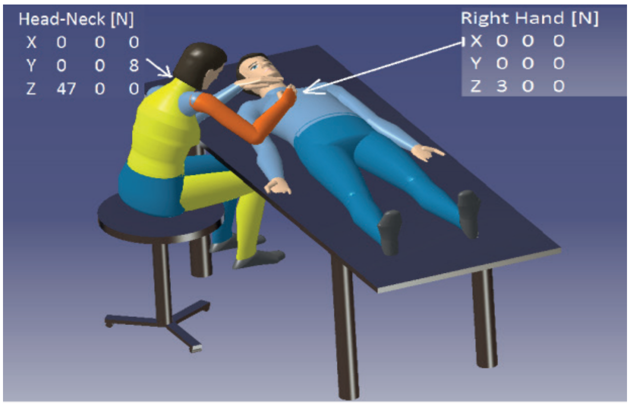

Figure 4. The mathematical model (position 1) cardiac surgeon with load to body parts during surgery

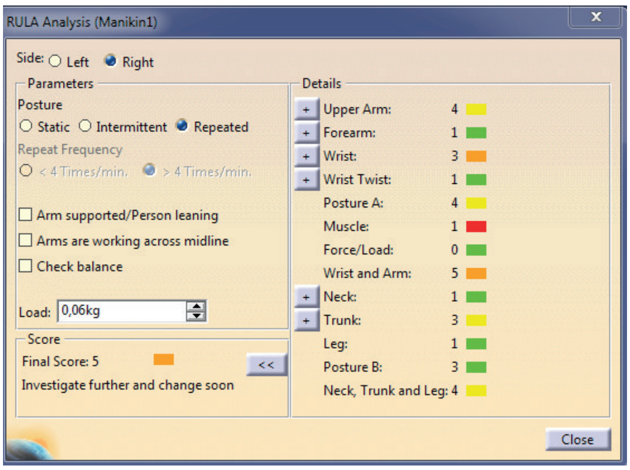

Figure 5. Load to the body during surgery

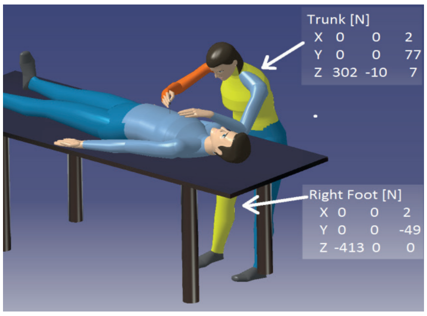

Figure 6. Mathematical model (position 2) cardiac surgeon with load to body parts during surgery

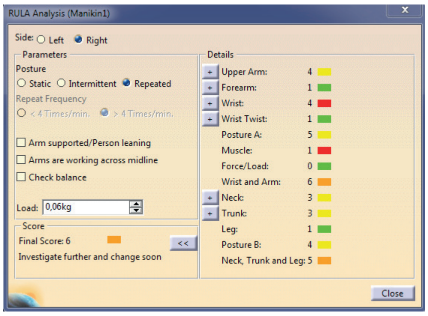

Figure 7. Load to the body during surgery

Figure 8. Typical pain in the area of cervical spine

Right Foot					Right Arm				
X	0	0	0	0	X	0	0	-5	-1
Y	0	0	74	0	Y	0	0	7	-3
Z	-292	0	0	0	Z	30	-12	0	0
Right Leg					Left Hand				
X	0	0	0	0	X	0	0	0	0
Y	0	0	74	-74	Y	0	0	0	0
Z	-264	292	0	0	Z	3	0	0	0
Right Thigh					Left Forearm				
X	0	0	0	0	X	0	0	-1	0
Y	0	0	-27	-74	Y	0	0	2	0
Z	-196	264	0	0	Z	12	-3	0	0
Left Foot					Left Arm				
X	0	0	0	0	X	0	0	0	1
Y	0	0	74	0	Y	0	0	8	-2
Z	-292	0	0	0	Z	30	-12	0	0
Left Leg					Head-Neck				
X	0	0	0	0	X	0	0	0	0
Y	0	0	74	-74	Y	0	0	8	0
Z	-264	292	0	0	Z	47	0	0	0
Left Thigh					Pelvis				
X	0	0	0	0	X	0	0	-1	1
Y	0	0	-27	-74	Y	0	0	87	-82
Z	-196	264	0	0	Z	391	-302	0	0
Right Hand					Trunk				
X	0	0	0	0	X	0	0	-1	4
Y	0	0	0	0	Y	0	0	82	-22
Z	3	0	0	0	Z	302	-107	0	0
Right Forearm									
X	0	0	1	0					
Y	0	0	3	0					
Z	12	-3	0	0					

Table 1. Results of the forces on the wire model–Sitting position

limited movements. This condition is called pain syndrome cervical spine (cervical syndrome).

3.2. Energy balance during work activities

Determination of energy consumption for work activities of the heart surgeon is based on the determination of the three components of energy:

- Calculations of the energy used for the joints during the surgery;
- Calculation of BMR energy.

Energy usage for a work activity is a good indicator of the effort needed for job and the workload of workers while performing work activities.

Calculation of internal energy used on the joints

TTo determine the load on joints we start from the burden of individual segments of the right and left side of the surgeon. Analyzed are all the key points that are suffering load, such as joints of the arm, elbow, shoulder and spinal column as a point where the reflected all the stress. Also, all segments will be seen in the context of their freedom of movement.

The analysis was done in three positions: "Operating po-sition 1", "Operating position 2 ', and each of these positions will be considered in its characteristic segments. These seg-

Right Foot					Right Arm				
X	0	0	2	0	X	0	0	-4	-2
Y	0	0	-49	0	Y	0	0	7	-3
Z	-413	0	0	0	Z	30	-12	0	0
Right Leg					Left Hand				
X	0	0	19	-2	X	0	0	0	0
Y	0	0	-52	49	Y	0	0	0	0
Z	-386	413	0	0	Z	3	0	0	0
Right Thigh					Left Forearm				
X	0	0	36	-19	X	0	0	-2	0
Y	0	0	-55	52	Y	0	0	2	0
Z	-317	386	0	0	Z	12	-3	0	0
Left Foot					Left Arm				
X	0	0	-1	0	X	0	0	3	2
Y	0	0	-20	0	Y	0	0	9	-2
Z	-171	0	0	0	Z	30	-12	0	0
Left Leg					Head-Neck				
X	0	0	-10	1	X	0	0	0	0
Y	0	0	-19	20	Y	0	0	10	0
Z	-143	171	0	0	Z	47	0	0	0
Left Thigh					Pelvis				
X	0	0	-16	10	X	0	0	2	-2
Y	0	0	-22	19	Y	0	0	82	-77
Z	-74	143	0	0	Z	391	-302	0	0
Right Hand					Trunk				
X	0	0	0	0	X	0	0	2	1
Y	0	0	0	0	Y	0	0	77	-25
Z	3	0	0	0	Z	302	-10	7	0
Right Forearm									
X	0	0	2	0					
Y	0	0	3	0					
Z	12	-3	0	0					

Table 2. Results of the force on the wire model–standing position

ments are: when the body takes the correct position, but is not yet burdened with external load, then when the surgeon receives the load and the third position when the load is lifted at the end of the position. Calculation of internal energy used on the joints is carried out in the context of software analysis of this model using CATIA R5v19. The results of this calculation are presented in tables.

3.3. The internal operation of the upper extremities for "Operating position 1" (sitting, 0.5h)

For "Operating position 1" the sum of energy over work cycles that are spent on work activity 1 is 881 Nm.

For "Operating position 2" sum of energy over work cycles that are spent on work activity 2 is 1517 Nm. The internal operation of the upper extremities for "Operating position 2" (standing, 4.5 h).

The total internal energy for the one work cycle, which includes input, transfer and disposal of a piece of luggage, the sum of already obtained energy consumptions.

EU = 881 + 1517 = 2398Nm

Eu – internal energy spent on joints per surgery

Calculation of BMR energy

BMR = 66 + (13.7 · M) + (5 · H) − 6, 8 · Y)

M–Mass of the respondent expressed in kg H–Height of the respondent expressed in cm Y – Age in years

In this analysis, the height of the subject is 1.66 m, weight 62 kg and belongs to the age of 45 years:

BMR = 66 + (13.7 · 62) + (5 · 166) − (6,8 · 45) = 1439.4 kCal/day

Energy consumption based on the BMR for the period of work activity, it is considered that the length of shifts is 8 hours, obtained using the above obtained value for the day, and multiplying it by a factor of load and period of activities.

BMR = 1439.4 · 1, 8 · ⅓ = 836.4 kCal/shift

Calculation of total energy

The total energy required for surgeon during the shift is the sum of BMR and Eur

BMR = 836.4 + 2398 = 3234.4 kCal/per operation

From the results obtained in energy consumption can be concluded that these activities fall under the category of dif-ficult jobs. In order to gain a clearer picture of the load of this work, the energy consumption can be compared with the ac-tivities of taking down a tree with a hand ax. Since the imple-mented ergonomic analyzes have shown that these tasks are performed in an ergonomically very unfavorable conditions,

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4. CONCLUSION

From the results obtained in energy consumption can be concluded that these activities fall under the category of difficult jobs. In order to gain a clearer picture of the severity of this work, the energy consumption it can be compared with the activities of taking down a tree with a hand ax. Since the implemented ergonomic analyzes have shown that these tasks are performed in an ergonomically very unfavorable conditions, the conclusion is imposed about the urgent need of adaptation of these jobs.

- Conflict of interest: none declared.

REFERENCES

1. Alexander R. Biomehanika. Izdateljstvo „Mir", Moskva, 1970 (In Russian).
2. Bošnjaković R. Redukcija buke, Gospodarski vestnik, Ljubljana, 1981.
3. Barnes RM. Studij pokreta i vremena, Panorama, Zagreb, 1964.
4. Bulat V. Sistem čovjek - stroj, „Informator", Zagreb, 1984.
5. Čuljat M, Muftić O. Primjena ergonomskih načela u eksploataciji, poljoprivredne mehanizacije, Zbornik radova, Vinkovci, 1982.
6. Davis PR, Stubbs SA. Safe Levels of Manual Forces for Young Males, Applied Ergonomics. 1977; 8: 141-50.
7. Donskij DD, Zacijorskij VM. Biomehanika, Izdateljstvo „Fizkultura i Sport", Moskva, 1979.
8. Flugel B,Greil H, Sommer K. Anthropologischer Atlas, Verlag Tribune Berlin, 1986.
9. Grandjean E. Fitting the Task to the Man, Taylor Francis, London, 1984.
10. Hettinger Th. Muskelkraft bei Mannern und Frauen, Zbl.Arb. Wis 14, 1960: 79-84.
11. Kolesnikov AE. Šum i vibracija, „Sudostroenie", Lenjingrad, 1988.
12. Keros P, Muftić O. Utjecaj ergonomskih pristupa na industrijsko oblikovanje, Zbornik radova Ergonomija u Jugoslaviji, Zagreb, 1974.
13. Keros P, Pećina M. Temelji anatomije čovjeka, Jumena, Zagreb, 1977.
14. Mairiaux Ph, Davis PR. Relation between intraabdominal. Pressure and lumbar Moments when lifting in the erect posture, Ergonomija.1984; 27(8): 883-94.
15. Muftić O, Kuprešak Ž. Zavisnost statike radne sposobnosti u životnoj dobi, Zaštita. 1978; 13(2): 7-14.
16. Veljović F. Biomehatronika. Mašinski fakultet Univerziteta u Sarajevu. Sarajevo, 2013.
17. Veljović F. Osnovi ergonomije. Mašinski fakultet Univerziteta u Sarajevu. Sarajevo 2003.