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 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
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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

This paper is to show the organism encumbrance of cardiac surgeon and how much energy is spent in the course of a surgical procedure.
3.2. Energy balance during work activities

**Calculation of internal energy used on the joints**

To 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 position 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 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 0 | X 0 0 0 0 |
| Y 0 0 74 0 -74 | Y 0 0 0 0 |
| Z -286 292 0 0 | Z 3 0 0 0 |

| Right Thigh | Left Forearm |
|-------------|--------------|
| X 0 0 0 0 0 | X 0 0 -1 0 |
| Y 0 0 27 -74 | Y 0 0 8 -2 |
| Z -196 264 0 0 | Z 12 -3 0 0 |

| Left Foot | Left Arm |
|-----------|----------|
| X 0 0 0 0 0 | X 0 0 0 1 |
| Y 0 0 74 0 0 | Y 0 0 0 0 |
| Z -286 292 0 0 | Z 47 0 0 0 |

| Left Leg | Head-Neck |
|----------|-----------|
| X 0 0 0 0 0 | X 0 0 0 0 |
| Y 0 0 74 -74 | Y 0 0 0 0 |
| Z -286 292 0 0 | Z 47 0 0 0 |

| Left Thigh | Pelvis |
|------------|--------|
| X 0 0 0 0 0 | X 0 0 0 1 |
| Y 0 0 27 -74 | Y 0 0 82 -82 |
| Z -196 264 0 0 | Z 391 -302 0 0 |

| Right Hand | Trunk |
|------------|-------|
| X 0 0 0 0 0 | X 0 0 0 0 |
| Y 0 0 74 -74 | Y 0 0 0 0 |
| Z -171 0 0 0 | Z 30 -12 0 0 |

| Right Forearm | |
|---------------|---|
| X 0 0 0 0 0 | X 0 0 0 0 |
| Y 0 0 0 0 0 | Y 0 0 77 -25 |
| Z 3 0 0 0 0 | Z 302 -10 7 0 |

Table 1. Results of the force 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 per-
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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

\[
BMR = 66 + (13.7 \cdot M) + (5 \cdot H) + (6,8 \cdot Y)
\]

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 \cdot 62) + (5 \cdot 166) + (6.8 \cdot 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 \cdot 1,8 \cdot \frac{1}{3} = 836.4 kCal/shift

Calculation of total energy

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

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 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.

4. CONCLUSION

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• Conflict of interest: none declared.

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