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Analysis of visualization index using technique of simultaneous laparoscopic operations

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Abstract

Fatigue is a temporary decrease in the efficiency of an organism or organ due to intensive or long-term work, which is manifested in a decrease in quantitative and qualitative indicators of work and deterioration of coordination of work functions. Groups of simultaneous operations (411 patients) and group of single operations (746 patients) were formed. In both groups these changes were insignificant in most cases (except for marginal values in obese patients III, there were 6 such cases in the first group and 8 in the second), corrections of the port administration scheme were performed when performing vertical gastrectomy in both groups. After the calculation, the average deviations were 1.2 cm in the first group and 1.4 cm in the second. When using a laparoscope with a viewing angle of 0 o, the approach distance of the laparoscope with its own method of access on average during normal surgery is (6.92 ± 0.306) cm and is slightly smaller than standard methods, the average value of the studied parameter in the control group is - (6.98 ± 0.258) cm (p <0.001). Visualisation during simultaneous laparoscopic operations using our developed technique was on the level with single laparoscopic operation, performed classically.

Key words: visualization; laparoscopy; simultaneous; surgery

Fatigue is a temporary decrease in the efficiency of an organism or organ due to intensive or long-term work, which is manifested in a decrease in quantitative and qualitative indicators of work and deterioration of coordination of work functions [1]. Central to the issue is the concept of professional or industrial fatigue, because it has the greatest impact on the human condition, develops faster, requires longer rest. The causes of fatigue can be many, such as improper rest, poor quality of rest, physiological factors, or illness, low tolerance to stress as a result of untrained, etc [2]. Its signs in mental and nervous work are visible due to the decreased level of concentration, distraction, decreased RAM and the ability to think logically, slow reaction, tremor of the fingers, etc. Recovery processes after mental and nervous work are much slower than after physical work. Changes in the body of the worker, stress, mental stress are often not completely eliminated and accumulate, turning into chronic fatigue, or fatigue and various diseases. The most common diseases of mental and nervous work are hypertension, neurosis, peptic ulcer disease, atherosclerosis, cardiovascular events. This load causes fatigue very quickly, because it is combined, and the subjective feeling grows much faster than with any simple mechanical physical work, requires longer rest. It is known that fatigue does not develop in the muscles, but in the central nervous system, this concept was put forward by Ivan Sechin, and has been developed. Development of his concept found confirmation and continued in the works of Pavlov, Rosenblatt, etc [3]. Thus, it is known that the main factor is psycho-emotional stress, the work is meaningful, with the need for constant analysis of the situation and actions corresponding to the surgeon in the operating room. It is also known that physical factors of fatigue in such a situation accelerate its development, reduce resources for mental activity, increase the risk of error and cause a rapid increase in fatigue, and its consequences, increases the time required for rest [4]. It is known that the rate of fatigue depends on the working posture of the employee. Forced awkward posture limits the ability to perform rational methods of work, which leads to increased energy consumption, rapid fatigue. Rationalization of working processes is important [3]. Taking for example work during a conventional laparoscopic operation: if the surgeon's posture is uncomfortable due to the fact that he has to occupy it, the instruments are placed in the wrong position, then after some time fatigue and discomfort will cause to a worker, in addition to physical stress, negative emotions, which will lead to stress, which will increase fatigue from work, which will increase the risk of error. The surgeon is forced to look for a more optimal position, so he will move the assistant, which will force the assistant to move to an awkward position and this chain will be repeated for him. Impairment of visualization and fencing with instruments will increase the stress factor, increase the psycho-emotional load [5]. There are frequent cases when, due to inconvenience and physical fatigue, surgeons feel more tired after one usual but uncomfortable operation than after several such operations with preserved ergonomics [6]. The time of such interventions increases, as do the risks of errors. That forces fatigue to be considered as a serious aspect of work [7]. Adverse factors in the operating room make the largest contribution to surgeons' fatigue, and the cost of their error can be high, forcing ergonomics to be considered as a way to combat such factors [8]. There are several methods available to determine fatigue. The method of calculating the critical flicker fusion frequency is widely used. This method is based on the characterization of the visual analyzer by some level of functional ability [9]. This level is determined by the limiting frequency of flashes of light, which the subject ceases to catch as a separate flicker, and perceives as a continuous light signal. With increasing fatigue, this frequency decreases, the decrease is directly proportional to fatigue, because with increasing psycho-emotional fatigue suffers and the ability of sensory systems. The frequency of flicker fusion in hertz is measured [10].

The fusion frequency fluctuates during the work shift and is a statistical value. Its decrease indicates a decrease in efficiency, and in a state of high efficiency it increases, but can never be higher than a certain physiological limit [11].

The most accessible, and accordingly the most common, methods of studying the efficiency of people in the workplace are test methods. With the help of special tests they study the properties of nervous processes (excitation and inhibition) and mental functions - indicators of attention, memory, perception, emotional stress, etc.

In addition to objective methods of assessing efficiency, it is possible to determine the subjective feeling. The survey method studies the subjective state of employees, which is determined during the work process, they estimate the amount of fatigue in points: no fatigue - 0, mild fatigue - 1, medium - 2, strong - 3, very strong - 4 points.

The indicators obtained during the working day have various natural measurements and qualitative characteristics. In some cases, an increase in the value of the indicator indicates an increase in human efficiency, in others - a decrease. Therefore, it is necessary to standardize the indicators, which are carried out in this way [12].

For each indicator on the basis of the received time series its average variable value is calculated:

$$\bar{a} = \frac{a_0 + a_1 + a_2 + a_3 + a_4 + \ldots + a_n}{n}$$

n – amount of measurements.

After that, the natural values of the indicators are expressed in standardized indicators (x). To do this, each value of the time series must be divided by the average variable and multiplied by 100.

$$x_a^0 = \frac{a_0 \cdot 100}{\bar{a}}; \; x_a^1 = \frac{a_1 \cdot 100}{\bar{a}}; \; x_a^n = \frac{a_n \cdot 100}{\bar{a}}$$

Therefore, we obtain a standardized series for this indicator:

$$x_a^0; \; x_a^1; \; x_a^2; \; x_a^3; \; \ldots \; x_a^n$$

Similarly, calculations are made for all other indicators. In this case, the indicators of the functions, which increase with decreasing efficiency, must be transformed into inverse values. To do this, subtract 100 from each indicator; then change the sign to the opposite and add 100 again.

The obtained dynamic series of standardized indicators characterize the dynamics of individual functions of the employee during the work shift.

To assess the integrated rate at each moment of observation, it is necessary to find the arithmetic mean of the standardized performance of all functions at this time by the formula

$$K_{iнт_i} = \frac{k_i^z + k_i^y + \ldots + k_i^n}{n}$$

Kінт — integrated rate indicator at the time of observation i; $\boldsymbol{K}^{z,\, y,\, \ldots,\, n}$ — standardized indicators of functions z, y, ..., n in the moment of observation i; n — the number of studied functions.

Similarly calculated integrated rates indicators for each observation point are used to construct a performance curve during the work shift.

To evaluate the integrated indicator, it is necessary to use the method of non-parametric statistics, which allows to combine the indicators obtained by different methods (for example, the index of CFFF, hand strength, time of sensorimotor reaction, etc.). To do this, the number of cases in which there were no changes compared to the initial values of α, the number of cases of improvement of β and the number of cases of deterioration of γ.

The integrated efficiency indicator at each time of observation is calculated by the formula

$$K_{iнт_i} = \frac{\beta - \gamma}{\alpha + \beta + \gamma}$$

When studying the efficiency of a group of workers according to the above formula, the rate of change for each function at each time of observation of Ki is calculated. The integrated indicator of the change in the functional state of employees at the time of each observation is calculated by the formula

$$K_{iHT} = \frac{\sum k_i}{n}$$

n — the number of studied functions, which were used to calculate individual coefficients.

The values of the coefficients Ki and Kint vary from +1 to -1. The "minus" sign indicates the deterioration of the functional state of the employee's body.

Taking into account the different features of the dynamics of efficiency in different production conditions allows us to develop measures to optimize efficiency. However, these measures will be more effective only if the daily and weekly dynamics of working capacity are taken into account, if possible. Provided that the work is not planned and normalized, static, the optimization of the workflow is possible by improving working conditions, ergonomics. For the work of surgeons, when it is impossible to accurately predict the number and time of operations, their complexity, and estimate the load in advance, this approach is especially relevant.

Aim of work

The aim of the experiment was to compare our own developed method of performing simultaneous laparoscopic operations with conventional techniques of performing only one operation on such parameters as ergonomics and visualization of the target organ. This section compares only the technical performance of the two methods.

Matherials and methods

Statistical information collected from database of laparoscopic surgical unit of Volynian regional clinical hospital. Patients that were includet in survey underwent laparoscopic operations. Group #1 underwent laparoscopic simultaneous operations (with laparoscopic cholecystectomy) and group #2 underwent single laparoscopic operation. Patients were randomizwd only by comorbidity factor.

Initially, the study was conducted with the lower extremities on a spatial bench model-simulator, which was developed as a model of the operating area. The area of operation was defined as a sphere with a radius of 6.5 cm, as an area in which surgery occurs at a time that does not require changing the position of both the surgeon and the assistant, as well as refocusing the camera, which requires additional movements, stress and time. This volume is not accidental. It was determined experimentally, and was equal to the sphere described by the tips of the surgeon's instruments, when moving no more than 10O, while maintaining the principles of placement of ports and instruments and the introduction of instruments 2/3 of the length at 330 mm. The need to go out of this area, respectively, requires either additional stress and entry of the surgeon and assistant in non-ergonomic positions, or moving the surgeon and assistant, instruments that require additional movements, increases fatigue, operation time. So the less you have to perform such actions - the better and more comfortable way of operation it is. It is also important that sufficient visualization is ensured while maintaining the possibility of comfortable operation and effective manipulation. Laparoscopic operations by their nature require a high level of visualization, and if this visualization is not provided by the laparoscope, it is necessary to change its position, angle of view, distance to the target organ. According to the above - the more frequent is the need to change the position of the tools, the less effective is the method. Also when moving the laparoscope you need to take into account the possible effect of 'fencing', which has an extremely negative effect on the operation, especially when you need a very close approach to the target organ, and the smaller the distance to the surgical area, the greater the risk of laparoscopic eye contamination and need to its cleaning that adds even more movements, increases time of operation, reduces concentration of the surgeon. Therefore, the minimum distance to the target organ required for its qualitative visualization was also estimated.

To evaluate the methods according to the established criteria, we took into account the frequency of needs to change the area of operational influence, the position of the laparoscope, the frequency of the fencing effect. Also, an indirect method was used to assess ergonomics, namely the assessment of ergonomics itself, because it is quite difficult to perform in numerical and statistical terms, and the consequences of the awkward, tense position of the surgeon - fatigue.

It is important to note that to maintain stereometric relationships in people with different body types, it was necessary to adjust the location of the ports, which made some changes in the ergonomic components due to changes in angles and lengths. But in both groups these changes were insignificant in most cases (except for marginal values in obese patients III, there were 6 such cases in the first group and 8 in the second), corrections of the port administration scheme were performed when performing vertical gastrectomy in both groups. After the calculation, the average deviations were 1.2 cm in the first group and 1.4 cm in the second.

Therefore, all the above indicators were measured when performing laparoscopic simultaneous operations in the study group (group 1) and control group (group 2) in all subgroups of surgical treatment to determine the mean. Namely: the need to go outside the operating area (average number per operation), the need to change the operating area and relocate the surgeon and assistant, instruments (average per operation), the frequency of fencing (average per operation), the minimum required distance to the target organs. The results are presented in table 1.

Table 1 - Indicators of the studied parameters and the results of statistical analysis

Method of laparoscopic opetarion		Regular operations			Simultaneous operations		
Body type		normosthenic	hypersthenic	asthenic	normosthenic	hypersthenic	asthenic
Going outside the operating area	(M±SD) Min-max	7,23±0,81 2-11	7,36±0,91 4-12	6,12±0,13 1-9	7,68±0,83 2-11	7,56±0,93 5-12	6,21±0,13 1-9
Pearson correlation in subgroups (bilateral level of significance)	hyperstenic	r=0,995**; p<0,001	–	–	r=0,992**; p<0,001	–	–
	asthenic	r=0,995**; p<0,001	r=0,999**; p<0,001	–	r=0,993**; p<0,001	r=0,997**; p<0,001	–
Multidimensional analysis of variance (MANOVA)		p=0,992			p=0,990		
Changing the location of surgeons and instruments	(M±SD) Min-max	11,74±1,8 4-17	–	–	12,01±2,03 6-18	–	–
Pearson correlation in subgroups (bilateral level of significance)	hyperstenic	r=0,986**; p<0,001	–	–	r=0,995**; p<0,001	–	–
	asthenic	r=0,987**; p<0,001	r=0,981**; p<0,001	–	r=0,952**; p<0,001	r=0,963**; p<0,001	–
Multidimensional analysis of variance (MANOVA), Tukey's criterion	hyperstenic	p=0,023	–	–	p=0,034	–	–
	asthenic	p=0,011	p<0,001	–	p=0,033	p<0,001	–
The percentage of approaching laparoscope with the angle of observation. 0o to operation area, cm	(M±SD) Min-max	6,54±0,492 3,8-8,2	–	–	6,65±0,486 4,2-9,8	–	–
The percentage of approaching laparoscope with the angle of observation. 30o to operation area, cm	(M±SD) Min-max	8,12±0,918 4,5-9,5	–	–	8,72±0,257 4,5-10	–	–
Frequency of fencing	(M±SD) Min-max	4,12±0,58 2-6	4,17±0,88 3-8	3,55±0,41 1-6	4,21±0,61 3-7	4,53±0,91 3-8	3,68±0,56 3-8

Notes: 1. **. The correlation is significant at the level of 0.01 (2-tailed);
2. M±SD – mean ± standard deviation of the mean;
3. Min-max – minimum-maximum value.

There was a significant correlation between the indicators of going beyond the surgical area and the patient's body type (Pearson correlation) and the absence of a significant difference when comparing their mean values (MANOVA) in the two groups. Thus, the results of statistical analysis show that for each of the methods of operations, increasing or decreasing the distance between the ports, depending on the type of body type, does not affect the availability of the object of operation.

Results

When comparing the distance of approach of the laparoscope to the object of operation, it was found that most often there is a need to approximate the target organ in the hypertensive type of patients' body structure. Most often, this need arises due to the increased number of visceral fat deposits in the large cap, which forces surgeons to 'look' for them, which requires a closer approach to the target organ. Note that this type is often combined with another negative aspect during the operation - when working with the target, especially with the use of energy platforms (monopolar coagulation, bipolar coagulation, ultrasonic coagulation) may fly droplets of molten fat with subsequent contamination of the eyelid paw. Therefore, the study paid attention to such a parameter as the distance of the laparoscope to the target organ.

When using a laparoscope with a viewing angle of 0 o, the approach distance of the laparoscope with its own method of access on average during normal surgery is (6.92 ± 0.306) cm and is slightly smaller than standard methods, the average value of the studied parameter in the control group is - (6.98 ± 0.258) cm ($p < 0.001$).

Therefore, analysing the possibility of high image detail (if necessary, it is possible to bring the laparoscope closer) and the possibility of prospective inspection and reduce the risk of contaminating the laparoscope eye at a greater distance from the target organ, both methods showed comparable rates.

In addition, it was found that the use of a laparoscope with a viewing angle of 30 o for standard and native methods provides more optimal conditions compared to a laparoscope with a viewing angle of 0 o.

Conclusion

1. Both groups have shown similar results of visualization.

2. Laparoscope with 30-degree angle of visualization required less approximating, less changing of position during the operation.

3. Our developed technique of simultaneous laparoscopic operations is effective and safe. It provides acceptable visualization during simultaneous operations.

References

1. Fatigue // Universal dictionary-encyclopedia. - 4 types. - К.: TEKA, 2006.

2. Causes of Fatigue and How to Manage It // Krista O'Connell, Elaine K. Luo, MD / Healthline May 2, 2019

3. Krushelnytska JV Physiology and psychology of work: Textbook. manual. - К .: KNEU, 2000. - 232 с.

4. "Fatigue". MedlinePlus. Retrieved April 30, 2020.

5. Effects of fatigue on surgeon performance and surgical outcomes: a systematic review. // Sturm L, Dawson D, Vaughan R, Hewett P, Hill AG, Graham JC, Maddern GJ / ANZ J Surg. 2011 Jul-Aug;81(7-8):502-9.

6. The Effect of Operating Time on Surgeons' Muscular Fatigue // PS Slack, CJ Coulson, X Ma, K Webster Ann R Coll / Surg Engl. 2008 Nov; 90(8): 651–657. / doi: 10.1308/003588408X321710 PMCID: PMC2727807 PMID: 18990280

7. Addressing Surgeon Fatigue: Current Understanding and Strategies for Mitigation // Janhofer DE, Lakhiani C, Song DH. / Plast Reconstr Surg. 2019 Oct; 144(4):693e-699e. doi: 10.1097/PRS.0000000000006075.

8. Surgeon Fatigue. A Prospective Analysis of the Incidence, Risk, and Intervals of Predicted Fatigue-Related Impairment in Residents // Frank McCormick, MD; John Kadzielski, MD; Christopher P. Landrigan, MD, MPH; et al / JAMA Network/JAMA Surgery May 2012. Arch Surg. 2012;147(5):430-435. doi:10.1001/archsurg.2012.84

9. Mantrova, IN Methodical guide on psychophysiological and psychological diagnostics / IN Mantra. - Ivanovo: LLC "Neurosoft", 2008. - P. 20 - 42

10. Filippov MM Human psychophysiology, Kyiv, 2003. - P.101–102.

11. Hadjinova, EP Emotional state, features of attention and antistress reactions with different types of profile of the lateral organization of the brain / E.P. Khadzhinova, LK Buslovskaya // Scientific Bulletin of Belgorod State University. Natural science. - Publisher: NIU BelGU - 2012. - №15 (134). - P. 103-109.

12. Medvedeva OA, Tarasenko AA, Aleksanyants GD // Modern problems of adaptive physical culture, adaptive sports and physical rehabilitation; Proceedings of the All-Russian Conference with International Participation (Krasnodar, December 10-11, 2009). - Krasnodar, 2009. - P. 182–185.