

## **Analysis of fatigue in surgeons after 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. The frequency of fencing also depended on the type of the body type of the patient, but with recalculation and averaging it was similar in both groups ( $4.18 \pm 0.228$  for their own method and  $3.98 \pm 0.201$  in the group of standard equipment). The similarity and severity and nature of changes in both groups are very noticeable on the diagrams. The changes are comparable, and are easily explained by the longer operation time and the larger amount of work, in comparison with the usual technique of one operation. Also, the changes did not exceed 15%, which indicates a slight work fatigue, and does not lead to overfatigue.

Our developed technique of simultaneous laparoscopic operations is effective and safe. It provides acceptable level of ergonomics and does not increase physical or mental pressure on surgeon.

**Key words: fatigue; 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. 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]. If 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].

### **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 the fatigue of surgeons caused by operations performed using two methods.

### **Materials and methods**

Statistical information collected from database of laparoscopic surgical unit of Volynian regional clinical hospital. Patients that were included in survey underwent laparoscopic operations. Group #1 (n=411) underwent laparoscopic simultaneous operations (with laparoscopic cholecystectomy) and group #2 (n=746) underwent single laparoscopic operation. Patients were randomized only by comorbidity factor.

After each operation surgeon underwent testing. In the survey method of estimating critical frequency of flicker fusion was used to evaluate mental fatigue. Method of estimating relative strength in surgeons was used evaluate physical fatigue.

The frequency of fencing also depended on the type of the body type of the patient, but with recalculation and averaging it was similar in both groups ( $4.18 \pm 0.228$  for their own method and  $3.98 \pm 0.201$  in the group of standard equipment).

The dynamics of fatigue development in surgeons after laparoscopic surgery are shown in Tables 1 (measurements of the critical frequency of flicker fusion), 2 (measurements

of muscle strength). Measurements were performed before and after operations to ensure the possibility of comparing the dynamics and assessing the impact of the operation on the condition of the surgeon.

**Table 1** - Critical flicker fusion frequency in surgeons (Hz), mean values

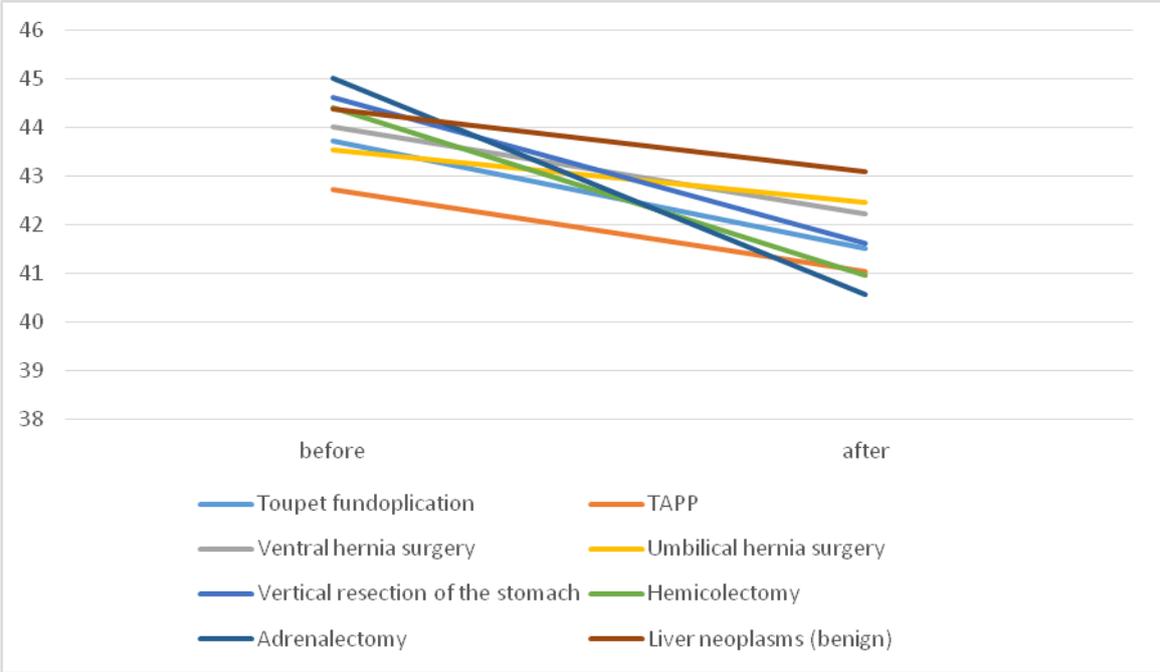
Name of surgery	Group of simultaneous operations (with cholecystectomy)(n=411)			Group of regular operations (n=746)		
	Before	After	Change	Before	After	Change
<del>Before/after operations</del>						
Toupet fundoplication	43,74	41,51	2,23	43,69	41,49	2,2
TAPP	42,72	41,05	1,67	43,25	41,32	1,93
Ventral hernia surgery	44,01	42,22	1,79	43,82	42,51	1,31
Umbilical hernia surgery	43,55	42,47	1,08	43,14	42,46	0,68
Vertical resection of the stomach	44,63	41,62	3,01	44,24	41,4	2,84
Hemicolectomy	44,42	40,98	3,44	43,97	41,06	2,91
Adrenalectomy	45,03	40,58	4,45	44,72	41,18	3,54
Liver neoplasms (benign)	44,39	43,09	1,3	44,49	43,82	1,67
Pancreatic neoplasms (benign)	45,11	40,85	4,26	44,68	40,64	4,04
Adhesiolysis	43,36	42,35	1,01	43,76	42,11	1,65
Choledocholithotomy	44,08	41,56	2,52	44,71	42,29	2,42
Antegrade cholangiography	42,89	42,07	0,82			

It is noticeable that in the group of simultaneous operations the critical frequency of flicker fusion decreased more (though not critically) in almost all subgroups than in the group of standard operations. Graphs 1 and 2 show this more clearly.

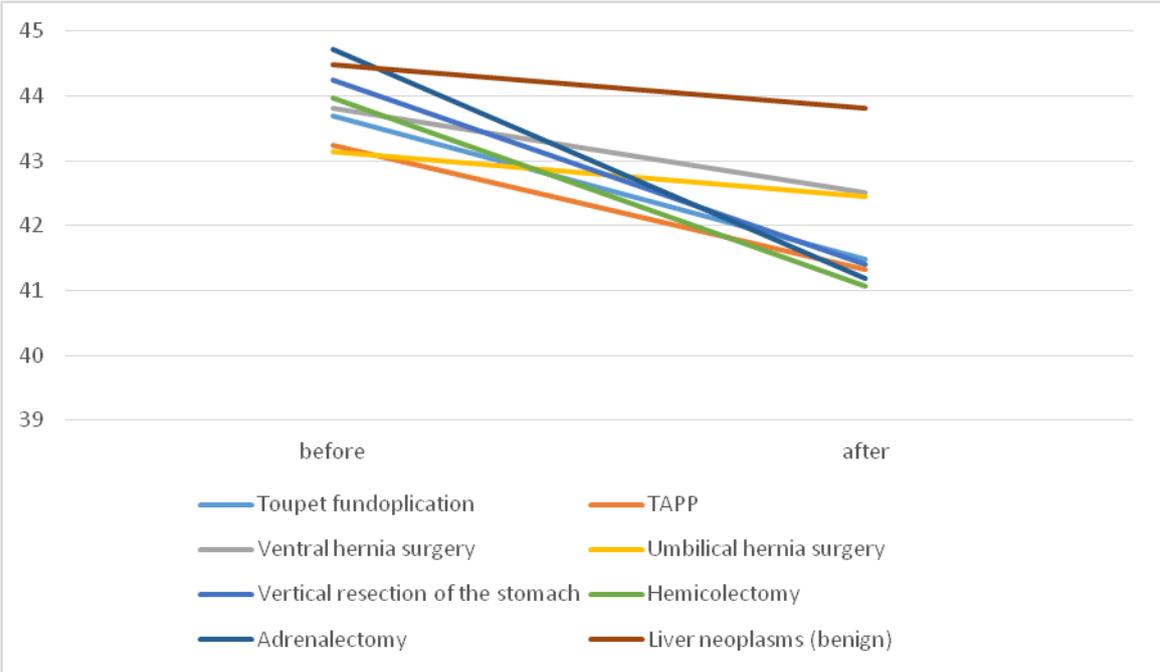
For clarity of comparison, the data is shown in diagrams 1 and 2, the nature and degree of psychological fatigue are similar in both groups. Although these changes occurred within the normal response of the human eye (40-46 Hz), which indicates the absence of the development of psychological fatigue after surgery. This, in turn, means that for recovery in both groups, a normal rest of 15 minutes is enough. breaks, according to the recommendations of working hygiene [3].

The method of measuring relative strength was used to assess muscle fatigue. Relative force is the compression force of the dynamometer (stronger hand) / body weight \* 100%. This assessment is very quick and easy, does not require a lot of money or time, while ensuring sufficient accuracy in assessing the physical component for statistical analysis and

characteristics of physical fatigue in surgeons after surgery. Tests were also performed before and after surgery, as for the critical flicker fusion frequency.



**Diagram 1** - The critical frequency of flicker fusion in surgeons (group 1) before and after operations in the group of simultaneous laparoscopic surgical treatment (with laparoscopic cholecystectomy) in Hertz (Hz)



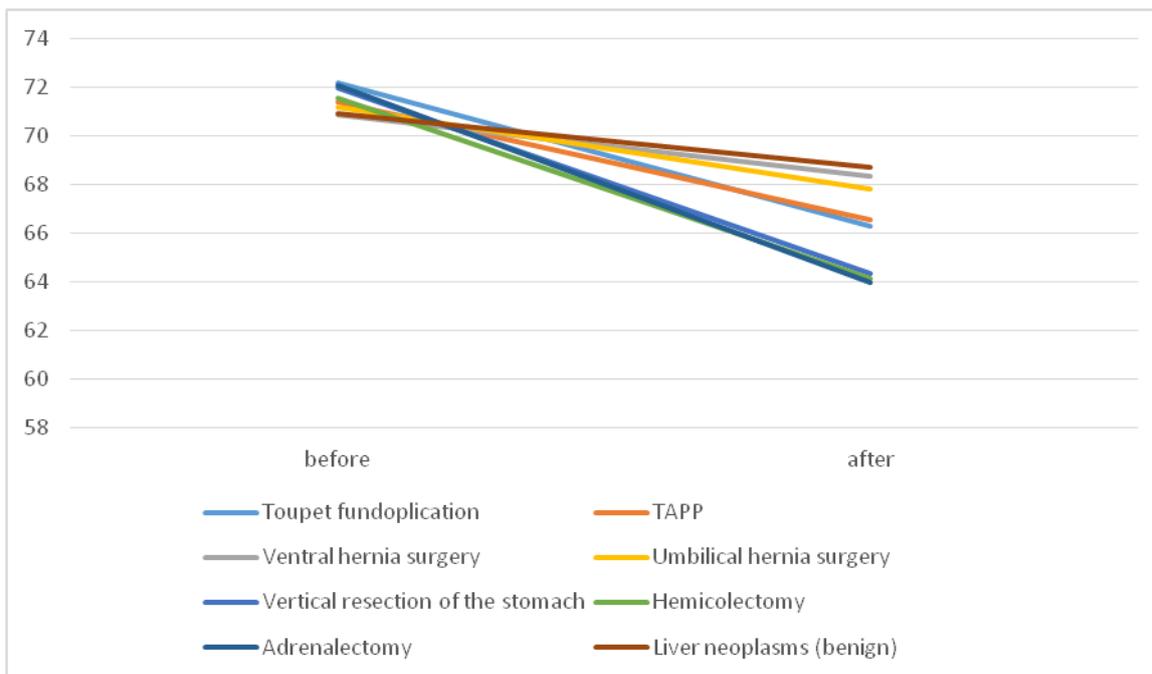
**Diagram 2** - The critical frequency of flicker fusion in surgeons (group 2) before and after operations in the group of regular laparoscopic surgical treatment in Hertz (Hz)

**Table 2** - Relative strength in surgeons (in%), average values

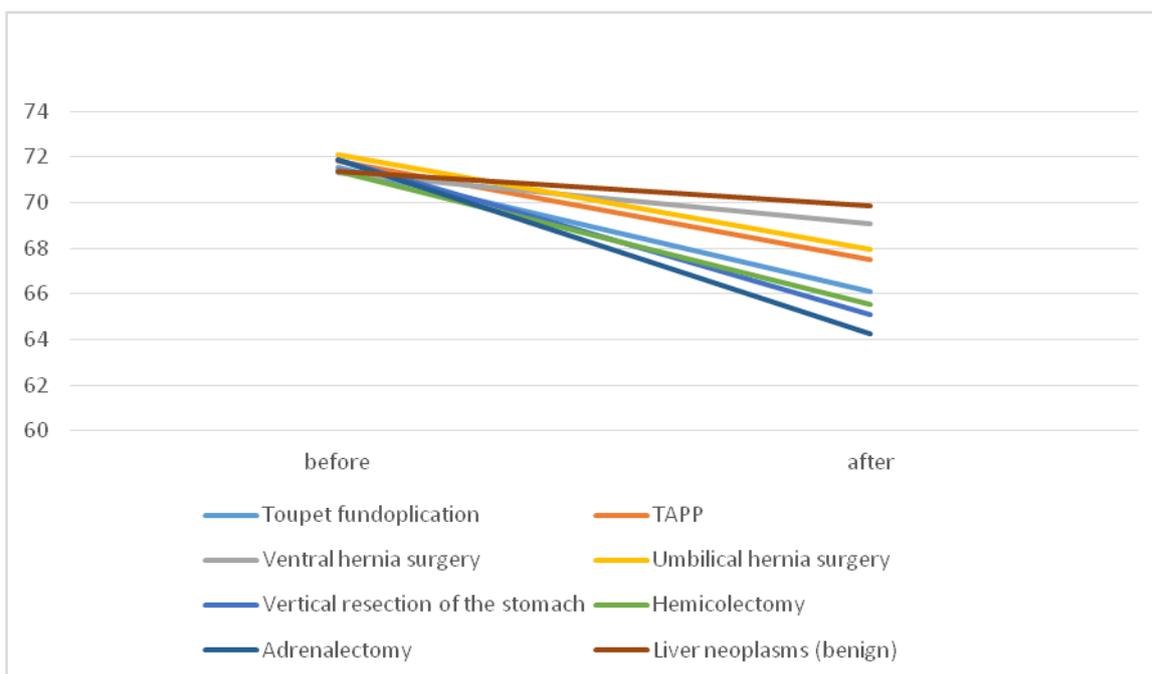
Name of surgery	Group of simultaneous operations (with cholecystectomy)(n=411)			Group of regular operations (n=746)		
	Before	After	Change	Before	After	Change
<del>Before/after operations</del>						
Toupet fundoplication	72,21	66,28	5,93	71,54	66,12	5,42
TAPP	71,41	66,58	4,83	71,82	67,5	4,32
Ventral hernia surgery	70,88	68,34	2,54	71,33	69,05	2,28
Umbilical hernia surgery	71,22	67,81	3,41	72,12	67,94	4,18
Vertical resection of the stomach	72,02	64,38	7,64	71,88	65,08	6,8
Hemicolectomy	71,58	64,12	7,46	71,39	65,52	5,87
Adrenalectomy	72,11	63,98	8,13	71,86	64,25	7,61
Liver neoplasms (benign)	70,95	68,72	2,23	71,39	69,88	1,51
Pancreatic neoplasms (benign)	71,45	64,82	6,63	72,06	66,01	6,05
Adhesiolysis	70,97	68,39	2,58	71,57	69,22	2,35
Choledocholithotomy	70,84	65,76	5,08	71,36	66,66	4,7
Antegrade cholangiography	71,39	66,82	4,57			

You can also see that in the group of simultaneous operations there is a slight increase in physical fatigue, but these changes are uncritical, and muscle strength remains high (more than 60%, which is a good indicator for adults). It is also worth noting and taking into account the specifics of the work process of surgeons, because it is known that people with a physical component of work have a higher relative strength, for surgeons it is within an additional 5%.

For clarity, the data on the change in relative strength is shown in Diagrams 3 and 4. The similarity and severity and nature of changes in both groups are very noticeable on the diagrams. The changes are comparable, and are easily explained by the longer operation time and the larger amount of work, in comparison with the usual technique of one operation. Also, the changes did not exceed 15%, which indicates a slight work fatigue, and does not lead to overfatigue. Therefore, in both groups, 15 minutes breaks are enough for recovery from work in accordance with working hygiene [3].



**Diagram 3** - Relative strength in surgeons (group 1) before and after simultaneous laparoscopic operations (with laparoscopic cholecystectomy) (in%)



**Diagram 4** - Relative strength in surgeons (group 2) before and after performing regular laparoscopic operations (in%)

## Results

In summary, we can say that there is no lag in the technical aspect of the technique of simultaneous operations. The level of visualization remains high. The frequency of side

effects and ‘fencing’ also does not increase in the group of simultaneous techniques. The minimum distance to the target organ is at a comparable level in both groups, which provides similar comfort for the surgeon and assistants in the group of classical techniques of one operation, and in the group of techniques of simultaneous operations. Both psychological and physical fatigue remain at a comparable level and do not reach the level of fatigue. This in turn indicates compliance with working hygiene.

### **Conclusion**

1. Physical fatigue did not differ in any subgroup of both groups. All measurements of relative physical health was on the point of slight physical fatigue after operation.

2. Mental fatigue did not differ in any subgroup of both groups. All measurements of CFFF showed normal mental reaction in surgeons.

3. Our developed technique of simultaneous laparoscopic operations is effective and safe. It provides acceptable level of ergonomics and does not increase physical or mental pressure on surgeon.

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