Aging population, increases the number of major abdominal surgery (MAS) performed in the elderly. Main goal of physiotherapy after that surgery is prevention postoperative complications and reduction of functional limitation. 

**The aim of the study** was to assess functional status elderly people after MAS during early postoperative physiotherapy.

**Material and methods.** In a prospective randomized study involved 34 patients scheduled for elective MAS, aged 65+. Patients were randomly assigned to receive PNF or conventional physiotherapy. The study included forced spirometry (FVC, FEV1, PEF) and functional tests (gait speed, up&go). Measurements were performed before surgery and the fourth day after surgery. Also analyzed age, sex, BMI and the level of postoperative independence (postoperative independence scale SAP). Kolmogorov-Smirnov test was used to check normal distribution, t-Student was used to check whether two sets of data differ significantly, and r-Pearsons for correlations testing. p values <0.05 were considered significant.

**Results.** After surgery the time of gait speed test and up and go test was significant longer in comparison to preoperative value. FVC%, FEV1%, PEF% values was decrease. In the PNF group was found significantly higher postoperative independence(SAP) and shorter length of stay in hospital compared to conventional physiotherapy group. Results of SAP and functional tests were significantly positive correlated.

**Conclusions.** Major abdominal surgery decrees efficiency of walking and lung ventilation after 65 year old in early postoperative period. Some techniques of the PNF concept used in improving older patients after the MAS may favourably affect the postoperative increase independence and reduce the time of hospitalization.

**Key words:** physiotherapy, colorectal surgery, elderly people, PNF (proprioceptive neuromuscular facilitation), functional status

The prolongation of the average lifespan creates new challenges for clinicians concerned with health problems of the elderly. Careful estimations of demographers indicate the increase of the number of the age group 65+ to the level of 25% of population in Poland within the next 20 years, with the present level of about 13% (1, 2, 3).

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The old age is a significant risk factor of colorectal diseases requiring surgical treatment. Colorectal cancer morbidity, occurrence of complications of colorectal cancer, complications of diverticular diseases as well as the risk of intestinal ischemia increases in people aged over 65 years (4, 5). If the prospect of returning to comparable level of daily activity and at least the same lifespan after the operations is realistic, the patient’s age is not a contraindication for surgery, even though it is a significant burden and increases the risk of postoperative complications (6-9).

The high risk of postoperative complications in the elderly, the persistent functional limitations after major abdominal surgery and economical factors stimulate the development of the Fast Track Surgery concept. These are programmes of early mobilization after major abdominal surgery effected with the strict cooperation of surgeons, anaesthesiologists, physiotherapists and nurses. Key elements of Fast Track Surgery are patient education, low invasive surgery, optimal anaesthetic procedure, reduction of postoperative intestinal obstruction, pain reduction, early feeding and full and early patient mobilization. One of the most important elements of the programme is physiotherapy directed at reduction of complication risk and fast patient mobilization. Detailed programme of physiotherapy is developed based on general condition, functional efficiency of the patient, the risk of complications, hospitalization time before surgery, the type of surgical intervention before surgery and method of anaesthesia. The steady elements of physiotherapy aim at maintenance of normal lung ventilation, efficient circulation – especially in the venous system of the lower limbs – and early pionization and walking (10-14).

Early mobilization of patients after major abdominal surgery consists in aiming at fast, gradual and safe pionization, efficient walking and full self-dependence at everyday living. The learning of pionization, respiratory, anticoagulant and general rehabilitating exercises should be started in the postoperative period. The beneficial situation is longer preparation for surgery by normalization of function of individual systems, increase of circulatory-respiratory efficiency, endurance and coordination. Directly before surgery, education includes respiratory exercises, effective cough, stabilization of the future postoperative wound, anticoagulant and general rehabilitat- ing exercises. Postoperative physiotherapy starts within several hours after the end of surgery.

In the beginning, it is a bedside rehabilitation and includes anticoagulant prophylaxis, respiratory exercises and effective cough with stabilization of a wound. Full pionization and walking starts usually on the first day. The first steps after the operations are taken by the patients with safeguard of physiotherapist, if needed, with the use of frame or support. From the beginning, it is aimed at rhythmic gait with allowing – if needed – a slightly inclined silhouette. Full patient mobilization does not end the process of rehabilitation. Depending on operations extend and patient condition, returning to full efficiency takes from several weeks to several months. In some patients, especially obese, with protein deficiencies, a special abdominal belt is recommended. The belt should be used until the full wound healing excluding the night rest (15-20).

Using of PNF concept (Propriceptive Neuromuscular Fascilitation) in perioperative rehabilitation facilitates global perception of needs and limitation of the patient while not limiting of the process of rehabilitation to prevention of complications. Philosophical assumptions of the concept are in favour in this regard. Positive attitude to the patient and his/her problems, global observation and consideration of global motor activities, mobilization of patient’s reserves by positive start of rehabilitation, functional thinking in the prospect of daily activities and pain reduction. Among main principles of facilitation of impulse transmission along nervous pathways in PNF concept, verbal, visual and manual contact of therapist with the patient is of special importance. The proper grip (so-called lumbrical grip) allows appropriate stimulation of receptors, facilitation of desired movement direction and dosing of optima manual resistance. Knowledge of irradiation principles i.e. radiation of stimulation of muscular tone secures from undertaking inappropriate movements and inducing dangerous tensions of operated region (23, 24, 25).

The study purpose was evaluation of functional state of the elderly after major surgery rehabilitated by different methods, according to traditional postoperative physiotherapy and with use elements of PNF concept.
MATERIAL AND METHODS

The study involved 41 patients of Clinical Department of General and Colorectal Surgery of Jerzy Popiełuszko Bielański Hospital in Warsaw qualified for major abdominal planned surgery. Participants were over 65 years of age. Recruitment for the study lasted from July 2010 to January 2012. The main reason for surgery of the patients were tumours of large intestine (79%), reconstruction of continuity of gastrointestinal tract (18%) and plastic surgery of major peristomal hernia (3%).

The patients were randomly assigned to the group rehabilitated by method with use of elements of PNF concept of a group subjected to traditional physiotherapy, based on classical kinesitherapy, further referred to as traditional group. Functional state in both groups was similar. Based on scale of evaluation of complex everyday activities (IADLS), full self-dependence of most of the patients was fund (88%). All patients were able for independent movement, in one case with the help of a walking stick. In the mental area, the patients presented with condition allowing conducting surveys. Most of the patients had at least one concomitant chronic disease (62%), with clear domination arterial hypertension joint degeneration. The distribution of individual characteristics in the studied groups is shown in tab. 1.

Some patients were excluded from the study upon its course. In four cases, there were contraindications for final tests as fever, diarrhoea and serious complications of postoperative wound. One patient refused participation in the final examination without giving reasons. The results of two studied patients were not considered in the analysis due to inappropriate qualification for the study, patients had low invasive surgery. 34 patients finished the study.

The initial examination was carried out three days before planned surgery, in included forced spirometry, functional tests and evaluation with the use of scales. Then, physiotherapy was carried out before and after surgery according to the methods for a give group. The final examinations were carried out on the fourth day after the surgery. Then, the initial tests were repeated, apart from it, during all postoperative hospitalization period, the level of patient independence was evaluated (SAP scale). In the study, the following tests and functional scales were used: 10-meters test of gait velocity, Timed Up&Go test, scale of evaluation complex daily activities (IADL Instrumental activity daily living scale) also called Lawton’s scale, scale of daily activity of UCLA (University of California Los Angeles) and original scale of independent postoperative patient’s activity (SAP). SAP scale was created for this study. It is used for determination of rate of independence return in basic movement activities on the first days after the operation. It evaluates in what time after surgery the patient starts independent rotating in the bed, carry out respiratory exercises, sitting with lower limbs down and lies down on the bed safely, walk in the room and a corridor and up and down the stairs. The sooner after surgery the patient carries out the given activity, the more points he/she receives. The maximal available value is 50 points tab. 2).

For evaluation of lung ventilation efficiency of the patients, ultrasound spirometer Easy One was used. The essential element of spirometer software is a database of due values, due to it is possible to show the results as a percent of the norm determined respectively for a given age, sex, race, mass and height. In the study, three indexes were evaluated, forced ventilation capacity (FVC), first-second forced expiratory volume (FEV1), and maximal expiratory flow (PEF). The study was carried out in pitting position.

Apart from the above mentioned research tools, subjective and objective study was carried out for needs of postoperative physiotherapy. Age, mass and height was determined, perimeter hips and waist, dietary habits,
smoking status, concomitant diseases and surgical history. After surgery, the procedure type, time of drains removal, urinary catheter and intrathecal anaesthesia, time to start oral feeding and discharge from the department. Data was collected in the study card prepared for that reason.

Perioperative rehabilitation, the same for all study subjects aimed at prevention of complications and reduction of functional limitations related to the operation by the early and full mobilization. Each patient had every day from Monday to Friday 30 minutes of individual exercises with physiotherapist and included in that time instruction of exercises for individual practice. The intensity of trainings was contained in the range of 40-50% of Maxima frequency of heart contractions. The physiotherapy is divided into two stages, before and after the operations. The first started on the day of admission of the patient to the department and included education and preparation for the operations, the second lasted from the first hours after the surgery until the day of discharge. In both groups, the learning of anticoagulant exercises, the effective cough and stabilization of the future surgical wound was the same. For both groups, the proceedings in the case of learning respiratory exercises and change of position was different. In the group rehabilitated traditionally, learning of breathing by thoracic course was based on active exercises free supported by upper limbs, in PNF group, manual resistance on sternum was used, upper and lower limbs, stimulation with the use of repeated initial stretch and bilateral symmetric moving standards of shoulder girdle and upper limbs. Differences in pre-operative education concerned also changes of position and method of mobilization. In the group traditionally rehabilitated, active free exercises were introduced of the lower limbs, upper limbs and trunk and instruction of position changes. In PNF group, turning to the sides were thought with the use combination of shoulder-blade and pelvis, i.e.tj. front elevation of the pelvis with concomitant anterior depression of the shoulder-blade, with transition from lying on the side to sitting, standard of posterior depression of the shoulder-blade, abduction, internal rotation of the upper supporting limb. In pitting position, reversible stabilization was used and so-called scooting, i.e. alternate movements of the pelvis forth and back.

Statistical analysis was carried out with the use of software SPSS 14.0. Kolmogorow-Smirnow test was used testing normality of distribution of a variable; t-Student test for dependent samples and r-Pearson’s analysis of correlation. p=0.05 level of significance was accepted.

RESULTS

In order to check if the method of rehabilitation had influence on the obtained results in measurements of indexes before and after operation, t-Studenta test was carried out for dependent samples. The results were show in tab. 3.

In both groups, statistically significant changes occurred of the evaluated indexes. In was found that in case of velocity test (s) and up&go test (s), an increase of index level occurred after the operations compared to the level before operation. In case of spirometric

<table>
<thead>
<tr>
<th>Independent patient activity</th>
<th>Time after surgery in hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12h</td>
</tr>
<tr>
<td>Turning in bed</td>
<td>5</td>
</tr>
<tr>
<td>Respiratory exercises</td>
<td>5</td>
</tr>
<tr>
<td>Sitting with the legs down</td>
<td>5</td>
</tr>
<tr>
<td>Safe lying down</td>
<td>5</td>
</tr>
<tr>
<td>SStanding by the bed</td>
<td>-</td>
</tr>
<tr>
<td>Walking in the room/going to toilet</td>
<td>-</td>
</tr>
<tr>
<td>Walking on the corridor for at least 50 meters</td>
<td>-</td>
</tr>
<tr>
<td>Staying out of the bed for at least 30 minutes</td>
<td>-</td>
</tr>
<tr>
<td>Coming one floor up and down the stairs</td>
<td>-</td>
</tr>
<tr>
<td>Returning to full activity</td>
<td>-</td>
</tr>
</tbody>
</table>

Total number of points
indexes FVC%, FEV1%, PEF%, a decrease of values after the operations occurred compared to the level before operation.

Differences between traditional group and PNF group concerning the result in SAP scale and hospitalization time were examined by t-Student test for independent samples. In tab. 4, the results of t-Student test are shown.

The mean level in SAP scale in PNF group was 36.94 (SD 6.85), and in a traditional group 28.31 (SD 6.66). Mean hospitalization time in PNF group was 7.94 (SD 1.3), and in traditional group 11.75 (SD 6.16) (fig. 1, 2).

In order to determine the relationship between changes of values of efficacy indexes and the level of SAP scale, indexes of the difference were calculated. From the value of analyzed indexes after the operation, the value before operation was subtracted and it was determined whether there is any relationship of these differential indexes and a level on a SAP scale. r-Pearson’s correlation analysis was used. In tab. 5, the results of conducted analyses were shown.

Table 3. Results of t-Student test for dependent samples concerning significance of a change of values of indexes measured before and after surgery in division into rehabilitation methods

<table>
<thead>
<tr>
<th>Index</th>
<th>Traditional group</th>
<th></th>
<th>PNF group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>test value</td>
<td>level of significance</td>
<td>test value</td>
<td>level of significance</td>
</tr>
<tr>
<td>Velocity test (s)</td>
<td>t(13) = 4.66</td>
<td>p &lt; 0.001</td>
<td>t(16) = 4.22</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Up and go test (s)</td>
<td>t(13) = 3.71</td>
<td>p = 0.003</td>
<td>t(16) = 2.82</td>
<td>p = 0.012</td>
</tr>
<tr>
<td>FVC%</td>
<td>t(15) = 4.86</td>
<td>p &lt; 0.001</td>
<td>t(16) = 6.14</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>FEV1%</td>
<td>t(15) = 4.23</td>
<td>p = 0.001</td>
<td>t(16) = 5.35</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>PEF%</td>
<td>t(15) = 5.66</td>
<td>p &lt; 0.001</td>
<td>t(16) = 2.82</td>
<td>p = 0.012</td>
</tr>
</tbody>
</table>

Table 4. The results of t-Student test for dependent values concerning the significance of a difference for dependent samples regarding significance of difference between traditional group and PNF group in respect of values level of SAP scale and hospitalization time

<table>
<thead>
<tr>
<th>Index</th>
<th>Test value</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP</td>
<td>t(32) = 3.72</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Hospitalization time</td>
<td>t(32) = 2.42</td>
<td>p = 0.027</td>
</tr>
</tbody>
</table>

Table 5. Correlation coefficients between the level on SAP scale and differences in measurements after and before surgery for measuring variables analyzed in the study obtained from r-Pearsons analysis of correlation

<table>
<thead>
<tr>
<th>Measuring variable</th>
<th>Correlation coefficient for SAP scale</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity test (s)</td>
<td>-0.47</td>
<td><strong>0.007</strong></td>
</tr>
<tr>
<td>Up and go test (s)</td>
<td>-0.32</td>
<td>0.082</td>
</tr>
<tr>
<td>FVC%</td>
<td>0.16</td>
<td>0.359</td>
</tr>
<tr>
<td>FEV1%</td>
<td>0.20</td>
<td>0.261</td>
</tr>
<tr>
<td>PEF%</td>
<td>0.26</td>
<td>0.137</td>
</tr>
</tbody>
</table>

**Ryc. 1. Values of SAP scale in division into rehabilitation methods, p=0.001**

**Ryc. 2. Hospitalization time in division into rehabilitation methods, p=0.027**
Statistically significant relationships were found between the level of value in SAP scale for velocity test. In means that when the more increase of value in velocity test occurred in the studied subjects, they had the lower level in SAP scale. Also, the clear tendency to occurrence of the relationship between the level in SAP scale and the difference in the results of „up&go” test. It would mean that the more increase of values in „up&go” test, the lower level in SAP scale they would have.

**DISCUSSION**

The study of functional state of the elderly after major abdominal surgery resulted in some observations which should be analyzed in the light of current knowledge and up-to-date studies. It is concluded from the analysis of indexes of gait efficiency and lung ventilation efficiency that there were statistically significant changes in measurements conducted on the fourth day after the operations compared to initial measurements. Mean time to conduct of gait velocity test was prolonged by 34.8% (n=34), and „up&go” test by 35.8% (n=34). Based on the obtained results in both tests, 10 people were classified for the group of increased risk of falls. Similar changes are described by Lawrence in his studies (9). Measurement which He did 7 days after major abdominal operations in the group of the elderly indicated prolongation of „up&go” test by 32% on average (n=372). The following measurements done by Lawrence in longer time periods showed that return to mean values in „up&go” test occurred after 6 weeks after operation.

Statistically significant changes concerned also spirometric indexes. Forced vital capacity (FVC) measured on the forced day after operation decreased by 16.9% on average (n=34), first-second forced expiratory volume (FEV1) by 15.7% (n=34), maximal expiratory flow (PEF) by 20% (n=34). In the study of Ribeiro et al., on the fourth day after the abdominal operations, a decrease of mean values of FVC by 23.8% (n=30), and FEV1 by 16.7% (n=30) (16). Schwenk et al. report that on the fourth day after resection of the tumour by classical method, mean FVC values in the group of the elderly by 14% (n=31) were lower than initial (11). A decrease of values of all indexes was observed also by Basse (12). In a group of patients aged 75 year on average, on the fourth day after laparotomy due to intestinal tumour, mean FVC values decreased by 13% (n=70), FEV1 (n=70) by 18% (n=70), and PEF by 15% (n=70). Original results are close to the values presented in other such studies and unanimously indicate a decreased lung ventilation efficiency in the early postoperative period, possible risk of respiratory complications and the need of prevention of these complications. The influence on the values obtained in the spirometric study may have two additional factors, the level of postoperative pain and fear of injuring the operated region. In relation to this, a decrease of the values of indexes of the spirometric indexes not necessarily indicates a decrease of power of respiratory muscles. However, the risk of occurrence of postoperative respiratory complications increases independently from the fact if the lung ventilation is limited by pain, fear or low muscle strength. Also, it should be stressed that in the examination of patients after abdominal operations, spirometry does not serve for evaluation of respiratory efficiency (in order to do that, arterial blood gasometry is carried out) but for quantitative evaluation of a degree of impairment of lung ventilation function (18, 19).

Also, differences in the level of points in the scale of independent patient activity in the studied groups are of note. It was found that PNF group had higher level in SAP scale compared to a traditional group. The difference in mean values of SAP points was over 23% (n=34). Higher level of values in PNF group may indicate a beneficial influence of the concept of Propriceptive Neuromuscular Facilitation on functional state and patient motivation. Occurrence of respectively lower differences in gait velocity tests and up and go test is significant, where values SAP scale are definitely higher. The obtained result is significant for programming of the early rehabilitation of the elderly after major abdominal surgery. Patients who earlier undertake activities related to pionization and walking are in the group of the lower risk of complications. Thus, it may be concluded that early physiotherapy after major abdominal surgery of the elderly, based on PNF concept, may improve patient indepen-
Physiotherapy based on PNF concept for elderly people after conventional colon surgery

dence more than traditional methods. The meaning of results in SAP scale should not be overestimated, however adjustment of individual points to functional deficits to functional deficits occurring directly after the operation causes that it may be useful for evaluation of patient independence.

The following analysis concerned the hospitalization time of the study subjects. It is a parameter often used for evaluation of efficacy of therapeutic programmes. The length of stay in hospital department becomes especially important in the context of programmes of fast surgical track. Of course shortening of this time is not the aim itself and always should correspond with safety and influence an increase of patient quality of life. The results of analysis indicate at the same time significantly shorter time of patient hospitalization of patients from PNF group. Mean difference of hospitalization time was 3.8 days, this means that patients from the traditional group had longer hospital stay by 1/3. However, drawing a conclusion on this basis of direct influence of PNF method on shortening of hospitalization time would be an exaggeration. It should be taken into consideration that the condition of the early discharge of the patient from surgical department is, among other things, fast return of intestinal peristalsis and a good functional state. If next studies on the influence of the method of rehabilitation on hospitalization time would confirm the importance of PNF concept, it would be a significant impulse for development of physiotherapy in programmes of „Fast Track Surgery”, especially in colorectal surgery.

Recapitulating the studies on functional state and methods of rehabilitation of the elderly after major abdominal surgery, it may be concluded that rehabilitation in general and colorectal surgery is very important for the whole treatment process. Despite the development of low-invasive surgical techniques, most of the intestinal operations is carried out with the use of so-called classical approach with extensive cut of the integuments and so with the increased risk of the complications. Appropriate intervention of a physiotherapist is in this situation very valuable for the elderly with concomitant diseases. Ina view of aging population and increased intestinal morbidity, studies on efficacy of the methods of perioperative rehabilitation is a good basis for development of fast surgical track. Observations and obtained results justify using elements of the PNF concept in physiotherapy in early perioperative period.

CONCLUSIONS

The studied group was not numerous therefore very reliable conclusions cannot be drawn. Thus, looking at the results of the studies from the appropriate distance it may be concluded that major abdominal surgery significantly deteriorate efficiency and gait velocity and lung ventilation efficiency in patients above 65 years of age in the early postoperative period.

Elements of the concept of Propriocceptive Neuromuscular Facilitation used in rehabilitation of the elderly patients after major abdominal surgery may influence the increase of postoperative self-dependence in the early postoperative period to greater extent than traditional rehabilitation methods.

Elements of the concept of Propriocceptive Neuromuscular Facilitation used in rehabilitation of the elderly patients after major abdominal surgery may have greater influence shortening the hospitalization time compared to traditional method of rehabilitation.

REFERENCES