

# Comparison of early inpatient rehabilitation in patients after coronary artery bypass grafting without cardiopulmonary bypass by means of the so-called minithoracotomy with patients after conventional cardiac surgery – authors' experience

Porównanie wczesnej rehabilitacji szpitalnej chorych leczonych metodą pomostowania naczyń wieńcowych bez krążenia pozaustrojowego, z tzw. małego dostępu, z chorymi po klasycznej rewaskularyzacji serca – doświadczenia własne

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## Key words

coronary artery bypass graft, MIDCAB, EACAB, cardiac rehabilitation

## Abstract

There is some evidence that focused and intense rehabilitation improve clinical outcome following conventional open-heart surgery. Recent developments in surgical techniques, which focused on the improvement in patient comfort, reduction in hospital stay and costs, has resulted in minimally invasive techniques, including Minimally Invasive Direct Coronary Artery Bypass (MIDCAB) and Endoscopic Atraumatic Coronary Artery Bypass (EACAB). EACAB is safer than on-pump coronary artery bypass graft (CABG), especially in high risk patients. Its use, however, is limited to a small subgroup of patients: those with suitable anatomy of coronary pathology, younger patients with rapidly progressing coronary artery disease or elderly patients with substantial co-morbidities, whom sternotomy and cardiopulmonary bypass pose significant risks to. In this latter group of patients, effective rehabilitation is, therefore, even more important. Prevention of disturbances in homeostasis resulting from reduced physical activity, and thus rate of recovery and effectiveness of cardiac surgery, are not dependent on early physical activity and the intensiveness of the inpatient rehabilitation only but also on psychological therapy, dietary advice and health-promoting education. In this study, we explore differences in inpatient rehabilitation methods and outcomes between the groups of patients who underwent on-pump CABG and MIDCAB operations. Our data show that inpatient rehabilitation following MIDCAB operations may be shorter than after on-pump CABG by 2 days on average.

## Słowa kluczowe

pomostowanie naczyń wieńcowych, MIDCAB, EACAB, rehabilitacja kardiologiczna

## Streszczenie

Dążenie do poprawy komfortu leczenia chorych, skrócenia czasu hospitalizacji i rehabilitacji szpitalnej, a w konsekwencji zmniejszenie kosztów leczenia a zapoczątkowało okres poszukiwania i wdrażania nowych technik w chirurgii naczyń wieńcowych. Od kilku lat przedmiotem dużego zainteresowania jest zastosowanie technik małoinwazyjnych, do których zalicza się operacje pomostowania naczyń wieńcowych bez krążenia pozaustrojowego z małego dostępu MIDCAB (ang. *Minimally Invasive Direct Coronary Artery Bypass*) i EACAB (ang. *Endoscopic Atraumatic Coronary Artery Bypass*). Są to metody bezpieczniejsze od klasycznej rewaskularyzacji chirurgicznej, szczególnie dla chorych zwiększonego ryzyka, jednak ich zastosowanie jest ograniczone do jednonaczyniowej choroby wieńcowej. Stosuje się je zwłaszcza u ludzi młodych, z szybko narastającymi zmianami miażdżycowymi w naczyniach, lub u chorych w podeszłym wieku, z obciążeniami narządowymi, u których sternotomia i krążenie pozaustrojowe istotnie podnoszą ryzyko operacji. Dla uzyskania optymalnego efektu zabiegu niezbędne jest kompleksowe działanie z udziałem klasycznej kardiologii oraz zastosowanie odpowiednich metod rehabilitacji należących do istotnych elementów postępowania po zabiegach kardiochirurgicznych. W artykule zwrócono uwagę na wczesne postępowanie usprawniające, które niewątpliwie rzutuje na dalsze wyniki. Intensywnie realizowany program pierwszego etapu rehabilitacji chroni pacjentów, niezależnie od techniki wykonanej operacji, przed zaburzeniem homeostazy

Authors' contribution: A - project of the study, work; B - collection of the data, information; C - statistical analysis; D - data interpretation; E - preparation of the manuscript; F - literature query; G - obtaining funds

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i przed następstwami hipokinezy. Celem pracy było omówienie różnic w programie rehabilitacji pacjentów po rewaskularyzacji chirurgicznej wykonanej metodą klasyczną z użyciem krążenia pozaustrojowego oraz metodą małoinwazyjną i problemów wynikających z zastosowania odmiennych technik zabiegowych na podstawie własnych doświadczeń. Przedstawione dane wskazują, że rehabilitacja szpitalna po operacjach metodą małoinwazyjną może być średnio o 2 dni krótsza niż po operacjach wykonanych metodą klasyczną.

**INTRODUCTION**

Surgical treatment of ischaemic heart disease by means of coronary artery bypass grafting (CABG) is one of the most verified and effective invasive therapeutic methods, markedly improving myocardial blood flow, quality of life and life expectancy<sup>1,2,3,4</sup>. The standard surgical procedure involving extracorporeal circulation and central sternotomy constitutes a major intervention within patient's organism, bearing a risk of many surgery-related complications, such as: neurological complications, microembolism, respiratory failure, renal failure and infections. Serious complications and high therapy costs constituting an important problem in classical revascularisation involving extracorporeal circulation as well as continuous technological progress resulted in a search for such surgical methods that would minimise negative sequels of this type of operations. Introduction of endovision systems into cardiac surgery enabled performance of procedures without use of extracorporeal circulation. They include:

- OPCAB (Off-Pump Coronary Artery Bypass Grafting), where mid-line sternotomy is applied as surgical access; it is used in patients with multi-vessel coronary artery disease;
- MIDCAB (ang. Minimally Invasive Direct Coronary Artery Bypass) and EACAB (ang. Endoscopic Atraumatic Coronary Artery Bypass)<sup>5,6,7,8</sup>, that is so called minimal access surgery used in

patients with single-vessel coronary artery disease

EACAB, performed using the access via the left anterior minithoracotomy, has been successfully conducted at the First Department of Cardiac Surgery, Medical University of Silesia for several years<sup>5,6,9</sup>. During the last 8 years, 600 such surgical procedures were performed. Approximately 1000 coronary artery by-pass graft operations using extracorporeal circulation are performed.

Experience of physiotherapists working at the I Department of Cardiac Surgery is associated with patients subjected to various surgical procedures. Patients undergoing coronary artery by-pass grafting with extracorporeal circulation constitute the largest group, however, the number of patients operated using minimally invasive methods is also increasing. As the number of such operations has increased, a verification of the standard rehabilitation program was conducted<sup>10</sup>.

The aim of this paper was to discuss differences between the rehabilitation programs applied in patients following coronary artery by-pass grafting performed using the classical technique with extracorporeal circulation and the minimally invasive method and to present, based on our experience, problems resulting from application of different surgical techniques.

It is widely accepted that rehabilitation has an effect on the degree and time of achievement of an improvement in cardio-respiratory function in

patients after cardiac surgery, treated both using the classical and the minimally invasive method, as well as it affects mental, social, professional, and economical consequences of the illness and its therapy<sup>11,12,13</sup>. Appropriately conducted rehabilitation involves three phases: inpatient, post-hospital, and the late, outpatient phase (Table 1)<sup>14</sup>.

**SPECIFIC PROBLEMS DURING REHABILITATION ASSOCIATED WITH THE TYPE OF APPLIED SURGICAL METHOD**

Prior to description of general differences among rehabilitation programs after cardiac surgery, specific problems resulting from the type of conducted operation especially affecting the course of early inpatient rehabilitation should be emphasized.

The classical revascularisation is used primarily in patients with multiple coronary artery changes. Extracorporeal circulation disturbs homeostasis of the organism and – via activation of factors of systemic inflammatory response – leads to undesirable effects within many organs, including organs of the respiratory, cardiovascular, or motor systems. However, post-surgery pain following sternotomy is the primary issue. It significantly limits movements of the thorax causing shallower breathing and avoidance of cough. This becomes accompanied by reflex, more upper position of the diaphragm re-

**Table 1**

<b>Phases of cardiac rehabilitation</b>		
<b>INPATIENT PHASE</b>	<b>POST-HOSPITAL PHASE</b>	<b>OUTPATIENT PHASE</b>
<ul style="list-style-type: none"> <li>- prevention of unfavourable sequels of immobilisation,</li> <li>- restoration of patient independence,</li> <li>- improvement of psychological status,</li> <li>- enabling possibly fastest discharge from the hospital and return home.</li> </ul>	<ul style="list-style-type: none"> <li>- amelioration of health and psychophysical functioning, especially of the cardiovascular and respiratory systems function, by introducing various forms of physical activity</li> </ul>	<ul style="list-style-type: none"> <li>- further improvement and possibly longest maintenance of the achieved physical agility,</li> <li>- systematic motivation to continuing the health-promoting style of life.</li> </ul>

sulting from topical cooling of the heart using saline with ice down to 4°C during surgery<sup>15</sup> thus markedly reducing the mechanics of respiration and increasing the risk of post-operation pulmonary complications (e.g.: inflammatory changes, atelectasis, pneumothorax). Risk of thrombosis resulting from post-operation use of agents delaying and accelerating fibrinolysis is another important problem associated with the classical surgery<sup>16</sup>. Additionally, as a result of the saphenous vein excision for bypassing, limb oedema occurs due to the compromised venous return.

Because of those unfavourable changes, the post-surgery period is frequently prolonged and requires major engagement of the physiotherapy team into the process of rehabilitation. Most often, many weeks, or even 4-6 months, are needed for a patient to regain complete agility<sup>17</sup>. Six months after the CABG procedure, 35-39% of patients experience thoracic and lower extremity pain that are related to the surgical procedure performed, 48% complain of fatigue or weakness sensations, and 18% experience dyspnoea<sup>18</sup>. The most frequent ailments persisting for over half year following operation include sternal pain associated with sternotomy (33%), shoulder pain (22%), oedema of the lower limbs (21%) and sensation of hearth rhythm disturbances (31%)<sup>19</sup>. Duration of rehabilitation is significantly prolonged in cases of post-surgery complications involving myocardial ischaemia, central nervous system ischaemia, sternal instability, or infections of post-operation wounds.

Surgery involving the so-called minimally invasive access significantly reduces the risk of complications associated with use of extracorporeal circulation, sternotomy, or collection of the veins from the lower extremities – procedures that markedly reduce patient functioning after classical operation. Minimally invasive surgery enables shortening of inpatient treatment<sup>20</sup> and of post-surgery rehabilitation as well as faster return to professional (3-4 weeks) and private lives<sup>21</sup>, which

significantly reduces the cost of therapy<sup>22</sup>. It should, however, be kept in mind that in post-EACAB patients, chest pain is more intense than in patients subjected to sternotomy during the first several days following operation<sup>23,24,25</sup>. Therefore, in order to conduct proper rehabilitation, it is necessary to appropriately use pharmacotherapy attenuating unfavourable effects of anterior thoracotomy.

### **DETAILED PROGRAM OF REHABILITATION IN PATIENTS WHO UNDERWENT EACAB SURGERY AND IN PATIENTS AFTER CABG WITH EXTRACORPOREAL CIRCULATION DURING EARLY INPATIENT PHASE (authors' experience)**

#### **Pre-surgery phase**

Rehabilitation process begins during the period of time preceding surgery because of the risk associated with operation. Patients planned for the classical or minimally invasive procedure are admitted one or two days prior to surgery. During this time, physiotherapist takes history (to acquire information on concomitant diseases, possible physical limitations, etc.) and conducts an instruction meeting – most often twice before the surgery. Patients are presented with aims of rehabilitation as well as with:

- exercises used after the surgery: respiratory, anti-thrombosis, general, correction
- respiratory exercises using an apparatus inducing inspiratory resistance in order to increase lung capacity (Tri-Flo II) or expiratory resistance aiding in bronchial tree clearance (a bottle filled with water or blowing onto a wood-wool sheet)
- correct respiration technique (using all respiratory paths with especial attention to diaphragmatic breathing)
- effective cough (performance of a series of three or four subsequent coughs during expiration)<sup>26</sup>.

Moreover, patients are psychologically prepared for the surgery, essential information about the disease is explained and adaptation difficulties to come during healing are presented. Conveying this necessary information to the patients reduces anxiety and facilitates future cooperation. In this way, patients easier and in more detail follow physiotherapist's instructions.

#### **Post-operation phase**

During the process of rehabilitation after a non-complicated surgery involving coronary artery by-pass grafting, two stages can be distinguished: the first – early, at an intensive care unit, lasting from the first post-surgery day to morning hours of the subsequent day, and the second – late, at post-operation ward: comprising the period from the 3<sup>rd</sup> to 6<sup>th</sup> day in post-classical by-pass grafting patients, and from the 2<sup>nd</sup> (afternoon hours) to 4<sup>th</sup> day following surgery.

Before and after all exercises, short history is taken pertaining to current patients general feeling and heart rate (HR), systemic blood pressure (BP) and haemoglobin saturation with oxygen (saturation) are measured. During the stay in the intensive care unit, cardiomonitor is attached to patients, which enables observation of possible changes in the electrocardiogram (ECG). After transition to the ward, continuous monitoring is not used, therefore, prior to and after the exercises, BP is determined by means of a sphygmomanometer and saturation and HR using a pulseoximeter. After completion of exercises, subjective assessment of exertion is performed according to the 15-point Borg scale (6-20). Following surgery, physiotherapy is started in the first day, independently of the type of operation. During this period of time, patients perform exercises learnt before operation, i.e. simple respiration exercises with practicing effective cough and stabilisation of the post-operation wound as well as anti-thrombosis exercises. Bronchial tree clearance is maintained not only by means of respira-

tion exercises, but also by chest percussion or other auxiliary procedures, e.g. inhalations. In post-EACAB patients, the exercises are most often performed in a sitting position with the lower limbs placed over the edge of the bed. As mentioned above, limitations associated with sternotomy and the resulting major wounds of the sternum and on the lower limbs – associated with saphenous vein excision – are not the case in these patients. All limbs are more intensely, fully, also asymmetrically involved during the exercises.

In patients after classical by-pass grafting, in turn, exercises are performed in a semi-sitting position achieved by bed adjustment and all exercises involving the upper extremities are performed symmetrically because of the necessity to stabilise the sternum. Additional precautions for sternum protection are applied<sup>27</sup> in a form of stabilising belt or positioning of the hands over the sternum during coughing. On the 1<sup>st</sup> and 2<sup>nd</sup> day, exercises of the upper limbs are performed up to the level of the shoulders; moreover, abrupt movements of the lower extremities, where the vein for grafting was taken from, are avoided during this period of time.

Independently of the type of surgery, maximum possible shortening of duration of patient immobilisation in bed is attempted. Therefore, on the second day (morning hours), head-up tilt is performed. It should be mentioned that early assumption of the upright position in post-EACAB patients is not recommended because of the maintained active thoracic drainage that is typically removed during late-evening hours of the 1<sup>st</sup> day following the operation.

During the early phase, individual exercises last 20 minutes and are conducted twice a day, while intensity of exercises in post-EACAB patients ranges from 11 to 13 points in the 15-point Borg scale; in post-CABG patients, the intensity is lower and ranges from 10 to 12 points.

Beginning with the second day (afternoon), patients with lateral incision participate, when not contra-indicated – in group exercising in a

gymnastic hall. The program includes general fitness training with alternating respiratory and correction exercises. General physical training involves dynamic exercises engaging small and large muscle groups at various baseline positions (sitting, standing), which positively affects coordination and patient agility, as well as exercises improving mobility of the shoulder girdle and the thorax. With the second day, walking is also introduced at gradually increasing distances and, starting with the third day, climbing up the stairs (half floor initially), always under physiotherapist's supervision.

Patients after classical operation most often participate in group exercises in the gymnastic hall beginning with the third day (dependently on the clinical status). These exercises are performed in a sitting position and involve respiratory, effective cough, anti-thrombosis, general physical as well as correction exercises. Because of limitations due to the wounds and lower limb oedema, the patients begin to walk as late as on the third day, while walking on steps is started on the fifth day.

During the late phase of rehabilitation, individual training lasts 20 minutes and group exercises 35-40 minutes. Both individual and group rehabilitation are performed once a day. Exercise intensity in post-EACAB patients is 12-14 points (in the Borg scale) and 11-13 points in post-CABG patients.

Upon completion of each group exercise session, all patients participate in a short lecture pertaining to further course of rehabilitation, re-

turn to every-day life, possibility to continue the exercises at home and combating the risk factors (including cessation to smoke, combating obesity and immobility). They participate in the sessions until discharge from the hospital (most frequently – directly home). To reinforce the effects of rehabilitation, the patients are encouraged to independently repeat the learnt exercises during afternoon and evening hours.

Appropriately conducted early inpatient phase of rehabilitation allows the patients with uncomplicated peri- and post-surgery course to achieve agility enabling leaving the hospital independently within an average of 4 days following minimally invasive operation or within 6 days on average in case of the classical procedure.

## SUMMARY

Intensively conducted program of the first phase of rehabilitation protects the patients (independently of surgical technique) from disturbances in homeostasis of the organism and from sequels of hypokinesia. Many factors should be considered when preparing the rehabilitation program, determining exercise intensity and duration. Certainly, clinical status of the patient is one of these factors; however, these factors also include the type of the applied surgical method. Dependently on the method, patients may experience specific problems after the surgery that have a significant impact on the course of early inpatient rehabilitation. Unfortunately, there are only a few articles on this topic.

**Table 2**

**Comparison of mean values of duration of hospitalisation (number of days) of the patients at the Department of Cardiac Surgery depending on the type of operation (non-complicated pre- and postoperative course)**

TYPE OF OPERATION		2005 (from January to June)	2006 (from January to June)
CABG	min	5	5
	mean	6 ±0.75	6 ±2.12
	max	8	8
EACAB	min	4	4
	mean	5 ±0.7	4 ±0.53
	max	6	6

**Table 3****Comparison of rehabilitation programs after EACAB and after CABG with cardiopulmonary bypass**

	<b>EACAB</b>	<b>CABG z użyciem krążenia pozaustrojowego</b>
1 <sup>st</sup> day ICU (Intensive Care Unit)	<ul style="list-style-type: none"> <li>- exercise intensity: 11-13 points (Borg scale),</li> <li>- respiration exercises, effective cough, chest percussion,</li> <li>- anti-thrombosis exercises,</li> <li>- sitting position with the lower extremities placed below the edge of the bed,</li> <li>- intensive involvement of the limbs (full range) during the exercises,</li> <li>- symmetrical and asymmetrical exercises.</li> </ul>	<ul style="list-style-type: none"> <li>- exercise intensity: 10-12 points (Borg scale)</li> <li>- respiration exercises, effective cough, chest percussion,</li> <li>- anti-thrombosis exercises,</li> <li>- passive sitting achieved using bed adjustment,</li> <li>- exercises of the upper extremities performed up to the level of the shoulders,</li> <li>- symmetrical exercises, avoidance of rapid lower extremity movements if the saphenous vein was taken.</li> </ul>
2 <sup>nd</sup> day ICU, Post- surgery ward	ICU: <ul style="list-style-type: none"> <li>- continuation of the 1st day exercises,</li> <li>- assuming upright position - morning hours, post-surgery unit:</li> <li>- group exercises in the gymnastic hall - afternoon hours,</li> <li>- exercises in a sitting and standing position,</li> <li>- walking on a gradually increasing distance.</li> </ul>	ICU: <ul style="list-style-type: none"> <li>- continuation of the 1st day exercises,</li> <li>- assuming upright position - morning hours, post-surgery unit:</li> <li>- individual exercises in patient's room - afternoon hours,</li> <li>- exercises in a sitting position,</li> <li>- independent walking to access bathroom.</li> </ul>
3rd day Post- surgery ward	<ul style="list-style-type: none"> <li>- exercise intensity: 12-14 points (Borg scale)</li> <li>- group exercises in the gymnastic hall,</li> <li>- walking on a gradually increasing distance,</li> <li>- individual exercises in patient's room - afternoon hours,</li> <li>- climbing up the stairs (0.5 floor).</li> </ul>	<ul style="list-style-type: none"> <li>- exercise intensity: 11-13 points (Borg scale)</li> <li>- group exercises in the gymnastic hall,</li> <li>- exercises in a sitting position,</li> <li>- individual exercises in patient's room - afternoon hours,</li> <li>- independent walking, depending on patient's general feeling.</li> </ul>
4th day As above	<ul style="list-style-type: none"> <li>- continuation of exercises of the previous day,</li> <li>- climbing up the stairs (1st or 1.5 floor),</li> <li>- discharge home.</li> </ul>	<ul style="list-style-type: none"> <li>- continuation of exercises of the previous day,</li> <li>- exercises in a sitting and standing position,</li> <li>- individual exercises in patient's room - afternoon hours,</li> <li>- walking on a gradually increasing distance.</li> </ul>
5th day As above		<ul style="list-style-type: none"> <li>- continuation of exercises of the previous day,</li> <li>- climbing up the stairs (0.5 floor).</li> </ul>
6th day As above		<ul style="list-style-type: none"> <li>- continuation of exercises of the previous day,</li> <li>- climbing up the stairs (1<sup>st</sup> floor).</li> </ul>
7th day As above		<ul style="list-style-type: none"> <li>- continuation of exercises of the previous day,</li> <li>- climbing up the stairs (1<sup>st</sup> and 1.5 floor),</li> <li>- discharge home or to another ward.</li> </ul>

Comparing the applied rehabilitation program in patients who underwent standard revascularisation to reports of other authors, it can be concluded that general principles of kinesitherapy are very similar<sup>12,28,29</sup>. However, the introduced modifications enable faster rehabilitation of patients with a smaller peri-operation trauma following minimally invasive procedures and correspond to worldwide tendencies towards maximum, safe shortening of hospitalisation of cardiac surgery patients<sup>30</sup>. Such approach is justified by a decreased risk of hospital infections and reduced therapy costs. Many authors stress out that fast and early mobilisation is beneficial and is completely safe provided it is associated with detailed observation of patients' psy-

chological and physical status, including assessment of their clinical status, type of operation and preparation for rehabilitation<sup>29,31</sup>. Many studies demonstrate that fast mobilisation is well tolerated by the patients<sup>32,33,34,35</sup>. It should, however, be kept in mind that too short hospitalisation, reducing duration of physiotherapeutic preparation for surgery as well as post-surgery rehabilitation, can increase the risk of post-operation complications and limit contact with the patient thus leading to neglecting educational and psychotherapeutic issues. Therefore, to achieve patients' satisfaction related to surgery results, it is strived to tight cooperation of the physician with the physiotherapist, dietician and psychologist. Long-term effect of sur-

gery largely depends on the quality and determination of both the patient and the whole therapeutic team.

It should also be emphasised that rehabilitation should be a continuous and life-time process. To achieve further, positive effects of rehabilitation initiated in the hospital, this treatment must be continued in outpatient conditions: in outpatient and rehabilitation clinics.

## References

1. Sjoland H., Caidahl K., Wiklund I., Haglid M., Hartford M., Karlson B. W. i wsp.: Impact of coronary artery bypass grafting on various aspect of quality of life. *Eur. J. Cardiothorac. Surg.* 1997; 12(4): 612-619
2. Bochenek A., Morawski W., Krejca M., Skarysz J., Skiba J., Pietrzycki A. i wsp.: Wczesne i odległe wyniki pomostowania tętnic wieńcowych u chorych po 70 roku życia. *Medipress Kard.* 1996; 3(1): 9-13

3. Caracciolo E.A., Davis K.B., Sopko G., Kaiser G.C., Corley S.D., Schaff H. i wsp.: Comparison of surgical and medical group survival in patients with left main equivalent coronary artery disease. Long-term CASS experience. *Circulation*, 1995; 91(9): 2335-1344
4. Eysymontt Z.: Znaczenie oceny jakości życia w procesie rehabilitacji pacjentów po zabiegach kardiologicznych. *Rehab. Med.* 2001; 5, nr specjalny: 39-42
5. Cisowski M., Gerber W., Janas R., Bochenek A.: Torakoskopowe pobranie tętnicy piersiowej wewnętrznej do małoinwazyjnego pomostowania tętnic wieńcowych. *Kard. Pol.* 2000; 52(2): 29-31
6. Cisowski M., Bochenek A.: Małoinwazyjne pomostowanie tętnic wieńcowych z wykorzystaniem wideoskopii – wyniki wczesne i odległe. *Kard. Pol.* 2001; 54(1): 84-88
7. Benetti F., Mariani M.A., Sani G., Boonstra P.W., Grandjean J.G., Giomarelli P. i wsp.: Video – assistend minimally invasive coronary operation without cardiopulmonary bypass: A Multicenter Study. *J. Thorac. Cardiovasc. Surg.* 1996; 112(6): 1478-1484
8. Benetti F., Ballester C., Sani G., Doonstra P., Grandjean J.: Video – assistend coronary bypass surgery. *J. Card. Surg.* 1995; 10(6): 620-625
9. Cisowski M., Bochenek A.: Wideoskopowe, miniinwazyjne pomostowanie u chorych ze zwężeniem gałęzi zstępującej przedniej lewej tętnicy wieńcowej. *Kardiochir. Torakochir. Pol.* 2004; 1(2): 51-59
10. Smolis – Bąk B., Kolsut P., Kazimierska B.: Nowe spojrzenie na rehabilitację przed i po zabiegach kardiologicznych wykonanych metodą torakotomii przedniej. *Nowa Klin.* 1999; 6(10): 1056-1057
11. Oleszczyk K., Wołyńska-Siężyńska A., Garus E., Sykosz T., Niedziela U.: Drugi etap rehabilitacji chorych po operacjach kardiologicznych – retrospektywna ocena poziomu satysfakcji chorych. *Post. Rehab.* 1995; 9(4): 27-34
12. Zawadzka-Byśko M., Dziduszko-Fedorko E.: Rehabilitacja kardiologiczna u pacjentów po zabiegach rewaskularyzacyjnych. *Stand. Med.* 2005; 2(1): 1402-1411
13. Gohlke H., Gohlke-Barwolf C.: Cardiac rehabilitation. *Eur. Heart J.* 1998; 19(7): 1004-1010
14. Polonński L., Rybicki J.: Rehabilitacja w dobie kardiologii inwazyjnej. *Kard. Pol.* 2003; 58 (6): 511-514
15. Samowski W., Kulesza J., Poniżyński A., Dyszkiewicz W.: Uniesienie przepony po operacjach kardiologicznych. *Pol. Merkuriusz Lek.* 2001; 10(55): 24-26
16. Kwolek A.: Rehabilitacja Medyczna. Wydawnictwo Medyczne Urban & Partner, Wrocław, 2003; 494-514
17. Rudnicki S.: Rehabilitacja po zawale i operacjach serca. *Med. Sportiva* 2001; 5 (2): S159-S169
18. Jenkins C.D., Stanton B.A., Jono R.T.: Quantifying and predicting recovery after heart surgery. *Psychosom. Med.* 1994; 56(3): 203-212
19. Engblom E., Hamalainen H., Lind J., Mattlar C.E., Ollila S., Kallio V et al.: Quality of life during rehabilitation after coronary artery bypass surgery. *Qual. Life Res.* 1992; 1(3): 167-175
20. Fraund S., Behnke H., Boening A., Cremer J.: Immediate postoperative extubation after minimally invasive direct coronary artery surgery (MIDCAB) *Interact. Cardiovasc. Thorac. Surg.* 2002; 1: 41-45
21. Biglioli P., Antona C., Alamanni F., Parolari A., Toscano T., Pompilio G., Polvani G.: Minimally invasive direct coronary artery bypass grafting: midterm results and quality of life. *Ann. Thorac. Surg.* 2000; 70: 456-460
22. Zembala M. (red.): Chirurgia naczyń wieńcowych. Wydawnictwo Lekarskie PZWL, Warszawa, 2002: 226-231
23. Walther T., Falk V., Metz S., Diegeler A., Battellini R., Autschbach R. i wsp.: Pain and quality of life after minimal invasive versus conventional cardiac surgery. *Ann. Thorac. Surg.* 1999; 67: 1643-1647
24. Behnke H., Cornelissen J., Kahl M., Möller F., Cremer J., Wulf H.: Postoperative pain therapy in minimally invasive direct coronary arterial bypass surgery. IV. opioid patient controlled analgesia versus intercostal block. *Anaesthesist.* 2002; 51(3): 175-179
25. Lichtenberg A., Hagl Ch., Harringer W., Klima U., Haverich A.: Effects of minimal invasive coronary artery bypass on pulmonary function and postoperative pain. *Ann. Thorac. Surg.* 2000; 70: 461-465
26. Storch-Ucziwek A., Plewa M., Nowak Z.: Sześciominutowy test marszowy w ocenie tolerancji wysiłkowej pacjentów z chorobą niedokrwienną serca leczonych metodą pomostowania naczyń wieńcowych (CABG). *Fizjoterapia* 2006; 14(2): 3-10
27. Fletcher G.F., Balady G.J., Amsterdam E.A., Chaitman B., Eckel R., Fleg J., i wsp.: Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. *Circulation* 2001; 104(14): 1694-1740
28. Kompleksowa rehabilitacja kardiologiczna. Stanowisko Komisji ds. Opracowania Standardów Rehabilitacji Kardiologicznej Polskiego Towarzystwa Kardiologicznego. Materiały zalecane przez Sekcję Rehabilitacji Kardiologicznej i Fizjologii Wysiłku PTK. *Folia Cardiologica* 2004; 11(A): A34-A35
29. Piwoda A., Jastrzębska B.: Optymalizacja wczesnej rehabilitacji pacjentów poddawanych zabiegom kardiologicznym – doświadczenia własne. *Rehab. Med.* 2005; 9(2): 39-47
30. Carrel T., Mohacsi P.: Optimal timing of rehabilitation after cardiac surgery: the surgeon's view. *Eur. Heart J.* 1998; 19(Suppl. 0): 038-041
31. Dylewicz P.: Rehabilitacja po chirurgicznym leczeniu choroby niedokrwiennej serca. *Kardiol. Pol.* 1998; 48(2): 159-162
32. Kazimierska B., Kowalik I., Dąbrowski R., Smolis-Bąk E., Rudnicki S.: Czy szybsze uruchamianie po rewaskularyzacji zapewnia bezpieczeństwo i aktywność chorym? *Rehab. Med.* 1999; 3, (Suppl.): 15-16
33. Kazimierska B., Smolis-Bąk E., Kowalik I., Dąbrowski R., Rudnicki S.: Czy skrócenie czasu rehabilitacji u chorych po wszczępieniu pomostów aortalno-wieńcowych pozwoli na pełne i prawidłowe ich uruchomienie? *Post. Rehab.* 2000; 14(1): 71-78
34. Kazimierska B., Smolis-Bąk E., Kowalik I., Malczewska B., Rudnicki S.: Długość modelu usprawniania a wydolność fizyczna pacjentów rehabilitowanych w szpitalu po CABG oceniana na podstawie próby wysiłkowej na bieżni. *Fizjoterapia* 2003; 11, 2(supl.): 24
35. Smolis-Bąk E.: Ocena wczesnej rehabilitacji pacjentów po zabiegach kardiologicznych (CABG) na podstawie trójstopniowej próby marszowej. *Post. Rehab.* 2005; 19(1): 19-27

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