Respiratory and clinical outcomes after coronary artery bypass surgery in male patients below and over 70 years of age

Yetmiş yaş altı ve üstü erkek hastalarda koroner arter bypass cerrahisinden sonra solunumsal ve klinik sonuçlar

Rengin Demir,[1] Semiramis Özyılmaz,[1] Ali Can Hatemi,[2] Kadir Çeviker,[2] İlhan Özgöl,[2] Zerrin Yiğit,[3] Erhan Kansız,[2] H. Nilgün Gürses[4]

Department of [1]Physiotherapy, [2]Cardiovascular Surgery, [3]Cardiology, Medicine Faculty of İstanbul University Cardiology Institute, İstanbul;
[4]Department of Physical Therapy and Rehabilitation, Medicine Faculty of İstanbul Bilim University School of Health, İstanbul

Background: This retrospective study was planned to evaluate respiratory functions and clinical outcomes in male patients below and over 70 years of age after coronary artery bypass surgery (CABS).

Methods: Medical charts of 918 patients who underwent CABS between January 2002 and September 2006 were investigated and 112 male patients with no missing data according to the inclusion criteria were recruited for the study, and they were divided into two groups according to their ages being below or over 70 years (younger group: 89 patients; mean age 57.6±5.3 years and elderly group: 23 patients; mean age 71.6±2.3). Pre- and postoperative respiratory function, respiratory muscle strength and clinical outcomes of both groups were compared, and correlations between these parameters were investigated.

Results: Before the surgery, vital capacity (VC; p=0.0006), forced vital capacity (FVC; p=0.0005), forced expiratory volume in 1 second (FEV_1; p<0.0001), FEV_1/FVC % (p=0.02), forced mid-expiratory flow (FMF; p<0.0001), forced expiratory flow (FEF; p=0.0005), maximal inspiratory pressure (P_{Imax}; p<0.0001) and maximal expiratory pressure (P_{Emax}; p=0.02) were significantly lower in elderly patients compared with the younger ones. The decrease in pulmonary functions, respiratory muscle strength and complication rates were similar in both groups postoperatively. Elderly patients required longer cardiopulmonary bypass time (p=0.03), intubation time (p=0.0004), intensive care unit stay (p=0.001) and postoperative hospital stay (p<0.0001) than younger patients.

Conclusion: Although postoperative clinical recovery was longer in our elderly patients than younger ones, it was still better than the outcomes observed in other studies. Thus, male patients over 70 years of age should not be denied CABS solely on the basis of age.

Key words: Coronary artery bypass surgery; pulmonary function test; respiratory muscle strength, clinical outcome.

Amaç: Geriye yönelik olarak planlanan bu çalışmada 70 yaş altı ve üstü erkek hastalarda koroner arter bypass cerrahisi (KABC) sonrası solunum fonksiyonları ve klinik sonuçları değerlendirildi.

Çalışma planı: Ocak 2002-Eylül 2006 tarihleri arasında KABC uygulanan 918 hastanın dosyası incelendi. Çalışmaya alınma kriterlerine yönelik hiçbir eksik bilgisi olmayan 112 erkek hasta 70 yaş altı veya üstü olarak iki gruba ayrıldı (genç grup: 89 hasta; ort. yaş 57.9±5.3 yıl; yaşlı grup: 23 hasta; ort. yaş 71.6±2.3) ve çalışmaya alındı. Her iki grubun ameliyat öncesi ve sonrası solunum fonksiyonları, solunum kas kuvveti ve klinik sonuçları karşılaştırıldı ve parametreler aralarındaki ilişki araştırıldı.

Bulgular: Ameliyat öncesi vital kapasite (VC; p=0.0006), zorlu vital kapasite (FVC; p=0.0005), 1. sn'deki zorlu ekspiratuvar volüm (FEV_1; p<0.0001), FEV_1/FVC % (p=0.02), zorlu ekspiratuvar ortası akış (FMF; p<0.0001), zorlu ekspiratuvar akış (FEF; p=0.0005), maksimal inspiratuvar basınç (P_{Imaks}; p<0.0001) ve maksimal ekspiratuvar basınç (P_{Emaks}; p=0.02) gençlerle karşılaştırıldığında, yaşlı hastalarda anlamlı olarak düşüktü. Ameliyat sonrası pulmoner fonksiyonlar, solunum kas kuvvetindeki azalma ve komplikasyon oranları iki grupta da benzerdi. Yaşlı hastalarda genç hastalara göre kardiyopulmoner bypass süreleri (p=0.03), entübasyon süreleri (p=0.0004), yoğun bakımda kalış günleri (p=0.001) ve ameliyat sonrası hastanede kalış süreleri (p<0.0001) daha uzundu.

Sonuç: Ameliyat sonrası klinik toparlanma gençlere göre yaşlılarda daha uzun olmasına rağmen yine de diğer çalışmaların sonuçlarına göre daha iyi bulundu. Bu nedenle 70 yaş üstü erkek hastalar sadece yaşlarından dolayı KABC'den alıkonulmamalıdır.

Anahtar sözcükler: Koroner arter bypass cerrahisi; solunum fonksiyon testi; solunum kas kuvveti, klinik sonuç.

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Yazışma adresi: Dr. H. Nilgün Gürses. İstanbul Bilim Üniversitesi Sağlık Yüksekokulu, Fizik Tedavi ve Rehabilitasyon Bölümü, 34394 Şişli, İstanbul. Tel: 0212 - 275 75 82 e-posta: gursesnil@yahoo.com

Coronary artery bypass surgery (CABS) is a safe and effective surgical intervention that is performed successfully in a wide range of patients. Patients who underwent this procedure are gaining an increasingly higher risk profile than in the past as a result of their lengthened life expectancy. Advanced age is associated with a diminished physiological reserve and a greater number of co-morbid illnesses, and operative mortality[1,2] together with multiorgan morbidity get significantly higher with advancing age.[2] It has been documented in a study that the increased mortality rates were associated with a greater number of co-morbidities (≥65 years);[3] however, a multivariate survival analysis failed to demonstrate advanced age (≥75 years) as an independent predictor of in-hospital and late death.[4] On the other hand, advanced age is associated with diminished pulmonary functions[5] and a cardiopulmonary bypass (CPB) obviously interferes with the pulmonary function.[6-7] Besides, the structural changes in the chest wall after the median sternotomy cause restrictive pulmonary dysfunction, which may last for weeks after the operation.[8] Moreover, it is a well-known fact that the loss of integrity of the respiratory muscles due to the surgical incision and the use of anesthetics may affect the contraction of the respiratory muscles and cause a decrease in the muscle strength.[9]

Some studies have investigated the respiratory muscle strength[10,11] and others have evaluated respiratory functions[6,7] before and after the CABS. More recent studies also assessed off-pump vs. on-pump CABS pulmonary outcomes.[12,13] However, research has yet failed to show the effect of cardiac surgery on pulmonary outcomes and respiratory muscle strength in the elderly population. Therefore, this study was planned to evaluate the respiratory function and muscle strength and the clinical outcome in male patients below and over 70 years of age who have undergone CABS.

PATIENTS AND METHODS

We performed reviews on the medical charts of 918 patients who underwent cardiac surgery in İstanbul University Institute of Cardiology between January 2002 and September 2006. During this process, we excluded female patients who underwent CABS and male patients who had significant valve disease, peripheral vascular disease, cerebrovascular disease, previous CABS or who underwent a resection of a ventricular aneurysm.

The medical charts selected for the retrospective study belonged to the male patients who had preoperative and postoperative pulmonary function tests, respiratory muscle strength test results and no missing data of interest for the purposes of this study. Six hundred four patients were excluded; 50 patients did not have complete data because of emergency surgeries and 116 patients' data were lost to follow-up. After this retrospective review, 112 patients who previously underwent CABS, with ages ranging from 23 to 76 years (mean 57.7±5.3), were recruited to the study. The subjects were classified into two groups: the group of elderly patients (≥70 years old; n=23; mean age 71.6±2.3) and the group consisting of younger patients (<70 years old; n=89; mean age 57.6±5.3 years).

The following data were collected from the medical charts/records in order to compare the outcomes of both groups: The preoperative patient characteristics (age, height, weight, body mass index), cardiac profiles [New York Heart Association (NYHA) functional classification, left ventricular ejection fraction, angina scale, previous myocardial infarction], preoperative coronary risk factors (hypertension, diabetes, hyperlipidemia, family history, smoking history), preoperative arterial blood gas measurements (PaO_2, SaO_2, $PaCO_2$), operative and postoperative data [number of bypass grafts, CPB time, cross clamp time, time of intubation, intensive care unit (ICU) stay], arterial blood gas measurements (the highest value of the day) taken on the second postoperative day with oxygen support, total hospital stay and postoperative complications. The postoperative extubation protocol of our cardiac surgery department were: The resolution of the disease state or condition, hemodynamic stability, absence of sepsis, adequate oxygenation status on decreased FiO_2 and decreased positive end-expiratory pressure/constant positive airway pressure (PEEP/CPAP), adequate ventilation status and $PaCO_2$. Prolonged ventilation was considered as the need for respiratory support for more than 24 hours.[14] The intensive care unit discharge protocol (accepted arterial blood pH, PaO_2, $PaCO_2$, lactic acid, HCO_3 value, stable hemodynamic status, no significant bleeding, no arrhythmias, normal ECG and normal neurological evaluation) was used for all patients in the routine ICU follow up. The hospital discharge criteria of patients after the operation were a favorable surgical site healing, stable hemodynamic status, no arrhythmias, no sign of infections, normal ECG and biochemical values and normal neurological, respiratory and gastrointestinal system evaluations.

Postoperative complications (atelectasis, pneumo thorax, bronchospasm, pneumonia, pleural effusion, tracheostomy, reintubation, postoperative myocardial infarction, atrial fibrillation, supraventricular tachycardia, intra-aortic balloon placement) were defined by a cardiovascular surgeon from the patient files.

Preoperative and postoperative pulmonary functions [vital capacity (VC), forced vital capacity (FVC), percent of predicted FVC (FVC %), forced expiratory volume in 1 second (FEV_1), percent of predicted

FEV_1 (FEV_1 %), forced mid-expiratory flow (FMF), forced expiratory flow (FEF), forced mid-expiratory flow time (FMFT), FEV_1/FVC ratio] and respiratory muscle strength [maximal inspiratory pressure (PI_{max}) and maximal expiratory pressure (PE_{max})] were also obtained from the patients' hospital records. Spirometric measurements were performed according to the American Thoracic Society recommendations[15] by using a spirometer (Lameris Vitalograph device) by cardiopulmonary physical therapists. Predicted values were calculated for FVC and FEV_1 using reference values from the Kamburoff-Woitowitz nomogram.[16] Since the bronchodilator response was not evaluated in our clinic, subjects' data were also analyzed according to the modified GOLD criteria[17] for chronic obstructive pulmonary disease (COPD).

The respiratory muscle strength was measured by the cardiopulmonary physical therapists in our hospital using the SensorMEDICS brand-Micro MPM device and through the technique of Black and Hyatt.[18] Relationships between age, preoperative pulmonary functions, maximal inspiratory and expiratory pressures, left ventricular ejection fraction, arterial blood gases and operation time (CPB time and cross clamp time), with the postoperative intubation time, ICU stay and total hospital stay were also investigated.

Chest physiotherapy was applied to all patients before and after the surgery as a part of a routine medical approach in our surgery department.

Statistical analysis

Comparisons between two groups were performed using the Student's t-test for continuous data or (if the sample distribution was not normal) the Mann-Whitney U-test. Categorical variables were evaluated using the Chi-squared (X^2) test or Fisher's exact tests (if $n<5$). Preoperative and postoperative results within groups were compared through the Paired t-test or the Wilcoxon Signed-rank test (if the sample distribution was not normal). Correlation coefficients between age, preoperative pulmonary functions, maximal inspiratory-expiratory pressures, arterial blood gases, left ventricular ejection fraction, CPB time, cross clamp time, postoperative intubation time, intensive care unit stay and total hospital stay were determined by the linear regression analysis. The results were expressed as mean ± standard deviation (SD). A p value of <0.05 was considered to be significant.

RESULTS

Table 1 shows the preoperative patient characteristics, operative and postoperative variables for each group and the comparison of clinical outcome between the two groups.

The two groups did not differ significantly in respect to the clinical characteristics, cardiac profile and coronary risk factors. PaO_2 and SaO_2 values were lower in the elderly group compared to the younger group. The mean numbers of bypass grafts were the same in both groups. But the elderly patients required longer CPB times, intubation times, ICU stay and postoperative hospital stay than the younger patients. None of our patients in both groups required prolonged ventilation. Postoperative complication rates were similar in both groups. None of our patients in either group used bronchodilators preoperatively or postoperatively. Only, three patients from the elderly group and four patients from the control group used bronchodilators at the second day of their stay in the intensive care unit.

Table 2 shows preoperative and postoperative mean spirometry and respiratory muscle strength values and the percentages of difference compared to the preoperative values in both groups. The comparative results for the two groups in respect to these parameters are also indicated.

Before the surgery, the preoperative values of all the parameters except for the FMFT, FVC % predicted and the FEV_1 % predicted were significantly lower in the elderly patients compared to the younger ones.

The mean preoperative values of FEV_1/FVC % that show the obstructive defects were normal in both groups. Still, there was a significant difference between the two groups with respect to the preoperative FEV_1/FVC ratios ($p=0.02$). According to the modified Gold criteria; four subjects (17.4%) in the elderly group and 16 subjects (17.9%) in younger group had obstructive lung defects as defined by a preoperative FEV_1/FVC <70%. The two groups did not differ significantly with respect to the obstructive lung defects.

After the surgery, when the preoperative and postoperative results within groups were compared, a significant decrease in PI_{max} and PE_{max} and respiratory functions was observed in both groups except in the FEV_1/FVC % and the FMFT values. Compared to the preoperative values, the postoperative values of all the parameters except for the FEV_1/FVC %, FMFT, FVC % predicted and FEV_1 % predicted were lower in the elderly patients compared to the younger patients. The percentage differences according to preoperative values of the PI_{max} and PE_{max} and respiratory functions except for the FEV_1/FVC % were similar in both groups.

There was a significant relationship between the age and the intubation time ($r=0.27$, $p=0.03$), pulmonary functions [FEV_1/FVC % ($r=-0.36$, $p=0.006$); FMF

(r=-0.34, p=0.009)] and the duration of ICU stay. The CPB (r=0.47, p=0.0009) and cross clamp times (r=0.34, p=0.02) were also observed to be related to the ICU stay. The CPB time was also related with the total duration of the hospital stay (r=0.42, p=0.004).

DISCUSSION

Even in healthy individuals, the lung function declines slowly throughout adult life,[19] let alone in elderly patients with cardiovascular disease.[20] Since most research studies took 70 years as the cut off age, we also used this

Table 1. Patient characteristics, operative and postoperative variables*

Variables	Elderly male patients (n=23)	Younger male patients (n=89)	*p*
Clinical characteristics			
Age (years)	71.6±2.3	57.6±5.3	<0.0001
Height (cm)	165.4±4.4	165.9±3.8	NS
Weight (kg)	76.3±9.9	79.7±8.8	NS
Body mass index (kg/m^2)	27.2±2.6	28.6±2.3	NS
Cardiac profile			
NYHA class	1.6±1.1	1.3±1.4	NS
Left ventricular ejection fraction (%)	48.8±10.1	50.9±9.3	NS
Angina	1.2±1.1	0.8±1.2	NS
Previous myocardial infarction	4 (17.4)	19 (21.3)	NS
Coronary risk factors			
Hypertension	5 (21.7)	19 (21.3)	NS
Diabetes mellitus	4 (17.4)	13 (14.6)	NS
Hyperlipidemia	4 (17.4)	12 (13.5)	NS
Family history	2 (8.7)	15 (6.8)	NS
Smoking history			
Number of cigarettes (day)	24.9±18.1	22.2±16.4	NS
Time of smoking (year)	24±13.7	22.6±14.8	NS
Ex-smoker	9 (39.1)	54 (60.7)	NS
Current smoker	2 (8.7)	20 (22.5)	NS
Arterial blood gases			
PaO_2 (mmHg)	75±14.8	85.21±10.3	0.0002
SaO_2 (%)	94.28±2.8	96.28±1.6	<0.0001
$PaCO_2$ (mmHg)	42.43±3.4	41.5±5.6	NS
Operative and postoperative data			
Number of bypass grafts	2.4±1.6	2.8±1.4	NS
Cardiopulmonary bypass time (min)	98.75±38.5	82.14±28.4	0.03
Cross clamp time (min)	54.37±19.1	46.11±18.6	NS
Intubation (hours)	14.3±4.0	11.3±3.4	0.0004
Intensive care unit stay (days)	2.9±1.5	1.9±1.2	0.001
Arterial blood gases (2nd day§)			
PaO_2 (mmHg)	111.42±4.6	116.50±9.4	0.01
SaO_2 (%)	96.30±9.4	98.1±1.8	NS
$PaCO_2$ (mmHg)	41.76±5.2	39±4.0	0.007
Total hospital stay (days)	8.8±2.0	7.2±1.6	<0.0001
Atelectasis	8 (34.8)	25 (28)	NS
Pneumothorax	1 (4.3)	–	NS
Bronchospasm	–	–	NS
Pneumonia	4 (17.4)	10 (11.2)	NS
Pleural effusion	2 (8.7)	4 (4.5)	NS
Tracheostomy	–	–	NS
Reintubation	–	–	NS
Postoperative myocardial infarction	–	–	NS
Atrial fibrillation	5 (21.7)	12 (13.5)	NS
Supraventricular tachycardia	2 (8.7)	4 (4.5)	NS
Intra-aortic balloon pump support	–	–	NS

*: Data are presented as mean ± SD, number of patients and/or percentage; §: Values were taken with oxygen support; NYHA: New York Heart Association classification; PaO_2: Partial arterial oxygen pressure; SaO_2: Arteriyal oxygen saturation; $PaCO_2$: Partial arterial carbondioxide pressure; NS: Non significant.

Table 2. Comparison of pre-and postoperative pulmonary functions, respiratory muscle strength

	Elderly male patients (n=23)			Younger male patients (n=89)			Between groups p value #		
	Pre-op	Post-op	Δ%	Pre-op	Post-op	Δ%	Pre-op	Post-op	Δ%
VC (L)	3.03±0.6	2.05±0.6*	-32.4±13.5	3.57±0.7	2.49±0.5*	-29.1±15.1	0.0006	0.001	NS
FVC (L)	3.04±0.6	2.06±0.6*	-32.3±13.8	3.59±0.7	2.50±0.5*	-29.1±15.2	0.0005	0.0009	NS
FVC (% predicted)	91.60±11.8	61.77± 17.2*	-32.4±13.5	92.06±16.8	64.1±12.9*	-26.3±16.9	NS	NS	NS
FEV_1 (L)	2.27±0.5	1.54±0.5*	-31.9±13.4	2.85±0.6	1.96±0.5*	-30.1±14.4	<0.0001	0.001	NS
FEV_1 (% predicted)	96.79±22.6	67.31±18.5*	-28.4±22.8	93.94±19.1	64.51±14.6*	-30.1±14.4	NS	NS	NS
FEV_1/FVC (%)	74.28±9.8	75±10.7	0.9±6.9	79.41±9.1	78.6±11.4	-0.9±11.6	0.02	NS	0.04
FMF (L/sec)	2.04±0.9	1.34±0.6*	-28.7±28.5	3.39±1.4	2.10±1.0*	-35.4±20.1	<0.0001	0.0004	NS
FEF (L/sec)	4.73±2.3	2.69±1.7*	-44.6±28.4	6.80±2.5	3.98±1.9*	-39.3±24.3	0.0005	0.009	NS
FMFT (sec)	1.04±0.8	1.00±0.6	3.0±39.4	0.86±1.0	0.85±0.5	18±42.4	NS	NS	NS
P_{Imax} (cm H_2O)	69.26±23.6	49.04±17.7*	-27.7±16.3	95.25±26.5	72.57±23.4*	-21.4±24.6	<0.0001	<0.0001	NS
P_{Emax} (cm H_2O)	117.78±51.8	88.96±28.3**	-17.7±25.8	144.26±45.0	108.34±34.1*	-20.3±27.8	0.02	0.01	NS

Δ%: Percent differences according to preoperative values; *: Paired t test or Wilcoxon signed-rank test, p<0.0001; **: Paired t test, p=0.003; #: Student's t-test (unpaired t test) or Mann-Whitney U-test; NS: Non significant.

criterion in our study. Our retrospective study has shown that the preoperative values for respiratory functions and muscle strength were significantly diminished in elderly male patients compared to younger ones in compliance with the findings of the above-mentioned studies.

Coronary artery bypass surgery adversely affects pulmonary function tests. After CABS, there is a significant worsening of the pulmonary function.[6,7,12] However, recent comparative studies between the conventional and off-pump coronary artery bypass grafting techniques have indicated that the CPB itself may not be the major contributor to the development of postoperative pulmonary dysfunction.[12,13] In our previous prospective study, we found that FVC and FEV_1 decreased 31.7% and 35.5%, respectively at two weeks postoperatively and remained below the baseline for about six months in middle-aged patients (mean age 53.6 years) operated for coronary artery disease.[7] It is interesting that in our present retrospective study, the early significant postoperative (pre-discharge) decrease in FVC was 32% in the elderly group and 29% in the younger group, while the decrease in FEV_1 was 31% in the elderly group and 30% in younger group, both parameters being within the range of our previous report.[7]

Although the ratio of the postoperative differences compared to the preoperative values from the pulmonary function tests were similar in two groups, the lower postoperative values obtained in the pulmonary function tests in elderly male patients compared to younger ones reflect the diminished values of the preoperative baseline assessments in aged patients. This finding causes a disadvantage to elderly male patients and increases the ICU stay and costs. Thus, we found a significant negative relationship between the preoperative FEV_1/FVC percentage and FMF values and the postoperative ICU stay in our patients undergoing CABS.

The range for the normal values for P_{Imax} and P_{Emax} is rather wide, and data about these measurements have been reported in the American Thoracic Society and the European Respiratory Society (ATS/ERS) statement on respiratory muscle testing. According to this statement, the variation among the measurements of P_{Imax} and P_{Emax} in these studies presumably indicates differences between the groups studied and the way in which the tests were performed and measured.[21] Normal values for the elderly have also been reported: The mean values ranged between 81-103 cm H_2O for P_{Imax} and 163-185 cm H_2O for P_{Emax} for the ages 70-75 and the decrease in mouth pressures was strongly correlated with age in healthy male subjects.[18,19,22] In our study, the mean preoperative P_{Imax} and P_{Emax} values for the elderly male group were 69 and 117 cm H_2O, respectively. These values are significantly lower than the P_{Imax} and P_{Emax} values of the younger male group as well as the results of the above-mentioned studies made on an elderly but healthy population. After the surgery, the statistically significant decrease in the respiratory muscle strength was similar in both groups of our CABS patients. The postoperative decrease in the inspiratory muscle strength in the younger male group (mean age 57.6 years) of our study was in accordance with the values of the study of Weiner et al.[11] on CABS patients (mean age 63.8 years).

As commonly known from the literature, postoperative recovery in elderly patients requires a longer

period than in younger patients. Delayed recovery in the elderly may be simply due to the aging process affecting all organs.[4] In CABS patients aged 70 years and over, the mean intubation time was 18.5 hours,[4] the range of mean ICU stay was 1.5-4.2 days and the mean duration of the postoperative hospital stay was 7.7-21.2 days.[4,23] In accordance with these studies, our elderly male patients required longer intubation (14.3 hours), longer ICU stays (2.9 days) and longer postoperative hospital stays (8.8 days) than the younger male patients, still, the intubation time was shorter than the results of the above-mentioned studies on elderly patients.

In their study, Wong et al.[24] reported that, despite the advancements in anesthesia and surgical management techniques, advanced age still remains as an independent predictor of delayed extubation and a requirement for prolonged intensive care.

In our study, although the intubation periods of both groups were within the normal intubation time ranges (<24 hrs) in accordance with the results of above study, the intubation time was the only parameter which was found to be significantly correlated with the ages of the patients. In another retrospective study we have conducted, in which the relationship between prolonged intubation and postoperative complication incidence under similar conditions following CABS was investigated, we have found that the patients who had longer partial bypass times and aortic clamp periods were ventilated for more than 24 hours and that this factor contributed to late complications following the bypass operation, where the complication risk of this group was 3.5 times higher than those who remained intubated for less than 24 hours.[14]

Hirose et al.[4] have reported longer intubation, ICU stay and postoperative hospital stay durations and more frequently observed major complications in their elderly CABS patients. However, although the elder patients had longer intubation times than the younger ones in our study, the frequency of complications was not significantly higher in the elderly patients. The intubation periods shorter than 24 hours that we have found in both of the groups in our study may also explain the similar complication rates seen in our study.

In this study, the elder patients had significantly longer CPB times than the younger ones. These longer CPB and cross clamp periods affected the ICU stay, and the CPB time affected the total hospital stay, but the same effect was not observed in the intubation times in contrast with the retrospective study we previously conducted.[14] This may again be explained by the absence of prolonged intubation periods in both groups participating in our study.

All these favorable results in our elderly male patients may be a reflection of both recent intraoperative technical advances and refinements in our ICU, and the preoperative and postoperative intense chest physiotherapy applied in our surgical department. Although in published studies, it has been clearly demonstrated that CABS in the geriatric population is associated with a higher risk compared to a younger population,[1-3] our findings clearly suggest that surgery may still offer the best chance to these elderly patients.

Limitations of the study

The major limitation of our study was its retrospective design. There was a wide variety of missing data about the patients who did not undergo either the baseline or follow-up pulmonary function or respiratory muscle strength measurements. The exclusion of female subjects and the patients who had emergency surgery or cardiac surgery other than CABS together with the patients who had co-morbid factors limited the study to a small patient group. But we believe that the exclusion of the latter two factors has strengthened the findings of our study and provided the chance to perform our investigation in a more homogenous population.

Although our retrospective analysis supplied important data about the postoperative clinical outcome, pulmonary functions, respiratory muscle strength and complications and the effect of age on these variables, we believe that a prospective randomized clinical trial will strengthen the findings of this present study.

In conclusions, the pulmonary functions and the maximal inspiratory and expiratory pressures in elderly male patients who have undergone CABS were lower than the group of younger male patients before the surgery. The negative effect of the operation and anesthesia on pulmonary functions and the respiratory muscle strength in patients who have undergone CABS was found to be similar in both groups. So, male patients of 70 years or more should not to be denied CABS solely on the basis of age and the deterioration of pulmonary functions.

Although the CPB time is longer in the elderly male patients, the advances in the CPB, myocardial protection and critical care techniques have improved the outcome in this patient group. But the postoperative course still requires longer intubation, ICU stay and postoperative hospital stay durations than younger patients.

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