Turkish Journal of Geriatrics
2013; 16 (1) 25-30

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RESEARCH

PROPENSITY MATCHED COMPARISON OF OUTCOMES OF CARDIAC SURGERY IN OCTOGENARIANS

ABSTRACT

Introduction: Increased longevity of the population leads to more elderly patients demanding healthcare in cardiac surgery. There is still skepticism on the topic of cardiac interventions performed in the elderly. Our study aimed to compare postoperative variables in patients aged 80 years or less with octogenarians by use of propensity score matching.

Materials and Method: Subjects were 1253 patients who underwent heart surgery in Central Anatolia in the same cardiac center. Propensity score matching was used to discriminate the influence of age on preoperative variables. Morbidity and mortality of 32 patients aged ≥80 and 1221 patients aged ≤79 were compared.

Results: After propensity score matching each group had 32 patients who were matched on all baseline preoperative characteristics. Arrhythmias occurred more frequently in the older age group. Intensive care unit and hospital length of stay, number of blood and blood products transfused, postoperative complications and mortality rates were similar in both groups.

Conclusion: The two age groups had similar morbidity and mortality. Advanced age does not result in worse outcome after cardiac surgery when compared with a propensity score matched younger age group. In carefully selected patients over 80 years of age, cardiac surgery can be performed safely.

Key Words: Aged; 80 and Over; Cardiac Surgical Procedures; Propensity Score.

ARAŞTIRMA

80 YAŞ VE ÜZERİ HASTALARDA EĞİLİM SKORU EŞLEŞMESİ İLE KALP CERRAHİSİ SONUÇLARININ KARŞILAŞTIRILMASI

ÖZ

Giriş: Toplumun yaşam süresinde meydana gelen artış, daha fazlı yaşlı insanın kalp cerrahisi girişimlerine ihtiyaç duymasına neden olmaktadır. Ancak, halen yaşlı hastalarda kalp cerrahisi uygulamaları konusunda şüphe mevcuttur. Bizim çalışmamızın amacı, eğilim skoru eşleşmesi kullanarak 80 yaş altı hastalarla, 80 yaş ve üzeri hastaların kalp cerrahisi sonuçlarının karşılaştırılmasıdır.

Gereç ve Yöntem: Orta Anadolu'da, aynı merkezde açık kalp cerrahisi geçiren toplam 1253 hasta incelendi. Yaşın preoperatif değişkenler üzerine olan etkisini ortadan kaldırmak için eğilim skoru eşleşmesi yapıldı. Kalp cerrahisi geçiren 80 yaş ve üzeri 32 hasta ile 79 yaş ve altı 1221 hasta morbidite ve mortalite sonuçları açısından karşılaştırıldı.

Bulgular: Her iki grupta da, eğilim skoru eşleşmesi yapıldıktan sonra, tüm preoperatif karakteristik özelliklerin eşlendiği 32 hasta kaldı. Yaşlı hasta grubunda aritmi sıklığı daha fazla idi. Yoğun bakım ve hastanede kalış süreleri, verilen kan ve kan ürünü sayıları, postoperatif komplikasyonlar ve mortalite her iki grupta da benzerdi.

Sonuç: Her iki yaş grubunda da morbidite ve mortalite benzerdi. Eğilim skoru eşleşmesi yapıldığında, ileri yaş kalp cerrahisi sonuçları açısından daha kötü sonuçlara yol açmamaktadır. İyi seçilmiş, 80 yaş ve üzeri hasta gruplarında kalp cerrahisi güvenle uygulanabilir.

Anahtar Sözcükler: Yaşlı; 80 Yaş ve Üzeri; Kardiyak Cerrahi Girişimler; Eğilim Skoru.

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Geliş Tarihi: 11/07/2012
(Received)

Kabul Tarihi: 18/11/2012
(Accepted)

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Introduction

So far has evolved in the era of cardiac surgery since the development of first heart-lung machine and its surgical applications in 1950s. Due to ongoing preventive measures and more sophisticated medical and surgical modalities, the age of population increases remarkably, so does the age of patients undergoing cardiac surgery. Based on Turkish Statistical Institute data, it is estimated that there are currently 2,019,000 people over 75 years of age (2.73% of the population); 40.3% male and 59.7% female. By the year 2023 that estimate will have risen to 2,588,000 (3.07% of the population); 39.4% male and 61.6% female (1). There are very few population by age group studies concerning cardiovascular disease in Turkey. It has been reported by The Turkish Ministry of Health in 2004 that 23.3% of male and 18.4% of female population over 80 years of age have cardiovascular disease (2). Being parallel with these findings, the number of cardiac operations in elderly patients has been rising over the last two decades (3). An analysis concerning quality of life in octogenarians found that after cardiac surgery, patients can function independently and recreate themselves (4). This is a fact supporting cardiac surgery be performed more willingly in the elderly population.

Vast number of investigations have evaluated outcomes after cardiac surgery in elderly population worldwide. Clinical data from Turkey has also been growing in recent years concerning septuagenarians (age 70-79) and octogenarians (age 80-89) (5-9). Treatment strategies for these age groups must consider the expectant outcomes, and as equally important, the costs and resource utilization.

Outcome analyses based on age mostly depend on retrospective data, so randomization is not possible. Also, accurate comparison after maintaining homogeneity of patient characteristics can not be made. In this context, propensity score matching is a more reliable method, because the studied outcome parameter is compared after every single parameter affecting its occurence is scored and unbiased. As mentioned by Blackstone EH, 'propensity score matching allows "apples to apples" comparisons instead of "apples to oranges" comparisons' (10).

In this study, we used propensity score matching to compare outcomes of cardiac surgery in octogenarians with the patients in younger age groups.

Materials and Method

Study Population

Thirty two patients aged 80 years or older who underwent cardiac surgery in a single center between December 2008 and October 2011 were studied. During the study period, totally 1253 patients were operated in Cardiovascular Surgery Department (reoperations excluded). The Hospital Ethics Committee approved the study based on retrospective data, waiving for individual consent.

To get matched pairs with similar clinical and preoperative characteristics (other than age), we have calculated a propensity score using a logistic regression model that included clinical and preoperative characteristics. Patients were matched one-to-one on propensity scores with "nearest neighbor matching" technique.

Perioperative Care

General anesthesia was given to the patients. After cardiopulmonary bypass (CPB) was instituted, an antegrade intermitant cold blood cardioplegia with terminal hot shot was used for myocardial management. Retrograde fashion was used only in cases of left main coronary stenosis and aortic valvular interventions. All patients were taken to the intensive care unit (ICU) intubated, and soon extubated depending on the hemodynamic and neurologic status of the patient.

The whole study period was 3 years, so we think that the year of operation may have not influenced outcomes. The surgical techniques and perioperative care did not differ during the study period.

Statistical Analysis

Statistical analyses were performed using SPSS software for Windows (version 17.0, Statistical Package for the Social Sciences Inc, Chicago, IL, USA). Continuous variables were expressed as "mean values ± standard deviation (SD)" and "median (25th-75th percentiles)". Categorical variables were expressed as number and percentages. Outcomes of the matched groups were compared using "independent samples t test" and "Mann-Whitney U test'' for continuous variables and "chi-square test" and "Fisher's exact test" for categorical variables. A p value under 0.05 was considered as "statistically significant".

Results

After propensity score matching, each age group had 32 patients. The mean ages of the two groups were 82.06 ± 2.34 (minimum:80, maximum:89) and 64.13 ± 8.97 (mini-

Table 1— Comparison of the Two Groups by Preoperative Characteristics

	≥80 years n (%)	≤80 years n (%)	p value*
Patient Total	32	32	
Male sex	20 (62.5)	21 (65.6)	0.794
Curent/Ex-smoker	19 (59.4)	21 (65.6)	0.606
Diabetes Mellitus	9 (28.1)	12 (37.5)	0.424
Hypertension	24 (75.0)	25 (78.1)	0.768
Peripheral Arterial Disease	1 (3.1)	1 (3.1)	1.000†
Stroke	1 (3.1)	—	1.000†
Carotid Disease	6 (18.8)	4 (12.5)	0.491
COPD/Asthma	9 (28.1)	10 (31.3)	0.784
Atrial Fibrillation	1 (3.1)	-	1.000†
LMCA Stenosis	4 (12.5)	2 (6.3)	0,672†
LVEF			0.948
≥0.60	12 (37.5)	14 (43.8)	
0.50-0.59	7 (21.9)	5 (15.6)	
0.46-0.49	1 (3.1)	1 (3.1)	
0.41-0.45	4 (12.5)	3 (9.4)	
0.35-0.40	5 (15.6)	7 (21.9)	
≤0.35	3 (9.4)	2 (6.3)	

*chi-square test.
†Fisher's exact test.
COPD, chronic obstructive lung disease; LMCA, left main coronary artery; LVEF, left ventricular ejection fraction.

Table 2— Comparison of the Two Groups by Intraoperative Characteristics

	≥80 years Mean ± SD [Median (25th-75th)]	≤80 years Mean ± SD [Median (25th-75th)]	p value*
BSA (kg/m²)	1.82 ± 0.19 [1.91 (1.68-1.96)]	1.88 ± 0.15 [1.89 (1.75-1.99)]	0.180
Cross-clamp time, min	47.93 ± 22.16 [37.5 (32.5-67.0)]	55.07 ± 21.56 [54.5 (38.5-70.5)]	0.215
CPB time, min	74.57 ± 24.15 [64.0 (53.0-86.5)]	79.24 ± 29.94 [74.5 (52.5-96.5)]	0.511
Number of grafts in CABG	2.68 ± 0.87 [3.0 (2.0-3.0)]	2.97 ± 1.33 [3.0 (2.0-4.0)]	0.310
	n (%)	n (%)	p value†
LIMA use in CABG	27 (87.1)	32 (100.0)	0.036

*independent samples t test.
†chi-square test.
BSA, body surface area; CPB, cardiopulmonary bypass; LIMA, left internal mammarian artery; CABG, coronary artery bypass grafting.

mum:45, maximum:78). The patients were matched on all preoperative variables (Table 1). Characteristics with zero incidences were not given in the table including chronic renal failure, preoperative hemodynamic instability/intraaortic balloon pump insertion, emergency operation and preoperative ventricular tachcardia/fibrillation.

Peripheral arterial disease was defined when history of therapeutic vascular intervention and/or history of claudication were present, or when there was evidence of disease on angiography or non-invasive tests. Carotid disease was defined when there was history of carotid intervention or demonstrated >40% stenosis on either carotid artery on angiography or non-invasive tests.

In non-octogenarian group three off-pump coronary artery bypass grafting (CABG), one aortic valve replacement concomitant with CABG, and 28 on-pump CABG procedures were performed. In the octogenarian group two off-pump CABG, two aortic valve replacement concomitant with CABG, one left ventricular aneurysm repair concomitant with CABG, one Bentall and 26 on-pump CABG procedures were performed. One patient in the octogenarian group was electively converted from an off-pump to on-pump CABG procedure and eveluated within the on-pump group.

The intraoperative chacteristics for the two matched groups were compared on Table 2. The cross-clamp times and CPB times did not differ between the groups. The octogenarians recieved 2.68 grafts whereas younger patients recieved 2.97 grafts (p>0.05). In CABG patients, octogenarians had 87.1% left internal mammarian artery conduits compared to 100% in non-octogenarians (p:0.036). The flow of the graft was less than required in those patients whom internal mammarian artery was not used. Intraaortic balloon counterpulsation was not required in any of these patients.

When postoperative variables for the two-matched groups were compared, mean time to extubation, length of stay in the ICU, postoperative length of stay, total hospital length of stay, total amount of chest tube drainage, mean number of fresh frozen plasma and packed red blood cell transfused were not different (Table 3). In older and younger age groups preoperative and postoperative hematocrit values were 39.37 ± 4.87/39.73 ± 4.87 (p>0.05) and 29.88 ± 2.62/29.62 ± 2.41(p>0.05) respectively. One patient in the octogenarian group could not be extubated, had tracheostomy and died after 3 months. One patient in the older age group was reop-

Table 3— Comparison of the Two Groups by Postoperative Variables

	≥80 years (n=32) Mean ± SD [Median (25th-75th)]	≤80 years (n=32) Mean ± SD [Median (25th-75th)]	p value*
ICU intubation time, hours	78.75 ± 379.81 [11.0 (9.5-13.5)]	7.34 ± 2.83 [6.75 (5.5-8.25)]	0.296
Length Of Stay			
ICU, hours	114.97 ± 373.32 [47.0 (43.5-48.0)]	44.56 ± 10.54 [46.0 (42.0-47.0)]	0.290
Preoperative, days	2.03 ± 1.28 [2.0 (1.0-2.0)]	1.66 ± 1.20 [1.0 (1.0-2.0)]	0.233
Postoperative, days	9.19 ± 14.91 [6.0 (5.0-7.5)]	6.16 ± 2.97 [5.0 (5.0-6.5)]	0.264
Total, days	11.22 ± 14.87 [8.0 (7.0-9.0)]	7.81 ± 3.45 [7.0 (6.0-8.5)]	0.212
Drainage tubes removed, hours	40.84 ± 10.66 [37.0 (31.0-45.0)]	33.41 ± 6.25 [32.0 (31.0-39.5)]	0.001
Total amount of drainage, ml	778.91 ± 334.39 [750.0 (575.0-1000.0)]	646.88 ± 291.80 [625.0 (450.0-900.0)]	0.097
Number of FFP used	2.41 ± 2.23 [2.5 (0.5-3.5)]	1.58 ± 2.06 [1.0(0.0-2.0)]	0.170
Number of packed RBC used	2.14 ± 2.16 [2.0 (0.0-3.5)]	1.84 ± 1.71 [2.0(0.5-3.0)]	0.579
	n(%)	n(%)	p value**
Postoperative Arrhythmia	12 (37.5)	4 (12.5)	0.021

*Independent samples t test
†chi-square test.
ICU, intensive care unit; AF, atrial fibrillation; FFP, fresh frozen plasma; RBC, Red blood cell.

erated for postoperative hemorrhage and none in younger age group (p>0.05). Preoperative use of clopidogrel and total amount of drainage were compared. In the octogenarian group there was only one patient who used clopidogrel preoperatively, so statistical comparison was not made. In the younger age group there were 5 patients who used clopidogrel preoperatively and drainage was 890 ± 383 ml, compared to 601 ± 255 ml in non-users (p:0.098). The only significant difference among postoperative variables was the occurence of postoperative arrhythmias; 37.5% in octogenarians compared to 12.5% in the younger age group (p:0.021). The arrhythmias included atrial arrhythmias, atrial fibrillation (AF), ventricular tachycardia/fibrillation and complete atrioventricular block. One patient in octogenarian group who had atrioventricular block following the aortic clamp release was temporarily paced, but 1 week later a permenant pacemaker was implanted intravenously. Amiodarone infusion was administered for all kinds of arrhythmias. One patient with AF in the younger age group was electrically cardioverted. One patient in the octogenarian group had ventricular tachycardia/fibrillation, which spontaneously resolved, and amiodarone was administered. Normal sinus rhythm was maintained in all cases. When arrhythmias were individually explored, there was no difference between groups.

The postoperative complications were compared on Table 4 and include postoperative renal failure, stroke, postoperative pericardial effusion requiring operative tube drainage, gastrointestinal hemorrhage, sternal dehiscence/ mediastenitis requiring sternal rewiring, respiratory problems requiring continious positive airway pressure support, low cardiac ouput due to AF, permenant pacemaker implantation, multisystem organ failure and death.

Renal failure was defined if peak postoperative creatinine was 1.5 times or greater the preoperative value. Stroke was

Table 4— Comparison of the Two Groups By Postoperative Complications

Outcome	≥80 years n (%)	≤80 years n (%)	p value*
Postoperative renal failure	8 (25.0)	5 (15.6)	0.351†
Renal failure requiring hemodialysis	1 (3.1)	-	1.000
Gastrointestinal hemorrhage	1 (3.1)	-	1.000
Sternal dehiscence/mediastenitis	-	1 (3.1)	1.000
Low CO (due to atrial fibrillation)	-	1 (3.1)	1.000
Postoperative pericardial effusion requiring operative tube drainage	1 (3.1)	-	1.000
Respiratory problems, CPAP support	1 (3.1)	1 (3.1)	1.000
Pacemaker Implantation	1 (3.1)	-	1.000
Multisystem Organ Failure	1 (3.1)	-	1.000
Death	1 (3.1)	-	1.000

*Fisher's exact test.
†chi-square test.
CO: cardiac output.

defined as a new focal neurologic deficit or coma diagnosed in the postoperative peiod. Postoperative stroke was not seen in both groups. Low cardiac output was diagnosed based on clinical parameters. There was only one mortality which was in the octogenarian group. The patient had postoperative renal failure requiring hemodialysis. Tracheostomy was performed and multsystem organ failure developed. All postoperative complications including death did not differ between the groups.

Discussion

The octogenarian patient is often assumed to be too fragile to undergo cardiac surgery. This prevents many patients from being referred to cardiac surgeon. Age related unwillingness of the patient to undergo surgery for social and religious reasons, lack of emotional support from family members and skeptical approach of non-cardiac surgeon physicians feed this false belief.

Age itself is a factor bringing comorbidities to the patient. It would be more reliable to compare patients with similiar comorbidities . Otherwise one young patient with few or no comorbidities would be compared to an older patient with multiple comorbidities. Propensity score matching allows to make comparison of patients with similar preoperative characteristics other than age.

One of the most important findings of this study is that the propensity-matched age groups did not differ significantly in major cardiac, neurologic, pulmonary, renal or gastrointestinal complications and inhospital mortality.

Mostly, it is suggested that blood and blood product transfusions are more commonly employed in older ages due to lower thresholds (11) and transfusions worsen morbidity and mortality (12,13). In our study amount of blood and blood products transfused did not differ between the groups.

Postoperative arrhythmias were more common in the older age group, which supports the fact that especially atrial arrhythmias increase with age due to age related atrial enlargement (14,15). Occurence of arrhythmias did not affect ICU stay among the groups in both the young and old age groups (p:0.763 and p:0.803 respectively). Also arrhythmias did not affect ICU stay when the groups were compared (p:0.290).

In many series evaluating the outcomes in octogenarians the postoperative non-fatal complications were higher in the older age groups (16-18). In this study there was no statistically signifiant difference between the older age and younger age groups, but this may be due to low number of patients.

Age is accepted as a remarkably important risk factor in cardiac surgery, but it is not easy to eliminate the effect of age on comorbidities accompanying in older age groups. This finding leads to conflicting results. By propensity score matching it is possible to eliminate the effect of age on existing comorbidities. Bhamidipati et al. (17), Scott et al. (18) and Barnett et al. (19) reported age 80 years or older to be an independent risk factor for postoperative morbidity, mortality and increased resource utilization, whereas Nissinen et al.

(3) and Mamoun et al. (11) found that advanced age is not associated with a worse outcome after CABG. In this study age was not found out to be a risk factor for mortality.

The main limitation of this study is the small number of patients. Despite propensity score matching was done, 32 octogenarian out of totally 1253 patients is less than desired. This in turn is due to suggested reasons earlier in the text. The number of octogenarian population not only with cardiovascular disease but also without cardiovascular disease is significantly lower in Turkey compared to western counterparts, since the average age of the population is lower. This is the explanation why there are very few data concerning cardiac interventions in octogenarians from Turkey. Lack of long-term follow-up and cost and resource utilization analysis are other potential limitations.

In this retrospective study, we concluded that, by eliminating the impact of age on comorbidities that could affect the outcome via propensity score matching, the postoperative major morbidities and mortality did not differ between octogenarians and younger patients. Given the increasing longevity of Turkish population in parallel with western countries, patients over 80 years of age will become a larger population undergoing cardiac surgery, and cardiac surgery can be performed safely in carefully selected patients in this age group.

Conflict of Interest

The authors did not declare any conflict of interest related to the investigation and production of the manuscript.

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