The Elderly Patient and Cardiac Surgery – A Mini-Review

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Key Words

Aging · Coronary artery bypass grafting · Aortic valve · Mitral valve · Endocarditis

Abstract

Introduction: Due to the increase in average life expectancy and the higher incidence of cardiovascular disease with advancing age, more elderly patients present for cardiac surgery nowadays. Advances in pre- and postoperative care mean that more elderly patients can be operated on safely and with a satisfactory outcome. Currently, coronary artery bypass surgery, aortic and mitral valve surgery and surgery of the ascending aorta are performed in elderly patients. **Objective:** In this review, we summarize the outcome of elderly patients undergoing various cardiac surgical procedures and give future perspectives for the treatment of elderly patients with cardiac surgery. **Methods:** A PubMed search for the period from 1980 to February 2009 was conducted with the following key words: ‘elderly patient’, ‘cardiac surgery’, ‘CABG aortic surgery’, ‘mitral valve surgery’ and ‘endocarditis’. Additional information concerning population demographics was obtained from the World Health Organization homepage. **Results:** More and more cardiac surgical procedures are offered to elderly patients. The short- and long-term survival rates of elderly patients are comparable to those of younger patients. Nevertheless, the risk for these patients is only acceptable in the absence of comorbidities. In particular, renal dysfunction, cerebrovascular disease and

a poor clinical state are associated with a worse outcome in elderly patients. **Conclusion:** The data available show that most cardiac surgical procedures can be performed in elderly patients with a satisfactory outcome. Careful patient selection, flawless surgery, meticulous hemostasis, perfect anesthesia and myocardial protection are basic requirements for the success of cardiac surgery in elderly patients.

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Introduction

In the scientific literature, different definitions of ‘elderly’ can be found [1, 2]. The border to elderly varies from 65 to 70 or even 80 years. For the sake of clarity, herein, we define the age of 70 years and above as elderly.

In industrialized countries, the proportion of people over 70 years old is growing [3] (fig. 1). Thirteen million US citizens are currently over the age of 75, and this number is expected to quadruple over the next 50 years [4]. According to the World Health Organization report *The Global Burden of Disease: 2004 Update* [5], ischemic heart disease is the number one cause of death nowadays (table 1). Approximately 25% of the population over 75 years suffers from symptoms of cardiovascular diseases [6]. While an age of 70 was considered a contraindication even for diagnostic procedures such as coronary angiography in 1984 [7], this and other ‘dogmas’ concerning the age of cardiovascular patients do not exist anymore. The

Fig. 1. Predicted aging of the population in the USA. Shown is the projected population in millions aged 45 years and over to 2050. Source: The President's Council on Bioethics (<http://bioethics.gov/>).

Table 1. Major global causes of death [5]

Causes of death	Deaths in millions	Percentage of total deaths
Coronary heart disease	7.20	12.2
Stroke and other cerebrovascular diseases	5.71	9.7
Lower respiratory tract infections	4.18	7.1
Chronic obstructive pulmonary disease	3.02	5.1
Diarrheal diseases	2.16	3.7
HIV/AIDS	2.04	3.5
Tuberculosis	1.46	2.5
Trachea, bronchus, lung cancers	1.32	2.3
Road traffic accidents	1.27	2.2
Prematurity and low birth weight	1.18	2.0

proportion of elderly patients undergoing cardiac surgery has steadily increased year for year.

In 2002, a total of 96,194 surgeries with cardiopulmonary bypass were performed in Germany alone, with 39.1% of the procedures performed in patients over the age of 70. Aging of society will inevitably lead to an increasing proportion of patients over 70 years undergoing cardiac surgery. Developments in myocardial protection, surgical technique, extracorporeal circulation and anes-

thesiological treatment allow for safe operations in the elderly.

Elderly patients with unstable coronary artery disease benefit from coronary artery bypass grafting (CABG) more than from conservative treatment, with a 3-year survival rate after CABG of 77%, compared to 55% in patients receiving conservative treatment [8, 9].

Although there is evidence suggesting improved quality of life in elderly patients who have undergone cardiac surgery [1], these patients still have a high risk of early mortality, morbidity and increased hospital costs [10, 11]. Therefore, the resulting attitude of primary care physicians and referring doctors may tend towards an excessively conservative direction [12–14], despite the fact that the in-hospital mortality rate of elderly patients undergoing cardiac surgery is well within the range of that for younger patients [2, 15], especially if they are free from significant comorbidities [16]. Nevertheless, elderly patients are more fragile, due to the fact that they have significantly reduced biological reserves. Flawless surgery, excellent myocardial protection, perfect hemostasis and adequate organ perfusion are basic requirements for cardiac surgery in elderly patients [2].

The elderly patient is an important topic not only in ischemic heart disease but also in other cardiovascular diseases amenable to cardiac surgery, e.g. valvular heart

disease, dissection of the aorta, chronic heart failure and cardiac arrhythmias. Aortic stenosis (AS), the most common heart valve disease in Western countries, occurs rather frequently in elderly patients. Aortic valve replacement (AVR) is the only curative therapy, and it has been shown that elderly patients aged 75 years or older benefit from cardiac surgery in comparison to conservatively treated patients [17, 18].

Surgery of the mitral valve in elderly patients is a controversial topic due to higher mortality and morbidity rates [19], especially when the procedure is combined with CABG or aortic valve surgery [19]. Nevertheless, recent studies indicate a beneficial effect of mitral valve surgery in elderly patients [20].

Other cardiac surgical interventions such as heart transplantation and implantation of ventricular assist devices are still not indicated in elderly patients due to the lack of biological reserve to withstand such invasive procedures. Major problems occurring in patients receiving ventricular assist devices are thromboembolism and a systemic inflammatory response. Elderly patients are more likely to develop such complications even after normal surgical interventions. Heart transplantation requires immunosuppression, which involves a higher risk of infection and pharmacological side effects; although these are mostly harmless for younger patients, they can be deadly for elderly patients. Apart from that, in times of organ shortage and rationing of health care costs, careful patient selection for heart transplantation and implantation of ventricular assist devices is inevitable. Nevertheless, more and more cardiac surgery procedures are now also available for elderly patients, including aneurysm surgery with deep hypothermia and circulatory arrest.

Cardiac Surgery and Elderly Patients: General Remarks

Alexander et al. [10] evaluated the data and postoperative course of 67,764 elderly patients who had undergone cardiac surgery in 22 hospitals in the USA. Of the total number of patients included in the study, 4,743 were over the age of 80. For the purposes of risk assessment, the patients were divided into 3 groups: CABG only, CABG and AVR and CABG and mitral valve replacement.

Octogenarians undergoing cardiac surgery had fewer comorbidities but higher disease severity and urgency than younger patients. The in-hospital mortality was

higher than in corresponding younger patients: CABG only, 8.1 versus 3.0%; CABG and AVR, 10.1 versus 7.8%, and CABG and mitral valve replacement, 19.6 versus 12.2%. Strokes and renal failure were the complications during the postoperative course which showed the largest difference in incidence between old and young patients. Octogenarians had twice the incidence of stroke and renal failure. Preoperative factors predicting the postoperative course of elderly patients were the same as in younger patients; that is, emergency surgery and prior CABG were the strongest risk factors. This multicenter trial showed quite clearly that age does not constitute an isolated risk factor for cardiac surgery and does not determine the postoperative outcome. This study also found that elderly patients without significant comorbidities had in-hospital mortality rates of 4.2% after CABG, 7% after CABG with AVR and 18.2% after CABG with mitral valve replacement.

Midterm Survival after Cardiac Surgery in Elderly Patients: Analysis of Predictors of Increased Mortality

The studies presented above show that it is possible to perform cardiac surgery in elderly patients with an acceptable outcome if they are free from comorbidities. Therefore, it would appear to be important to identify risk factors and predictors of increased mortality and morbidity. Srinivasan et al. [21] investigated the data of 840 consecutive patients ≥ 75 years who underwent cardiac surgery (CABG and/or valve replacement). A total of 162 deaths (19.3%) occurred during the study period, with a total follow-up time of 1,866 patient years. Survival in elderly patients at 5 years was 71.7%, compared to 70.9% in the age- and sex-matched general population ($p = 0.252$). Multivariate analysis for independent predictors of increased mortality showed that renal dysfunction ($p < 0.001$), valve(s) surgery ($p < 0.001$), cerebrovascular disease ($p = 0.003$) and poor general condition ($p = 0.011$) were the major risk factors.

Long-Term Survival after Cardiac Surgery in Elderly Patients

As mentioned above, short-term results favor cardiac surgery in elderly patients. In another study, not only the early results but also the long-term outcome of 601 patients over the age of 80 were compared with 5,698 pa-

tients between the age of 70 and 79 and with 11,386 patients between the age of 60 and 69 [22].

As expected, the proportion of women in the group of octogenarians was significantly higher in comparison to 60 to 69 year olds (44.4 vs. 25.6%), and compared to the normal demographic gender distribution. More octogenarians had class IV angina (54.1 vs. 38.9%) and congestive heart failure class IV (4.9 vs. 3.0%). The overall perioperative mortality in the oldest group was 9.1% in comparison to 3.4% in the youngest group. Among octogenarians undergoing isolated CABG with saphenous veins as the only bypass grafts, the perioperative mortality was 8.2%; in emergency cases, this rose to 24.1%. Rather interesting was that isolated elective left internal mammary artery CABG had an in-hospital mortality among octogenarians of 2.3%. This should encourage cardiac surgeons to use the left internal mammary artery as a conduit in CABG surgery in elderly patients as well. Comparing octogenarians and septuagenarians, there was a significant difference only for elective CABG performed with saphenous vein grafting. Emergent CABG-saphenous vein grafting and both elective and emergent left internal mammary artery CABG showed no difference between these age groups. In this study, only 5.7% of octogenarians undergoing isolated AVR died during hospitalization. When CABG was performed in conjunction, the in-hospital mortality rose to 9.7%. Isolated mitral valve replacement had a mortality of 16.7%. This rose to 33.3% when CABG was performed concomitantly. These numbers show that one should be restrictive with the indication for a mitral valve replacement in octogenarians. When comparing the in-hospital mortality after valvular cardiac surgery in the 3 age groups, there was no significant difference between octogenarians and septuagenarians (7.3 vs. 5.7%); only in patients between 60 and 69 years was there significantly lower in-hospital mortality (2.5%).

When looking at the long-term results for the survival rates of octogenarians, they are only slightly worse than those of septuagenarians during the first 10 years after cardiac surgery. Octogenarians had median 2-, 5- and 10-year survival rates of 75, 55 and 12%, and septuagenarians 83, 69 and 35%, respectively. The corresponding survival rates of patients between 60 and 69 years were higher (90, 81 and 58%, respectively). These data show that the midterm life expectancy after cardiac surgery is quite similar between octogenarians and septuagenarians. Ten years after cardiac surgery, the survival rate of the octogenarians drops, in line with the natural life expectancy.

In another study, Mortasawi et al. [23] investigated short- and long-term results (3-year follow-up period) of 121 patients >80 years undergoing isolated CABG. The overall in-hospital mortality was 6.6% in patients over 90 (1.5% in younger patients). In-hospital mortality for elective CABG was 5.9%. In emergency cases, the in-hospital mortality for octogenarians was 16.7%. One-year survival was 89.9%, 2-year survival 84.3% and 3-year survival 67.4%. Analysis of predictors of mortality revealed the following factors: ejection fraction less than 50%; history of recent left ventricular failure; extent of coronary artery disease; perioperative use of an intraaortic balloon pump, and symptomatic pericardial effusion. One year after CABG, 90% of the survivors were free from angina. Two years after CABG, this rate was 82.6%, and after 3 years it was 78.1%. Permanent nursing care was not required by 94.3% of patients after 1 year and 91.5% after 2 years.

Aortic Valve Surgery

AS is an important entity in elderly patients, since the prevalence of AS is related to age. Due to the fact that many elderly patients suffer not only from isolated AS but also from significant comorbidities, the decision to operate on elderly patients for symptomatic AS raises specific problems. However, little is known regarding the proportion of elderly patients with AS who are denied intervention [24, 25]. Jung et al. [26, 27] investigated the data of 216 patients aged 75 years or older with severe AS included in the Euro Heart Survey on Valvular Heart Disease. A decision to operate was made in 72 patients (33%). In a multivariable analysis, left ventricular ejection fraction and age were significantly associated with the decision not to operate, whereas the Charlson comorbidity index was not. With the advent of transcatheter aortic valve implantation, the situation has changed completely, as high-risk patients with significant comorbidities are the primary target population for this therapeutic modality. In a study by Himbert et al. [28] of high-risk patients with AS, the mean age of the study population was 82 years. Of 160 consecutive patients at high risk or with contraindications to surgery, 75 were treated with transcatheter aortic valve implantation. The transfemoral approach was used as the first option, and the transapical approach was chosen when contraindications to the former were present. Being able to offer either transfemoral or transapical aortic valve implantation expands the scope of the treatment of AS in elderly patients and provides satisfactory results at 1 year in this population [28].

Mitral Valve Surgery

Some studies recommend restrictive indications for mitral valve surgery in elderly patients [19]. Tsai et al. [19] compared the outcome of elderly patients who underwent cardiac surgery for coronary artery disease or AS with those who underwent mitral valve surgery. In their study, 303 patients underwent isolated CABG (group I), 132 had AVR only or combined with CABG (group II), 42 had a mitral valve replacement only or in combination with CABG (group III), 31 had a mitral valve repair and CABG (group IV) and 20 patients had a double-valve procedure only or combined with CABG (group V). The 30-day mortality was 8.3% in group I, 4.5% in group II, 29% in group III, 23% in group IV and 30% in group V. One-year and 5-year survival rates were as follows: 82 and 62% for group I, 82 and 62% for group II, 85 and 58% for group II, 61 and 37% for group IV, 56 and 19% for group IV and 63 and 15% for group V. This study shows that patients undergoing CABG and AVR had better results in terms of improvement in quality of life compared with patients undergoing mitral valve surgery or combined interventions [19].

On the other hand, there are data in favor of mitral valve surgery in elderly patients. Grossi et al. [20] confirmed the favorable outcome of mitral valve reconstruction in elderly patients, as long as the patients are free from significant comorbidities and surgery is conducted in a flawless manner. For isolated mitral valve reconstruction, the in-hospital mortality rate was 6.5%, and it was 17.0% when this procedure was combined with coronary revascularization in patients aged 70 and older. The mortality rate when mitral valve reconstruction was combined with another valve procedure was 13.2%. The rate of 5-year freedom from late cardiac death was 100% in the isolated mitral valve reconstruction group and 79.7% in the group who had mitral valve reconstruction combined with a concomitant procedure. Despite the recognized superiority of mitral valve reconstruction in younger patients, mitral valve replacement is performed more frequently in elderly patients and perceived to be equivalent to repair. Recently Ailawadi et al. [29] showed that mitral valve repair had significantly lower mortality than replacement in patients aged 75 years or older; in particular, the postoperative stroke rate was lower in the repair group than in the replacement group. Even though there are no clear guidelines that mitral valve reconstruction is preferable in octogenarians, based on the data available, we recommend mitral valve reconstruction in elderly patients.

Nowadays, new approaches to mitral valve surgery, in particular various catheter-based techniques, are being tested and offer an alternative to open heart surgery with the potential to make mitral valve intervention an option for older and sicker patients. These modalities include placing devices into the coronary sinus to support the mitral annulus and direct percutaneous leaflet repair. These approaches are already attractive for use in older patients and will hopefully make treatments available to many patients with no current options. Mitral valve replacement can also be performed through small incisions, sometimes with the help of a surgical robot and without stopping the heart. Sound clinical data on these novel technologies are still lacking [30].

Endocarditis in Elderly Patients

Remadi et al. [31] investigated the outcome of elderly patients treated medically or surgically for endocarditis and found it comparable with younger patients (in-hospital mortality rate 16% in elderly patients and 19% in younger patients). For patients older than 75 years, severe sepsis and neurological events were identified as 2 factors associated with higher in-hospital mortality. However, the long-term prognosis of elderly patients was worse (36-month survival rate $40.8 \pm 6.8\%$), mainly due to a higher comorbidity index. Surgery in elderly patients may be an option and should be considered in selected patients [31].

Redo Valvular Surgery in Elderly Patients

Maganti et al. [32] investigated the outcome of elderly patients undergoing redo valve surgery. The data of 112 patients aged 75 and above were retrospectively analyzed. All patients had had a previous surgical intervention on the valve of interest. There were 12 operative (10.7%) and 47 late deaths (42%). Cardiovascular events were the cause of death in 32 patients. Overall 5-year survival was $67 \pm 5\%$. The freedom from valve-related mortality and morbidity was $86 \pm 4\%$ at 5 years. This study shows that redo valve surgery can be performed in the elderly, with a slightly elevated but acceptable risk of mortality. Despite the fact that comparable younger patients have better survival rates, the 5-year survival of elderly patients undergoing redo valvular surgery is higher than the expected survival without surgery [32].

Anticoagulation or Antiplatelet Therapy of Bioprosthetic Heart Valve Recipients

Improvement in the performance and longevity of biological valve prostheses has increased their use in recent years [33]. Aortic bioprostheses are commonly used in elderly patients or when the risks of anticoagulation are high. Freedom from anticoagulation is the main advantage of bioprostheses in comparison to mechanical prostheses. There are no clear guidelines concerning the anticoagulation regime after biological AVR. For example, the 2006 guidelines of the American Heart Association and the American College of Cardiology recommend the use of acetylsalicylic acid in all recipients of bioprosthetic heart valves as well as consideration of the use of vitamin K antagonists for 3 months, with a target INR of 2.0–3.0 [34]. The European Society of Cardiology recommends the use of a vitamin K antagonist for 3 months after AVR [35]. The British Society of Haematology does not recommend the use of vitamin K antagonists for the first 3 months after AVR if patients are in sinus rhythm, although it does not contraindicate the prescription of vitamin K antagonists [36]. Colli et al. [37] investigated the outcome of different anticoagulation and/or antiplatelet therapies in bioprosthetic heart valve recipients. In summary, this review showed that in patients without thromboembolic risk factors, antiplatelet therapy as antithrombotic protection during the early postoperative period after AVR with a bioprosthesis is sufficient. Nevertheless, this conclusion is made on the basis of retrospective, small trials. From the data we analyzed for the current article, we can summarize that most elderly patients receive biological valve replacements and anticoagulation is to be used cautiously if at all.

Aortic Surgery

Traditionally, surgeries of the ascending aorta and the aortic arch for aortic aneurysms and aortic dissections were denied elderly patients. Deep hypothermia, circulatory arrest, long cardiopulmonary bypass time, brain perfusion and long aortic cross-clamping times are basic elements of several aortic surgeries. All these measures are associated with increased risk. However, recent data show that more and more elderly patients undergo cardiac surgery for diseases of the aorta [38]. Better outcome of cardiac operations in octogenarians due to medical progress has resulted in an increased

number of referrals of elderly patients for aortic surgery [39]. These measures make aortic surgery much safer. Therefore, it seems reasonable to offer aortic surgery also to elderly patients. Chen and Hsu [40] showed that aortic surgery requiring deep hypothermic circulatory arrest can be performed in elderly patients with acceptable results. Nevertheless, these surgeries are high-risk interventions. Meticulous patient selection, excellent brain perfusion, myocardial protection and a perfect surgical procedure are basic necessities for successful aortic surgery, especially for elderly patients. Recently, alternative surgical techniques, such as debranching of the aortic arch and subsequent stenting, have gained popularity and offer an option for older and sicker patients. Stenting of the aorta, which was introduced into clinical practice in the mid-1990s, made treatment of aortic diseases possible even in elderly patients with comorbidities [38].

The Main Complication of Cardiac Surgery in Elderly Patients: Stroke

The results of cardiac surgery in patients >80 years are comparable to those in patients aged 70–79 years, as discussed above, so that it is suitable to perform cardiac surgery in octogenarians if they are free from significant comorbidities. The main difference between octogenarians and younger patients with regard to the outcome after cardiac surgery is the incidence of cerebrovascular damage and strokes. Almassi et al. [41] investigated the determinants and outcome of stroke in cardiac surgical patients. Data of 4,941 patients undergoing cardiac surgery were analyzed. Among other stroke predictors, patient age correlated with a higher risk of stroke after cardiac surgery. Patients over 70 years had a probability of stroke of 5.25%; in contrast, 3.51% of patients between 60 and 69 years suffered from stroke. One explanation for this phenomenon might be increased atherosclerosis of the ascending aorta, which is associated with the age of the patient. Schachner et al. [42] showed that the maximum ascending aortic wall thickness correlates significantly with the age of the patient. Therefore, an epiaortic ultrasound scan before cannulation is strongly recommended, especially in elderly patients. However, excellent surgery, meticulous hemostasis, accurate organ perfusion and perfect myocardial protection are absolutely necessary for cardiac surgical success in elderly patients [2].

Quality of Life

Previous data show that elderly patients can undergo cardiac surgery with a slightly elevated but acceptable risk. However, is a cardiac intervention in elderly patients also beneficial for the quality of life of these patients? An average 80-year-old person in Germany has a life expectancy of 7.2 years [43]. Therefore, not only the perioperative survival but also freedom from symptoms must be considered in connection with cardiac surgery in the elderly patient. Heijmeriks et al. [44] investigated the quality of life after CABG and valve surgery in patients over 75 years old. Two and 6 months after cardiac surgery in all patients (elderly or not), the data showed a significant attenuation of their symptoms in comparison to the preoperative status. Moreover, 70% of the patients showed a significant improvement in their psychological status. The rates of depression and anxiety decreased. Using the New York Heart Association classification, after cardiac surgery, 76% of the depressive patients and 81% of the nondepressive patients were in a New York Heart Association class 1 or more levels below their preoperative class.

Discussion and Conclusion

The aging of society is inevitably leading to greater numbers of elderly patients undergoing cardiac surgery. Even though mortality and morbidity are increased in elderly patients, data from several studies indicate that elderly patients have a higher but acceptable risk when undergoing cardiac surgery [10, 22]. Nevertheless, the risk for these patients is only acceptable in the absence of comorbidities. In particular, renal dysfunction, cerebrovascular disease, valve surgery and a poor clinical state are associated with a worse outcome in elderly patients [21]. As the data from the Euro Heart Survey show, these comorbidities do not influence the decision to operate as strongly as they should [26]. In contrast, age and left ventricular dysfunction were the main criteria for denying elderly patients cardiac surgery [26]. The data presented in this review show that the importance of age and cardiac variables is overemphasized compared with that of comorbidities in deciding whether or not to operate. These findings underline the difficulties of decision making with regard to surgery in the elderly, for whom current guidelines provide only limited recommendations.

Another important issue is the type of cardiac surgery that is employed; CABG only, AVR only or both in com-

bination all have a quite satisfactory outcome. In contrast, mitral valve surgery and combined valve surgeries have a worse outcome in elderly patients. These findings suggest that one can be more liberal with the decision to operate in elderly patients with coronary artery disease and/or AS, while it is necessary to be more conservative with regard to patients who have to undergo mitral valve surgery [19].

In the future, the number of elderly patients undergoing cardiac surgery will increase. At the moment, many surgeons place their hopes in 'off-pump' techniques to avoid the use of cardiopulmonary bypass and to reduce the risk of a stroke. Nevertheless, these techniques also have disadvantages, such as intraoperative arrhythmias. Moreover, 'off-pump' coronary surgery is technically challenging and not achievable in every case, and clear evidence of advantages with this procedure in elderly patients is lacking [45].

Another possible strategy is the use of minimally invasive or totally endoscopic procedures [46, 47]. These procedures are associated with a number of advantages, e.g. better cosmetic results, smaller incisions, which are associated with lower rates of deep and superficial wound healing problems, and no sternal dehiscence. In addition, with these procedures, patient mobilization is quicker, which is especially important for elderly patients. However, minimally invasive and totally endoscopic procedures are limited to special experienced centers at the moment, and there are no clear data showing the influence of such techniques on the outcome in elderly patients.

In summary, we can conclude that due to technical and medical improvements, cardiac surgery is feasible in elderly patients with acceptable risk in terms of mortality and morbidity. Decision making is rather difficult in elderly patients. For cardiac surgery in elderly patients to be successful, a broad risk assessment and careful patient selection are indispensable. Flawless surgery, meticulous hemostasis, excellent myocardial protection and perfect anesthesiological management are basic requirements for cardiac surgery in elderly patients.

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