Review Article

Cardiovascular surgery in the elderly: an update

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Abstract The aging of the population and improvements in outcomes after cardiovascular surgery have resulted in a worldwide growing demand of complex surgical intervention for elderly patients. We briefly review the up-to-date English-language literature with particular focus on cardiovascular surgery in elderly patients. With earlier referral, careful preoperative evaluation, strategic planning, and the continuing efforts in optimizing surgical techniques, operative mortality and morbidity following primary or reoperative coronary artery bypass grafting and valvular interventions are expected to fall in this high-risk patient subset. Importantly, accumulating evidence indicates that elderly patients may benefit from improved functional status and quality of life after cardiovascular surgical therapy (Geriatr Cardiol 2005;2(2):123-128).

Key Words cardiovascular surgery; coronary artery bypass grafting; elderly; reoperation; risk factor; valve replacement

Introduction

Health care for an aging population has progressively become a vital challenge not only in industrialized societies but also in many developing countries including China. For instance, the number of Chinese people aged 65 or older is anticipated to increase from the current of around 100 millions to more than 200 millions in 2008 (14% of the total population of China). By the year 2036, the same group may surge to over 300 millions and represent up to 20 % of the total population. In the US, although the demographic profile appears much smaller, an almost identical aging trend is also expected, as one in 12 Americans will be older than 80 years by the year 2050.

For elderly people, cardiovascular disease has been consistently ranked to be at the top of the killer list. Such a fact is clearly reflected by the worldwide annual increase in cases undergoing either percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). As far as long-term outcome is concerned, surgery may still offer the best chance to these patients. Such an important conclusion has been repeatedly confirmed, interestingly, first and foremost by cardiologists rather than by cardiac surgeons. Evidence from a randomized bypass versus angioplasty revascularization investigation (BARI) trial clearly showed the survival benefit of CABG over PCI in diabetic patients during a 7-year follow-up period. In particular, CABG should be the preferred strategy for revascularization in the elderly diabetic patients aged 65 years and over. More recently, the Cleveland Clinic investigators also demonstrated that in 6,033 consecutive patients with multivessel coronary artery disease and many high-risk characteristics, CABG was associated with better survival than PCI after adjustment for risk profile. Although prospective research in the elderly population undergoing cardiac operations is less well documented, numerous lessons have been learned over the past decade. Now we briefly review the up-to-date English-language literature with particular emphasis on cardiovascular surgery in hexagonarians (aged 60 to 69 years), septuagenarians (aged 70 to 79 years), and octogenarians (aged 80 years or older).

Perioperative care: risk factors and complications

It has long been identified that age itself is a crucial risk factor for patients undergoing cardiac operations, which is obviously related to the physiological process of aging with a natural decline in the functional reserve of the organs. Advanced age is often associated with other risk factors or extracardiac comorbidities such as diabetes, hypertension, renal impairment, history of stroke, and even previous cardiac interventions. Hence, it is explicable that surgical mortality as well as postoperative complications were significantly greater in octogenarians than in their younger counterparts. In the largest series to date of octogenarians (n=601) undergoing cardiac operations, Emory University group reported an overall operative mortality rate of 9.1% compared with 6.7% in septuagenarians (n=5,698). Barnett and colleagues also observed that octogenarians (n=444) had a nearly double mortality rate compared with younger patients (n=7,917). Moreover, the incidence of nonfatal postoperative complications was significantly higher among octogenarians than non-octogenarians. In fact, the single best univariate predictor of at least one complication after surgery was age greater than 80 years. Despite recent improvements in “fast-track” management, advanced age remains an independent predictor of delayed extubation and prolonged stay in an intensive care unit (ICU) or in a hospital. Therefore, patient
selection for surgery in octogenarians is not always straightforward, with the majority of these patients operated upon for symptoms rather than for prognosis. In a small series from Italy, Gatti and associates found that the major predictors for postoperative complications in high-risk octogenarians were heart failure status (NYHA class IV), severe angina (CCS class 4), and prolonged aortic cross-clamping time. These authors suggested that earlier surgical therapy may be preferable in this particular group of patients. It was also reported that preoperative renal failure and urgent or emergent operation significantly increased the risk of early death, while cerebral vascular disease and prolonged postoperative ventilation were the additional risk factors for late death. Owing to the significantly increased length of stays in ICU and in hospital for octogenarians than for the younger patient subgroups, total direct costs were 26.8% higher in octogenarians (about additional US$ 4,818 per patient).

**Outcome: long-term survival and quality of life**

As suggested by the Emory University group, although there was a more rapid survival decline beyond 5 years in octogenarians, the median postoperative 5-year survival in this group of patients was 55%, compared to 69% in septuagenarians and 81% in hexagenarians. At the age of 80, for instance, the remaining life expectancy in Sweden is 8.8 years for females and 6.9 years for males. Collins and colleagues observed that the 36-month survival rate after open-heart surgery in 183 Swedish patients aged between 80 and 84 years was 85.6%, which did not differ from the normal population matched for age and gender. More importantly, postoperative quality of life among these patients was comparable or even better than in the general population. Similar findings were reported in an earlier Canadian study involving 127 patients older than 80 years at the time of their cardiac operation, and 80% of them had an actual 2-year survival. Because the elderly patients benefited from improved functional status and quality of life, 3/4 of these survivors rated their health as good or excellent and the majority (82.5%) of them would undergo a cardiac operation again in retrospect.

**CABG: state-of-the-art**

The principles and techniques of choice for surgical myocardial revascularization in elderly patients remain less absolute or even controversial, when compared with the young. Nevertheless, a growing body of recent evidence has impacted significantly on our decision-making process and daily practice. For example, strategies such as aggressive or more liberal preoperative use of intraaortic balloon pumping have been shown to be beneficial in patients aged 70 years or older. Arterial grafting, using internal mammary artery or even radial artery, has also been suggested to reduce operative mortality and improve survival as well as long-term quality of life in septuagenarians and octogenarians. A retrospective multivariate analysis in 987 octogenarians identified that the exclusive use of saphenous vein graft to be an independent predictor of operative mortality and late death. Interestingly, the completeness of revascularization had no positive influence on postoperative survival, recurrent angina, and functional status among 358 octogenarians. In another study, however, incomplete revascularization was identified by logistic multivariable regression as an independent risk factor for early death (within 180 days) in 859 patients aged 75 or older.

Over the past decade, off-pump CABG has gained enormous popularity worldwide. Numerous clinical series have indicated that the avoidance of cardiopulmonary bypass (CPB) could result in lesser degree of inflammatory injury and, in turn, minimize the incidence of postoperative myocardial, renal, or neurological injuries. It is believed that the off-pump approach may be particularly beneficial in high-risk patients with multiple co-morbidities, especially in the elderly. Off-pump CABG was shown to reduce postoperative ICU stay, morbidity and mortality in patients aged 75 years or older. A recent meta-analysis of 8 observational studies between 1999 and 2003 in patients aged 70 years or older undergoing off-pump (n=764) or on-pump CABG (n=2253) showed that the former approach was associated with a much lower incidence of postoperative atrial fibrillation. In patients undergoing off-pump CABG, however, the incidence of atrial fibrillation appeared to be greater in octogenarians than in the younger age groups.

Among many unanswered questions is whether off-pump technique could significantly reduce postoperative brain injury. Neurological deterioration following CABG could manifest from a serious stroke to subtle cognitive impairment. Their underlying etiology is obviously multifactorial, while embolization and perioperative cerebral hypoperfusion are known to be the commonest causes. It is evident that the incidence of aortic atheroma increased with age. Goto and co-workers noted that multiple small brain infarctions could be detected before CABG in 83 out of 421 patients aged 60 years or older by magnetic resonance imaging (although 59% of them were asymptomatic), which might predispose postoperative neurological dysfunction. Hence, off-pump CABG using no-touch technique and total arterial grafting could theoretically be advantageous in elderly patients, particularly those with severe atherosclerosis. Indeed, Ricci and colleagues showed that octogenarians undergoing off-pump CABG (n=97) experienced remarkably less perioperative strokes than those receiving conventional CABG (n=172). The Montreal Heart Institute investigators also demonstrated that among 125 octogenarians undergoing CABG the type of surgery (on- or off-pump) was an independent predictor of operative mortality and strokes, which occurred 4 times more often in the CPB group. In another recent meta-analysis including 9 observational studies between 1999 and 2002 in patients aged 70 years and older underwent CABG with (n=3,222) or without (n=1,253) CPB, the incidence of strokes appeared significantly lower in the off-pump group. Nonetheless, this important observation is certainly to be validated in future prospective, randomized trial involving a much larger patient population.

Taken together, there is both bad and good news. On the one hand, the patients now referred for CABG are generally...
"older and sicker" than the same group a decade ago, as shown by the Society of Thoracic Surgeons (STS) Database – the largest voluntary database in medicine to date – which recorded 1,154,486 patients underwent CABG between 1990 and 1999 at 522 North American centers. The mean age of these patients increased from 63.7 in 1990 to 65.1 in 1999, corresponding to the predicted operative risk (2.6% in 1990 and 3.4% in 1999) and the ratio of female gender (25.7% in 1990 and 28.7% in 1999). According to the STS database, surgical mortality was even higher among elderly women than men. On the other hand, the observed operative mortality decreased from 3.9% in 1990 to 3.0% in 1999 and this trend was also true in patients 65 years and older (5.4% in 1990 to 4.1% in 1999). It is believed that significant technical advantages in surgery, cardiology, perioperative care, and better quality measures in a more dedicated and specialized team, have all contributed to the improvement in the outcome over the past decade. In particular, evidence in favor of off-pump CABG as the approach of choice for elderly patients has been widely available.

Valvular surgery: type and prosthesis of choice

Valve replacement operations can be performed in the elderly with acceptable mortality and morbidity, although combined (often with CABG) or urgent/emergent procedures and preoperative heart failure may significantly increase surgical mortality from 8.9% to 15.34% in this patient population. In general, the hospital mortality rate was also higher in women than in men. There is a wealth of knowledge and long-term follow-up data supporting the use of the bioprosthesis as the valve of choice for the elderly. In 2,075 patients aged 65 and older who underwent valve replacement using a porcine bioprosthesis, actuarial freedom from valve failure at 9 years was 94.4% and at 18 years was 83.7% (in total 74 valves failed from all causes). Chiappini and associates noticed that the type of prosthesis was in fact a significant predictor of late mortality in 115 octogenarians undergoing aortic valve replacement. Mechanical prostheses were commonly chosen in their study due to a narrowed aortic annulus or a concomitant atrial fibrillation, which led to an actuarial 5-year survival rate of 56.7% compared to 81.7% in the bioprosthesis group. The authors suggested that thromboembolic or hemorrhagic events related to the anticoagulant therapy increased the risk of late death in octogenarians after receiving mechanical prosthesis. On the contrary, elderly patients had a more favorable quality of life following bioprosthesis replacement operations compared with normal subjects matched for age and sex. A significantly improved survival following stentless rather than stented bioprosthesis replacement has also been proposed in elderly patients with aortic stenosis, especially in those with a small aortic root. Interestingly, recent evidence indicated that the use of smaller aortic valve prostheses in the elderly patients may not adversely affect the incidence of early or late mortality, which is somewhat against the conventional thinking. By combining a pool of 9 multi-institutional databases involving 13,258 aortic valve replacements, Blackstone and colleagues concluded that using durable nonthrombogenic prosthesis is more important than concentrating on better hemodynamic performance in order to improve long-term survival. After aortic valve replacement with a bioprosthesis, however, anticoagulation may still be indicated in elderly patients with larger valve size (≥27 mm) or preoperative endocarditis.

Meanwhile, the ideal treatment for isolated nonrheumatic, nonischemic mitral regurgitation in the elderly remains largely unclear. Increased tissue fragility may make mitral repair less predictable and more complex in older patients, particularly when calcification is present. Recently published 10-year experience at the Mayo Clinic highlighted their surgical outcome in octogenarians of mitral repair or replacement of predominantly degenerative mitral regurgitation. In this study: (1) the overall 5-year survival was 61% which was comparable with that in the general population matched for age and gender; (2) mitral repair was proven to be a reliable approach as none of the patients needed reoperation. Similar to other series, preoperative left ventricular functional status had significant impact on late cardiac complications, suggesting early surgery is preferable in octogenarians. Retrospective review of STS database, involving 31,688 patients who underwent mitral valve replacement from 1997 to 2000, revealed that surgical mortality increased from 4.1% in patients aged <50 years up to 17.0% in those aged 80 years or more. Four important risk factors, including hemodynamic instability, NYHA class IV, renal failure, and concomitant CABG were identified to raise operative mortality significantly, exceeding 4-fold among the elderly patients. Another smaller series also suggested that chronic obstructive lung disease, preoperative use of intraaortic balloon, and postoperative stroke may be additional predictors of hospital death in octogenarians. It is noteworthy that in patients with cardiomyopathy and severe mitral regurgitation, mitral repair utilizing an undersizing overcorrecting annuloplasty ring has been advocated recently by Bolling and associates.

Reoperations: an unavoidable, expanding pool

As life expectancy continues to grow, so too will the proportion of elderly patients presented for cardiovascular reoperations, which naturally, represents a serious challenge to cardiac surgeons. Although the safety and efficacy of first-time open-heart surgical interventions in elderly patients have been well established, little is known for reoperations in this cohort. In general, the 30-day mortality was considerably higher for reoperations in the elderly, particularly in those undergoing combined CABG and valve procedures. One of the largest series to date, involving 739 patients aged 70 years or older who underwent redo-CABG between 1983 and 1993 at the Cleveland Clinic, revealed that preoperative renal impairment, female gender, emergency nature, poor left ventricular function, and left main coronary disease to be the major risk factors associated with increased in-hospital mortality. It is believed that myocardial protection with the combination of antegrade and retrograde cardioplegia is of
utmost importance in reoperative CABG, mainly because myocardial distribution of antegrade cardioplegia could be unpredictable during this particular setting and diseased but patent vein grafts may predispose intraoperative coronary atheroembolization.51 Recently, off-pump CABG was suggested to be a safe and potentially better approach for reoperative revascularization.52 However, off-pump CABG may be associated with a higher incidence of incomplete revascularization even in experienced hands.50 In fact, the 5-year clinical outcome was found to be significantly worse in the redo-CABG group than in the matched first-time CABG group, likely related to the higher incidence of incomplete revascularization and greater perioperative myocardial injury in the former group.53

In 400 patients who underwent reoperative valve replacement at Massachusetts General Hospital for failed bioprostheses, Akins and associates demonstrated that age greater than 65 years, male gender, renal insufficiency, and non-elective operation were predictors of in-hospital death. Recently, the same group of surgeons also summarized their experience of first-time aortic valve replacement in 132 patients who had previous cardiac operations on CPB.55 With an overall mortality rate of 6.7%, they suggested that routine replacement of a minimally diseased aortic valve during CABG is not necessary.56 Excellent early results for repeat aortic or mitral valve replacement have also been reported by the Mayo Clinic group, supporting the selection of bioprostheses over mechanical prostheses. Similarly, in view of acceptable mortality and morbidity associated with redo mitral valve surgery, primary mitral commissurotomy or repair should be recommended even in the developing countries.58

Surgery of thoracic aorta: evidence and ethics

By summarizing data from 18 large referral centers in 6 countries since 1996, reports from the International Registry of Acute Aortic Dissection have provided some new insights into this old disease.60,61 Acute type A aortic dissection is one of the most serious medical emergencies that carry significant mortality in absence of surgical intervention. Despite improved surgical techniques and perioperative management, operative mortality remains high in recent decades, particularly for the elderly patients.59 In fact, age ≥70 years has been identified to be an independent predictor of death for acute type A aortic dissection.60 In patients aged 70 or older (32% of the total patients enrolled), although surgical mortality (37.5%) was better than the one with medical therapy alone (52.5%), it was significantly higher than that in the younger group (23.0%).59 In patients aged 80 to 84 years, however, surgical intervention carries no advantage over medical therapy for type A aortic dissection (both mortality rate was 45.5%).59 On the other hand, for acute type B aortic dissection, elderly patients (age ≥70 years) with hypotension/shock had the highest risk of death (56%), followed by any branch vessel involvement (28.6%) or presence of periaortic hematoma (10.5%).61 Nevertheless, without any of these 3 risk factors, the mortality rate among elderly patients with acute type B aortic dissection was extremely low (1.3%).62 Recent review of the world literature indicated that medical treatment is even favorable in octogenarians with intramural hematoma of the thoracic aorta.63

In short, it has been clearly evident that patient selection plays a crucial role in determining surgical outcome for patients with acute aortic dissection.60,62 A recent report from an Italian group suggested that surgical intervention for type A acute aortic dissection in octogenarians is unlikely to reverse a fatal outcome,64 which indeed raised some important moral, ethical, and practical concerns.65 Although acceptable surgical results could be achieved in some selected octogenarians following hypothermic circulatory arrest for repairing thoracic aorta,65-68 increased incidence of perioperative stroke has also been recognized in this particular patient population.66-68 There is a general consensus now that compared to younger patients with acute aortic dissection or thoracic aortic aneurysm, the clinical characteristics, management, and outcome are significantly different in the elderly.69-71 Emergency operations, especially in those elderly patients with preoperative disorder of the vital organ systems, may increase the possibility of adverse outcome dramatically.66,69,71

Summary

The aging of the population and improvements in outcomes after cardiovascular procedures have resulted in a growing demand of complex surgical intervention for the elderly patients. Such an inevitable challenge is present not only in the industrialized societies but also in many developing countries. With earlier referral, careful preoperative evaluation, strategic planning, and the continuing efforts in optimizing surgical techniques as well as CPB management operative mortality and morbidity following primary or reoperative cardiovascular interventions are expected to fall even in this high-risk patient subset. Although ethical issues are important to consider in the elderly cohort with increased surgical risk, the surgeons' decision should be based on available evidence and be justified in the best interest of the individual patient.

References


