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ORIGINAL ARTICLE

Early Outcomes After Mitral Valve Repair versus Replacement in the Elderly: A Propensity Matched Analysis

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Background To compare early outcomes of mitral valve repair versus replacement in elderly patients with degenerative mitral valve disease.

Methods A retrospective review of prospectively collected clinical data of patients over 75 years of age, who underwent mitral valve surgery for degenerative disease, between 2010 and 2013, was carried out. Those undergoing mitral valve repair and replacement were propensity matched to adjust for baseline clinical differences.

Results A total 260 patients were identified: mitral valve repair was undertaken in 145 and replacement in 115 patients. After propensity matching, 78 patients were included in each group. In the entire, unmatched population, in-hospital mortality was significantly higher in those undergoing replacement compared with those undergoing repair (9.6% vs 1.4%, $p = 0.003$). In-hospital death occurred in six (7.7%) of the propensity matched replacement group and none in the repair group ($p = 0.012$). Amongst the propensity matched groups, probability of survival at 1, 2 and 3 years were 0.94, 0.90 and 0.86 respectively for the repair group and 0.85, 0.77 and 0.69 for the replacement group: the HR for death between replacement and repair is 2.5 (1.2-5.4), $p = 0.012$.

Conclusions Within the limitations imposed by retrospective analyses, our study demonstrates that, in elderly patients with degenerative disease of the mitral valve, repair is associated with improved short-term and mid-term outcomes compared with mitral valve replacement.

Keywords Mitral valve surgery • Elderly • Repairs versus replacement • Degenerative mitral valvular disease

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Introduction

Currently, mitral valve repair (MVr) is preferred to mitral valve replacement (MVR) for degenerative mitral valvular diseases [1]. Previous studies have shown that mitral valve repair for degenerative mitral valve disease is associated with better short- and long-term outcomes, comparable durability and less incidence of thromboembolism when compared to MVR [2–5]. However, there is evidence suggesting that long-term survival following MVR is equivalent to MVr [6]. As we are increasingly faced with older patients with more complex diseases, controversy remains regarding the optimal management of elderly patients with degenerative mitral valve disease. Some advocate performing MVR rather than MVr in these patients because of concerns about frailty, poor quality of tissues, calcified annuli and prolonged ischaemic and bypass times when difficult repairs are attempted [6,7].

The aim of this study is to compare the clinical outcomes in a consecutive cohort of patients undergoing surgery in the form of repair or replacement for degenerative mitral valve disease.

Materials and Methods

Study Population

All patients ≥75 years of age undergoing mitral valve surgery (with or without an additional procedure) for degenerative mitral valve regurgitation in a single tertiary centre between 1 June 2010 and 30 June 2013 were identified from a prospectively entered database. This included demographic and procedural details and a clinical audit officer validated each patient record. Patients with active neoplastic disease and history of previous mitral surgery were excluded. In addition, patients with ischaemic and rheumatic mitral valvular disease were excluded. A total of 260 patients were identified over the study period. The medical records were reviewed retrospectively to provide additional procedural and clinical details not routinely recorded in the database.

Outcome Measures

The primary outcomes of the study are late mortality (time to all-cause mortality from intervention to end of data collection) and in-hospital operative mortality. Data on patient mortality was obtained from the Office for National Statistics death certification records linked to the National Adult Cardiac Surgery Audit database in January 2015 [8].

Secondary outcomes included postoperative outcomes such as cross-clamp and cardiopulmonary bypass times, perioperative blood loss and ventilation time.

Statistical Analysis

Reporting mortality and morbidity after valve operation is followed according to the guidelines by Edmunds et al. [9,10]. Data is presented as percentages and mean ±SD for normally distributed continuous variables or median (interquartile range) for asymmetrically distributed continuous variables. To compare patient and operative data between MVR and MVr groups, differences in proportions are tested with a chi-squared test if all expected counts were greater than five or Fisher's exact test otherwise. Differences in continuous variables were tested with an unpaired Student t-test for normally distributed variables or Mann-Whitney U-test otherwise.

Propensity matching was carried out to minimise any selection bias due to the differences in clinical characteristics between mitral valve repair and replacement treatment groups. For each patient in the cohort a propensity score indicating the likelihood of MV replacement rather than repair was calculated by the use of a non-parsimonious multivariable logistic regression model using STATA version 12 and the pscore add on file [11]. Covariates included in the logistic regression model to calculate the propensity score were: age, gender, additional procedure (other than isolated mitral valve surgery), logistic EuroSCORE, left ventricular ejection fraction, urgent priority, redo cardiac surgery, estimated glomerular filtration rate (calculated by Cockcroft-Gault formula [12]), history of cerebrovascular disease and diabetes status. The C-statistic for the propensity score model was 0.726 and the Hosmer-Lemeshow test for goodness of fit was 0.380. To identify matched pairs of patients undergoing mitral valve replacement and repair, we used the following algorithm: 1:1 optimal match with a ±0.03 caliper and no replacement. Clinical outcomes in the matched population were analysed with Cox proportional hazards regression stratified by matched-pair.

Stata v.12 (StataCorp, College Station, Texas) was used for statistical analysis [9]. All tests were two-sided and statistical significance declared when p-values ≤0.05.

Ethics

The study complies with the Declaration of Helsinki and was approved by the institutional review committee.

Results

Of the 260 patients identified in the cohort, 145 (55.8%) underwent mitral valve repair and 115 underwent mitral valve replacement (44.2%). Propensity score matching identified 78 pairs of patients. Table 1 lists the demographic, clinical and procedural characteristics by treatment group for the unmatched population and for the propensity matched groups. After propensity matching, no significant imbalance was identified in covariates between the groups.

Procedural Details

Amongst the propensity matched group who underwent mitral valve replacement, five (6.4%) underwent an initial attempt at repair.

Cross-clamp and cardiopulmonary bypass times were significantly longer in the replacement group.

The majority of the patients in the MVR group had preservation of the sub-valvular apparatus (n = 76, 97.5%).

Table 1 Baseline characteristics in unmatched population and propensity matched groups.

	Unmatched population (n = 260)				Propensity matched pairs (n = 156)			
	Replace (n = 115)	Repair (n = 145)	p-value	Std diff (%)	Replace (n = 78)	Repair (n = 78)	p-value	Std diff (%)
Age (years)	80.4 ± 4.0	79.0 ± 3.4	0.003	36*	79.8 ± 3.7	79.8 ± 3.7	0.949	−1.0
Male	65(56.5)	91(62.8)	0.308	−12	47(60.3)	45(57.7)	0.745	−5.2
Additional procedure	87(75.7)	93(64.1)	0.046	25.2*	58(74.4)	59(75.6)	0.853	−2.9
LV function								
Good	67(58.3)	88(60.7)	0.460	−4.9	51(65.4)	51(65.4)	0.955	0.0
Moderate	35(30.4)	47(32.4)		−4.2	20(25.6)	19(24.4)		2.9
Poor	13(11.3)	10(6.9)		15.3	7(9.0)	8(10.3)		−4.3
Redo surgery	13(11.3)	2(1.4)	0.001	41.4*	4(5.1)	2(2.6)	0.681	13.3
CCS class								
No angina	73(63.5)	99(68.3)	0.460	−10.1	51(65.4)	54(69.2)	0.931	−8.2
1	22(19.1)	23(15.9)		8.6	15(19.2)	14(18.0)		3.3
2	15(13.0)	21(14.5)		−4.2	10(12.8)	9(11.5)		3.9
3	5(4.4)	2(1.4)		17.8	2(2.6)	1(1.3)		9.3
4	0(0)	0(0)		0	0(0)	0(0)		0.0
NYHA class								
I	5(4.4)	14(9.7)	0.098	−20.8	2(2.6)	7(9.0)	0.108	−27.6
II	34(29.6)	53(36.6)		−14.8	28(35.9)	29(37.2)		−2.6
III	59(51.3)	66(45.5)		11.6	37(47.4)	38(48.7)		−2.5
IV	17(14.8)	12(8.3)		20.4	11(14.1)	4(5.1)		30.6
Previous MI	21(18.3)	18(12.4)	0.190	16.2	10(12.8)	8(10.3)	0.616	8.0
Hypertension	80(69.6)	100(69.0)	0.917	1.3	53(68.0)	51(65.4)	0.734	5.4
Diabetes	11(9.6)	11(7.6)	0.569	7.0	7(9.0)	7(9.0)	1.00	0.0
Smoker								
Never	52(45.2)	67(46.2)	0.805	−2.0	37(47.4)	36(46.2)	0.873	2.6
Previous	61(53.0)	77(53.1)		−0.1	40(51.3)	42(53.9)		−5.1
Current	2(1.7)	1(0.7)		9.6	1(1.3)	0(0)		16.0
Cerbrovascular disease	15(13.0)	7(4.8)	0.018	29.0*	4(5.1)	5(6.4)	0.731	−5.5
eGFR (ml•min^{-1})	46.6 ± 16.3	51.7 ± 17.0	0.014	−30.8	47.9 ± 17.5	48.8 ± 16.1	0.759	−4.9
Airways disease	20(17.4)	21(14.5)	0.523	7.9	12(15.4)	14(18.0)	0.667	−6.8
Logistic EuroSCORE (%)	13(7.9–22.9)	9.1(6.2–15.5)	<0.001	49.1*	9.9(7.5–15.6)	10.7(6.6–18.5)	0.958	−10.4
Priority								
Elective	95(82.6)	128(88.3)	0.148	−16.1	67(85.9)	67(85.9)	1.00	0.0
Urgent	18(15.7)	17(11.7)		11.4	11(14.1)	11(14.1)		0.0
Emergent	2(1.7)	0(0)		18.7	0(0)	0(0)		0.0

Abbreviations: LV: left ventricle; CCS class: Canadian Cardiac Society angina status; NYHA: New York Heart Association breathlessness status; MI: myocardial infarction; eGFR: estimated glomerular filtration rate; Std diff: standardised difference.
*eGFR (ml/min).

Except for one (mechanical prosthesis) all the patients had bioprostheses.

About one-fifth of the patients in each group underwent isolated mitral valve surgery—the remainder undergoing combined procedures (Table 2).

In the propensity matched mitral valve repair group, Gortex neo-chords were used in 33 (42.3%); quadrangular or triangular resection in 15 (19.2%) patients; the remainders had either edge-to-edge repair, closure of cleft or plication procedure. Most of the patients had an annuloplasty ring as part of the repair. Annular decalcification was performed in two (2.6%) patients in the MVr group.

Postoperative Outcome

Table 3 lists the postoperative outcomes for propensity matched mitral valve repair and replacement groups; in addition, perioperative blood loss was significantly greater and ventilation time significantly longer in the latter. Five

Table 2 Procedures of the propensity matched patients.

Surgical procedures	Mitral valve replacement	Mitral valve repair
Isolated MVS n (%)	20(25.6)	18(23)
MVS+ CABG	12(15.4)	16(20.5)
MVS + AVR	20(25.6)	9(11.5)
MVS + TVS± AF ABLATION	10(12.8)	11(14.1)
MVS + AVR + CABG	7(8.9)	3(3.8)
MVS + AVR + TVS	3(3.9)	6(7.7)
MVS + AVR + TVS + CABG	3(3.9)	1(1.3)
Other Procedures	3(3.9)	14(17.9)

Abbreviations: MVS: Mitral valve surgery; CABG: Coronary artery bypass grafting; AVR: Aortic valve replacement; TVR: Tricuspid valve surgery; AF: atrial fibrillation.

patients underwent an initial attempted repair then subsequent replacement. Secondary analysis with these patients excluded had no impact on the results.

Survival Outcomes

Amongst the propensity matched groups, median follow-up was 26.4 months. At which point mortality was 7/51(13.7%) and 9/39 (23.1%) in the repair and replacement groups respectively: HR for death with MVR 2.61 (1.22–5.58), p = 0.013 (Figure 1). When stratified by matched pair the HR for death with MVR was 5.0 (1.71–14.63), p = 0.003. A number of variables in the propensity matched groups had standardised differences >10%, which is the value by convention where they are considered to be imbalanced. The only imbalanced variable which was a multivariate predictor of death was EuroSCORE, the HR for death with MVR remained significant in the propensity matched groups if adjusted for EuroSCORE: HR 3.89 (1.74–8.73, p = 0.001). The HR for death with MVR remained highly statistically significant if any of the other variables with a standardised difference >10% after propensity matching were included in the model.

We performed a subgroup analysis in order to investigate the incidence of in-hospital/30 day mortality in the two groups after excluding the patients who had concomitant aortic valve replacement. There were 46 patients in the MVR group and 57 patients in the MVr group. The in-hospital/30 day mortality was significantly higher in the replacement group (8.7%, n = 4) when compared to the repair group (0%) (p = 0.036).

Table 3 Peri and postoperative characteristics and outcomes for propensity matched MV repair and replacement groups.

	Mitral valve replacement	Mitral valve repair	p-value
Post-op blood loss (ml)	550(300–900)	325(250–750)	0.047
Ventilation time (hours)	11.8(6.4–17.9)	8(5.2–12.7)	0.017
IABP post-op	6(7.7%)	3(3.9%)	0.495
Inotropic support post-op	21(26.9%)	25(32.0%)	0.482
Noradrenaline post-op	10(12.8%)	8(10.3%)	0.616
Tamponade requiring return to theatre	10(12.8%)	8(10.3%)	0.616
Respiratory failure requiring re-intubation	12(15.4%)	6(7.7%)	0.133
NIV post-op	8(10.3%)	7(9.0%)	0.786
Post-op tracheostomy	2(2.6%)	2(2.6%)	1.0
AKI requiring CVVHF post-op	7(9.0%)	2(2.6%)	0.167
Stoke/intra-cranial bleed post-op	1(1.3%)	1(1.3%)	1.0
Cardiac arrest with ROSC post-op	1(1.3%)	1(1.3%)	1.0
Atrial flutter post-op	14(18.0%)	15(19.2%)	0.837
In-hospital death	6(7.7%)	0(0%)	0.012

Abbreviations: CPB: cardio-pulmonary bypass; IABP: intra-aortic balloon pump; NIV: non-invasive ventilation; AKI: acute kidney injury; CVVHF: continuous veno-venous haemofiltration; ROSC: return of spontaneous circulation.

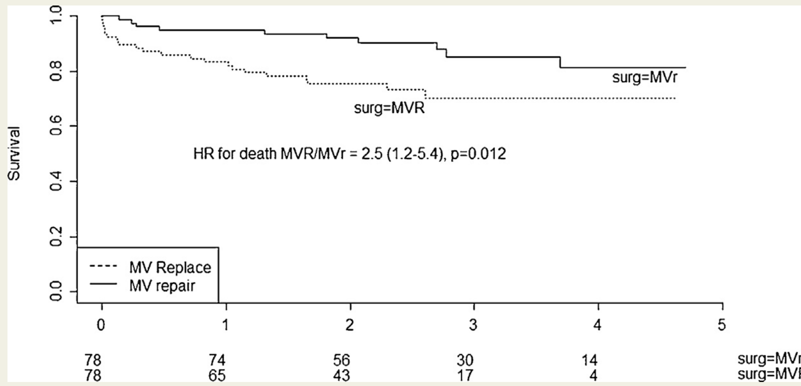

Figure 1 Kaplan-Meier curves showing survival rates for propensity matched patients with mitral valve repair or replacement.

More patients in the MVr group were discharged home directly from the cardiothoracic surgical centre when compared to the MVR group (78% vs 62%).

Discussion

This study shows that mitral valve repair in the elderly is associated with good outcomes overall and specifically improved short-term and mid-term survival as well as decreased perioperative blood loss and ventilation time compared with mitral valve replacement.

In England and Wales life expectancy at birth in 2012 was 79.5 years for men and 83.3 years (83.3–83.4) for women [13]. It is expected to reach 85.7 years in men and 87.6 years in women in England and Wales by 2030 [13]. Accordingly, the average age of patients referred for cardiac surgery has increased in addition to having significantly higher risk profiles and comorbidities. Degenerative multivalvular disease is more common amongst this elderly population, and a significant proportion of those need additional cardiac procedures. It is imperative that these patients are offered the procedure with the best clinical outcome when feasible.

Previous studies have shown mitral valve repair for degenerative mitral valvular disease to be associated with better short- and long-term outcomes, comparable durability and reduced incidence of thromboembolism when compared to MVR [2–5,14]. Despite the superior short- and long-term outcomes of MVr in younger patients, MVR is increasing performed in the elderly, as it is perceived to be equivalent. Several studies reported MVr to be associated with better outcomes in elderly patients undergoing mitral valve surgery for mixed aetiology ([15–18]. Our study is unique in that it has specifically investigated the outcome of elderly patients undergoing mitral valve surgery for degenerative mitral valvular disease.

Proponents of MVR in the elderly claim that, since MVR with preservation of subvalvular apparatus doesn't adversely affect left ventricular function [19] and MVr is often associated with longer bypass and ischaemic times [6,7], it is probably better to perform a relatively simple replacement procedure in these elderly patients with complex disease. Failed repair in these elderly patients may result in higher mortality and poor outcome. However, in our study, the patients who underwent MVr had shorter ischaemic and bypass times. Even the patients in our series who had failed attempt at repair did not appear to have suffered adverse clinical outcomes.

Our study demonstrated that more patients in the MVr group were discharged home directly from the cardiothoracic surgical centre when compared to the MVR group (78% vs 62%). The remainder of the patients who survived following the operation were transferred to a secondary care facility for extended rehabilitation. Henry et al. investigated the effect of patient disposition on long-term survival following mitral valve surgery in octogenarians [20] concluding that those who are discharged home directly from the surgical centre had better long-term survival. We might therefore expect that the improved short-term survival and direct discharge rates in the MVr group compared with the MVR group may contribute to better medium- and long-term outcomes.

Only a fifth of the patients in our series underwent isolated mitral valve surgery. Concomitant procedures included multiple valve surgery. Our study reaffirms the findings of a previous study that demonstrated the superiority of MVr with aortic valve replacement when compared to double valve replacement [21].

It is known that hospitals performing greater volumes of mitral valve procedures achieve far greater success rate at valve repair along with decreased mortality [22]. In our institution, over 2000 adult cardiac cases are performed per year with a large number of elderly patients undergoing mitral valve repair with excellent outcome. Surgeons who perform high volume mitral valve surgery perform the majority of mitral valve repairs.

It is increasingly recognised that early surgical intervention on patients with mitral regurgitation results in improved outcomes [22,23]. However, in our series, 48% of patients in the MVR group and 42% in the MVr group had NYHA III/IV symptoms. It may have been that earlier detection and referral would have resulted in even better clinical outcomes in these patients.

Preservation of the subvalvular apparatus during MVR maintains left ventricular function with good long-term outcomes [19]. In our series the vast majority of the patients had subvalvular preservation during MVR. Despite that, the outcome in the repair group was significantly superior.

Limitations

This is an observational study with retrospective analysis of prospectively collected data, which has important limitations. There are variables that are not possible to adjust for within the scope of propensity matching or by any other means of adjustment, which would be balanced in a randomised trial of sufficient size. We did not adjust for the complexity of the mitral valvular disease. By necessity, there will be a degree of bias in the selection of procedures. Patients with less complex mitral valvular disease might have undergone repair and hence had a superior outcome. Most of the high-risk cases were discussed in a specialised heart forum. However the final decision to replace or repair depended on the operating surgeon as with many other cardiac surgical procedures. The decision process to perform repair or replacement is complex and depends on the experience of the operating surgeon, the valve lesion, the patient characteristics and perceived longevity. It is difficult to correct for these natural confounds in a retrospective analysis. Nonetheless, the results from this study demonstrate outcomes in the real world from mitral surgery.

Consequently mitral surgery is operator dependent, and most of the surgeons performing mitral valve repair have a high volume mitral practice, which may not have been the case in those performing valve replacement.

Another limitation of the study was the absence of long-term follow-up echocardiography data to detect recurrence of mitral regurgitation in the repair group. However, this was not the primary objective of the study.

Conclusions

Within the limitations imposed by retrospective analyses, our study demonstrates an association between improved outcomes and MVr for degenerative mitral valvular disease in the elderly.

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