Systematic Review

A meta-analysis of mitral valve repair versus replacement for ischemic mitral regurgitation

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Background: The development of ischemic mitral regurgitation (IMR) portends a poor prognosis and is associated with adverse long-term outcomes. Although both mitral valve repair (MVr) and mitral valve replacement (MVR) have been performed in the surgical management of IMR, there remains uncertainty regarding the optimal approach. The aim of the present study was to meta-analyze these two procedures, with mortality as the primary endpoint.

Methods: Seven databases were systematically searched for studies reporting peri-operative or late mortality following MVr and MVR for IMR. Data were independently extracted by two reviewers and meta-analyzed according to pre-defined study selection criteria and clinical endpoints.

Results: Overall, 22 observational studies (n=3,815 patients) and one randomized controlled trial (n=251) were included. Meta-analysis demonstrated significantly reduced peri-operative mortality [relative risk (RR) 0.61; 95% confidence intervals (CI), 0.47-0.77; I^2=0%; P<0.001] and late mortality (RR, 0.78; 95% CI, 0.67-0.92; I^2=0%; P=0.002) following MVr. This finding was more pronounced in studies with longer follow-up beyond 3 years. At latest follow-up, recurrence of at least moderate mitral regurgitation (MR) was higher following MVr (RR, 5.21; 95% CI, 2.66-10.22; I^2=46%; P<0.001) but the incidence of mitral valve re-operations were similar.

Conclusions: In the present meta-analysis, MVr was associated with reduced peri-operative and late mortality compared to MVR, despite an increased recurrence of at least moderate MR at follow-up. However, these findings must be considered within the context of the differing patient characteristics that may affect allocation to MVr or MVR. Larger prospective studies are warranted to further compare long-term survival and freedom from re-intervention.

Keywords: Mitral valve repair (MVr); mitral valve replacement (MVR); ischemic mitral regurgitation (IMR); meta-analysis

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Introduction

Ischemic mitral regurgitation (IMR) is a frequent complication of myocardial infarction, occurring in 13% to 50% of cases (1,2). The presence of IMR portends a poor prognosis and is associated with reduced long-term survival and impaired functional status (2,3). The pathophysiology of IMR mainly relates to the chronic adverse left ventricular (LV) remodeling that occurs following myocardial injury resulting in tethered mitral leaflets with poor coaptation.

Current practice guidelines recommend mitral valve repair (MVr) or mitral valve replacement (MVR) for severe IMR, but do not specify which procedure represents the optimal surgical approach (4,5). Potential benefits of MVr over MVR

have been well described for other etiologies of mitral valve disease, particularly degenerative MR (6). However, IMR poses a unique surgical challenge as mitral regurgitation (MR) can occur in the presence of a structurally normal valve. Given the lack of multiple prospective randomized trials, a rigorous assessment of MVr and MVR requires a systematic and critical analysis of the current literature. The present meta-analysis aimed to assess the clinical outcomes of patients who underwent MVr or MVR for IMR.

Methods

Search strategy and study selection

Electronic searches were performed using Ovid Medline, Embase, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Cochrane Methodology Register, Database of Abstracts of Reviews of Effects and ACP Journal Club from their dates of inception to July 2015. The search terms "mitral" and ("ischemic" or "ischaemic") and ("repair" or "replacement" or "annuloplasty") and ("mortality" or "death" or "survival") were entered as keywords and MeSH terms. This was supplemented by hand searching the reference lists of key reviews and all potentially relevant studies.

Two reviewers (A.S. and D.D.) independently screened the title and abstract of records identified in the search. Full-text publications were subsequently reviewed separately if either reviewer considered the manuscript as being potentially eligible. Disagreements regarding final study inclusion were resolved by discussion and consensus.

Eligibility criteria

Eligible studies were those reporting peri-operative or late mortality following MVr and MVR in patients with IMR. Studies were excluded if: (I) cohorts had mixed mitral valve etiologies and mortality data for the ischemic subset could not be separately determined; (II) concomitant surgical ventricular restoration was performed in either group; (III) there were fewer than ten patients in either the MVr or MVR group.

All publications were limited to those involving human subjects and written in English. Abstracts, conference presentations, editorials and expert opinions were excluded. Review articles were omitted because of potential publication bias and duplication of results. When institutions published duplicated studies with accumulating numbers of patients or increased lengths of follow-up, only the most complete reports were included for quantitative assessment.

Data extraction

All data were independently extracted from text, tables and figures by two investigators (A.S. and D.D.). The final results were reviewed by the senior reviewer (C.C.). The pre-determined primary endpoints were peri-operative and late mortality. Peri-operative mortality was defined as death within 30 days after surgery or during the same hospitalization. Late mortality was defined as death occurring during study follow-up period (minimum 12 months). Secondary outcomes included recurrence of at least moderate MR (grade ≥2), mitral valve re-operation, and echocardiographic measurements of LV remodeling.

Statistical analysis

Baseline characteristics and operative details were presented as raw values (%), mean ± standard deviation or median [interquartile range (IQR)] unless otherwise indicated. Pooled values for clinical outcomes were calculated using the DerSimonian-Laird random-effects model (7). The relative risk (RR) was used as the summary statistic, and reported with 95% confidence intervals (CI). Meta-analyses were performed using random-effects models to take into account the anticipated clinical and methodological diversity between studies. The I^2 statistic was used to estimate the percentage of total variation across studies due to heterogeneity rather than chance, with values exceeding 50% indicative of considerable heterogeneity.

Publication bias was assessed using funnel plots comparing log risk estimates with their standard error. Egger's linear regression method and Begg's rank correlation test were used to detect funnel plot asymmetry, and the Trim-and-Fill method was used to explore the impact of studies potentially missing due to publication bias (8-10). Statistical analysis was conducted with Review Manager Version 5.1.2 (Cochrane Collaboration, Software Update, Oxford, UK) and Comprehensive Meta-Analysis v2.2 (Biostat Inc, Englewood, NJ, USA). All P values were two sided, and values <0.05 were considered statistically significant.

Results

A total of 1,125 unique records were identified through

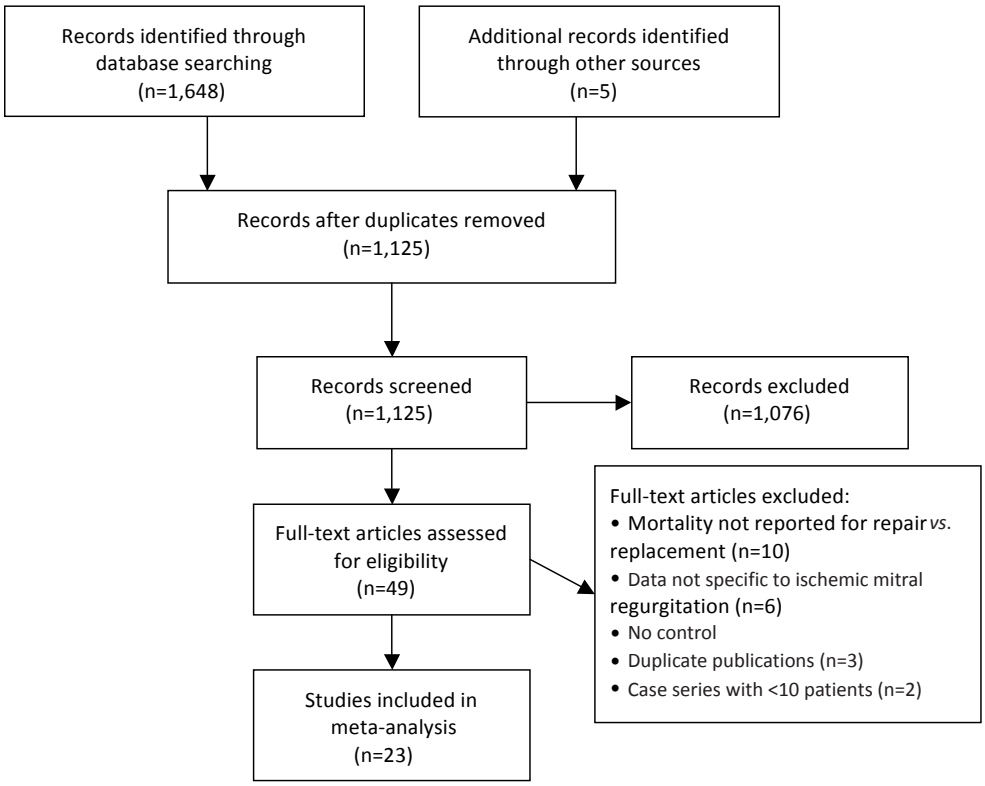

Figure 1 Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flowchart summarizing the study selection process.

the database searches. Of these, 1,076 were excluded on the basis of title and abstract content. After screening the full text of the remaining 49 articles, 23 studies met the criteria for inclusion (11-33). The study selection process is summarized in *Figure 1*.

Of the included studies, there were 21 retrospective observational studies, one prospective observational study (OS) and one randomized controlled trial (*Table 1*). These included data on a total of 4,066 patients, including 2,357 patients who underwent MVr and 1,709 who underwent MVR. The median study sample size was 130 (range, 49-522). The mean or median follow-up duration was reported in 18 studies, ranging from 12 to 92.4 months. Baseline patient characteristics and risk factor profiles are summarized in *Table 2*, and a summary of operative details is presented in *Table 3*.

Peri-operative mortality

In 19 observational studies and one RCT involving a total of 3,133 patients, MVr was associated with significantly reduced perioperative mortality (pooled incidences of 6.6% *vs*. 11.4%; RR, 0.61; 95% CI, 0.47-0.77; I^2=0%; P<0.001; *Figure 2*).

Late mortality

In ten observational studies and one RCT involving a total of 2,216 patients, MVr was associated with significantly reduced late mortality (pooled incidences of 16.8% *vs*. 22.2%; RR, 0.78; 95% CI, 0.67-0.92; I^2=0%; P=0.002; *Figure 3*). The median lengths of follow-up of these studies ranged from 12 to 92.4 months.

Subgroup analysis of late mortality was performed by duration of study follow-up. In studies with median follow-up ranging from 12-36 months, late mortality was not significantly reduced following MVr (pooled incidences of 15.7% *vs*. 19.4%; RR, 0.80; 95% CI, 0.56-1.13; I^2=0%; P=0.20). In studies with median follow-up beyond 36 months, late mortality was significantly reduced following MVr (pooled incidences of 18.9% *vs*. 26.7%; RR, 0.78; 95% CI, 0.66-0.93; I^2=0%; P=0.006).

Mitral valve re-operation

At latest follow-up, MVr was not statistically significantly

Table 1 Summary of studies comparing mitral valve repair versus replacement for ischemic mitral regurgitation

Study	Country	Study period	Study design	MVr (n)	MVR (n)	Follow-up (months)
Acker *et al*. 2014 (11)	USA	2009-2012	RCT	126	125	12[M]
Yoshida *et al*. 2014 (33)	Japan	1999-2012	Retrospective OS	26	37	51.2±28.3
Lio *et al*. 2014 (20)	Italy	2002-2011	Retrospective OS	98	28	45 [20-68]
Roshanali *et al*. 2013 (30)	Iran	2007-2010	Prospective OS	151	26	41.4±8.2
Lorusso *et al*. 2013 (22)	Italy	1996-2011	Retrospective OS, PM	244	244	46.5 [26.6-69.0]
Ljubacev *et al*. 2013 (21)	Croatia	2006-2008	Retrospective OS	34	41	NR
Chan *et al*. 2011 (15)	Canada	2001-2010	Retrospective OS, PM	65	65	30±25.2
Qiu *et al*. 2010 (27)	China	2001-2009	Retrospective OS	112	106	49.1±14.1
Magne *et al*. 2009 (23)	Canada	1995-2008	Retrospective OS, PM	186	184	31.2 [6.0-63.6]
Sadeghian *et al*. 2008 (31)	Iran	2002-2005	Retrospective OS	29	20	18.9±2.1
Milano *et al*. 2008 (26)	USA	1998-2006	Retrospective OS	416	106	92.4[M]
Micovic *et al*. 2008 (25)	Serbia	2000-2005	Retrospective OS	86	52	NR
Silberman *et al*. 2006 (32)	Israel	1993-2002	Retrospective OS	38	14	38[m]
Bonacchi *et al*. 2006 (13)	Italy	1995-2003	Retrospective OS	36	18	32[m]
Al-Radi *et al*. 2005 (12)	Canada	1990-2001	Retrospective OS	65	137	NR
Reece *et al*. 2004 (12)	USA	1995-2002	Retrospective OS	54	56	NR
Mantovani *et al*. 2004 (24)	Italy	1993-2003	Retrospective OS	61	41	27.5[M]
Calafiore *et al*. 2004 (14)	Italy	1988-2002	Retrospective OS	82	20	39±35
Grossi *et al*. 2001 (18)	USA	1976-1996	Retrospective OS	152	71	14.6[M]
Hausmann *et al*. 1999 (19)	Germany	1986-1998	Retrospective OS	140	197	84[M]
Choudhary *et al*. 1999 (16)	India	1988-1998	Retrospective OS	39	33	41.6±10.2
Cohn *et al*. 1995 (17)	USA	1984-1994	Retrospective OS	94	56	31.2[m]
Rankin *et al*. 1988 (28)	USA	1981-1987	Retrospective OS	23	32	NR

[M], median; [m], mean; OS, observational study; PM, propensity-matched; RCT, randomized controlled trial; NR, not reported.

associated with mitral valve re-operation when compared to MVR using data from nine observational studies and one RCT involving a total of 1,749 patients (pooled incidences of 5.0% *vs*. 5.0%; RR, 1.22; 95% CI, 0.60-2.48; I^2=40%; P=0.58; *Figure 4*).

Recurrence of MR

At latest follow-up, recurrence of at least moderate MR was significantly higher following MVr in five observational studies and one RCT involving a total of 1,329 patients (pooled incidences of 22.1% *vs*. 4.5%; RR, 5.21; 95% CI, 2.66-10.22; I^2=46%; P<0.001; *Figure 5*).

Echocardiographic measurements

A complete summary of pre- and post-operative echocardiographic measurements is displayed in *Table S1*. Due to the lack of raw data available, it was not possible to conduct meta-analyses for these endpoints.

Sensitivity analyses

It was noted that earlier studies on MVr were associated with lower incidences of subvalvular preservation and use of annuloplasty ring, as shown in *Table 3*. Hence, sensitivity analyses were conducted to only include studies in which the mid-point of the study period was 2000 or later. Restricting analyses to these studies did not significantly impact on the result for peri-operative mortality (RR, 0.62; 95% CI, 0.42-0.91; I^2=0%; P=0.01), late mortality (RR, 0.83; 95% CI, 0.70-0.90; I^2=0%; P=0.04) or recurrence of at least moderate MR (RR, 5.64; 95% CI, 3.41-9.34; I^2=20%; P<0.001). However, there was a trend towards increased

Table 2 Summary of baseline patient characteristics and risk factor profiles in studies comparing mitral valve repair versus replacement for ischemic mitral regurgitation

Study	Age		Male (%)		HTN (%)		Diabetes (%)		AF (%)		NYHA III-IV (%)		MR grade	
	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR
Acker *et al*. 2014 (11)	69±10	68±9	61	62	NR	NR	38	33	36	28	58	61	NR	NR
Yoshida *et al*. 2014 (33)	65±10	72±9	87	69	NR	NR	41	50	NR	NR	38	81	3.1±0.5	3.6±0.5
Lio *et al*. 2014 (20)	65±11	70±10	74	61	81	89	35	32	NR	NR	61	71	NR	NR
Roshanali *et al*. 2013 (30)	56±12	57±10	83	77	NR	NR	NR	NR	NR	NR	NR	NR	3.6±0.5	3.5±0.5
Lorusso *et al*. 2013 (22)	66±7	66±8	73	69	41	41	36	35	12	13	NR	NR	2.8±0.5	2.8±0.5
Ljubacev *et al*. 2013 (21)	NR	NR	NR	NR	85	80	32	56	26	17	NR	NR	NR	NR
Chan *et al*. 2011 (15)	67±9	69±10	69	64	NR	NR	NR	NR	NR	NR	55	37	NR	NR
Qiu *et al*. 2010 (27)	71±9	72±11	64	56	72	75	30	32	28	26	53	49	NR	NR
Magne *et al*. 2009 (23)	66±9	66±10	69	60	58	51	33	29	26	25	57	76	NR	NR
Sadeghian *et al*. 2008 (31)	62±9	64±8	76	65	28	20	45	10	NR	NR	NR	NR	NR	NR
Milano *et al*. 2008 (26)	66	67	56	47	74	60	39	26	NR	NR	51	45	NR	NR
Micovic *et al*. 2008 (25)	61[M]	62[M]	72	73	74	65	21	15	27	29	64	50	2.7±0.6	2.5±0.7
Silberman *et al*. 2006 (32)	62±10	67±7	74	93	50	57	45	57	NR	NR	NR	NR	NR	NR
Bonacchi *et al*. 2006 (13)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Al-Radi *et al*. 2005 (12)	NR	NR	65	59	55	49	23	20	20	12	91	90	NR	NR
Reece *et al*. 2004 (12)	67±1	69±1	41	68	NR	NR	22	21	NR	NR	NR	NR	NR	NR
Mantovani *et al*. 2004 (24)	68±7	68±7	67	54	54	51	26	15	NR	NR	NR	NR	3.1±0.8	3.0±0.8
Calafiore *et al*. 2004 (14)	66±8	66±10	76	85	53	30	32	15	23	15	96	100	3.1±0.8	3.3±0.7
Grossi *et al*. 2001 (18)	68	68	64	59	NR	NR	30	31	NR	NR	95	97	NR	NR
Hausmann *et al*. 1999 (19)	62	64	NR	NR	NR	NR	NR	NR	24	58	NR	NR	NR	NR
Choudhary *et al*. 1999 (16)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	64	79	NR	NR
Cohn *et al*. 1995 (17)	66	69	55	48	NR	NR	NR	NR	NR	NR	89	98	NR	NR
Rankin *et al*. 1988 (28)	62±10	63±7	66	63	NR	NR	NR	NR	NR	NR	NR	NR	3.7±0.6	3.7±0.5

Data presented as mean ± standard deviation or % of patients unless otherwise indicated. AF, atrial fibrillation; LVEF, left ventricular ejection fraction; [M], median; MR, mitral regurgitation; NR, not reported.

Table 3 Summary of operative details in studies comparing mitral valve repair versus replacement for ischemic mitral regurgitation

Study	Concomitant CABG (%)		Concomitant TV repair (%)		MVR prosthesis type (%)		Subvalvular preservation in MVR group (%)		MVr partial/ suture annuloplasty (%)	MVr ring annuloplasty (%)
	MVr	MVR	MVr	MVR	Mechanical	Bioprosthesis	Anterior + posterior	Posterior		
Acker *et al*. 2014 (11)	74	75	13	18	NR	NR	100	0	0	100
Yoshida *et al*. 2014 (33)	89	58	30	38	4	96	100	0	0	100
Lio *et al*. 2014 (20)	100	100	NR	NR	36	64	100	0	0	100
Roshanali *et al*. 2013 (30)	100	100	NR	NR	100	0	100	0	NR	NR
Lorusso *et al*. 2013 (22)	100	100	0	0	47	53	NR	NR	0	100
Ljubacev *et al*. 2013 (21)	100	100	NR	NR	NR	NR	NR	NR	NR	NR
Chan *et al*. 2011 (15)	75	86	NR	NR	26	74	42	58	0	100
Qiu *et al*. 2010 (27)	100	100	NR	NR	38	62	11	89	0	100
Magne *et al*. 2009 (23)	94	84	0	0	79	21	20	66	0	100
Sadeghian *et al*. 2008 (31)	100	100	NR	NR	NR	NR	NR	NR	NR	93
Milano *et al*. 2008 (26)	NR	NR	NR	NR	72	28	NR	NR	9	91
Micovic *et al*. 2008 (25)	100	100	16	10	100	0	0	100	NR	95
Silberman *et al*. 2006 (32)	NR	NR	NR	NR	100	0	NR	NR	0	100
Bonacchi *et al*. 2006 (13)	NR	NR	NR	NR	NR	NR	0	100	17	83
Al-Radi *et al*. 2005 (12)	NR	NR	NR	NR	36	64	16	55	0	100
Reece *et al*. 2004 (12)	100	100	NR	NR	NR	NR	NR	NR	0	100
Mantovani *et al*. 2004 (24)	100	100	NR	NR	76	24	0	100	0	100
Calafiore *et al*. 2004 (14)	89	100	18	15	45	55	NR	NR	18	6
Grossi *et al*. 2001 (18)	89	80	NR	NR	18	82	NR	NR	23	77
Hausmann *et al*. 1999 (19)	97	88	NR	NR	53	47	NR	NR	100	0
Choudhary *et al*. 1999 (16)	NR	NR	NR	NR	100	0	0	100	NR	0
Cohn *et al*. 1995 (17)	NR	NR	NR	NR	29	71	0	100	15	85
Rankin *et al*. 1988 (28)	NR	NR	NR	NR	15	85	NR	NR	22	8

CABG, coronary artery bypass grafting; MVr, mitral valve repair; MVR, mitral valve replacement; NR, not reported; TV, tricuspid valve.

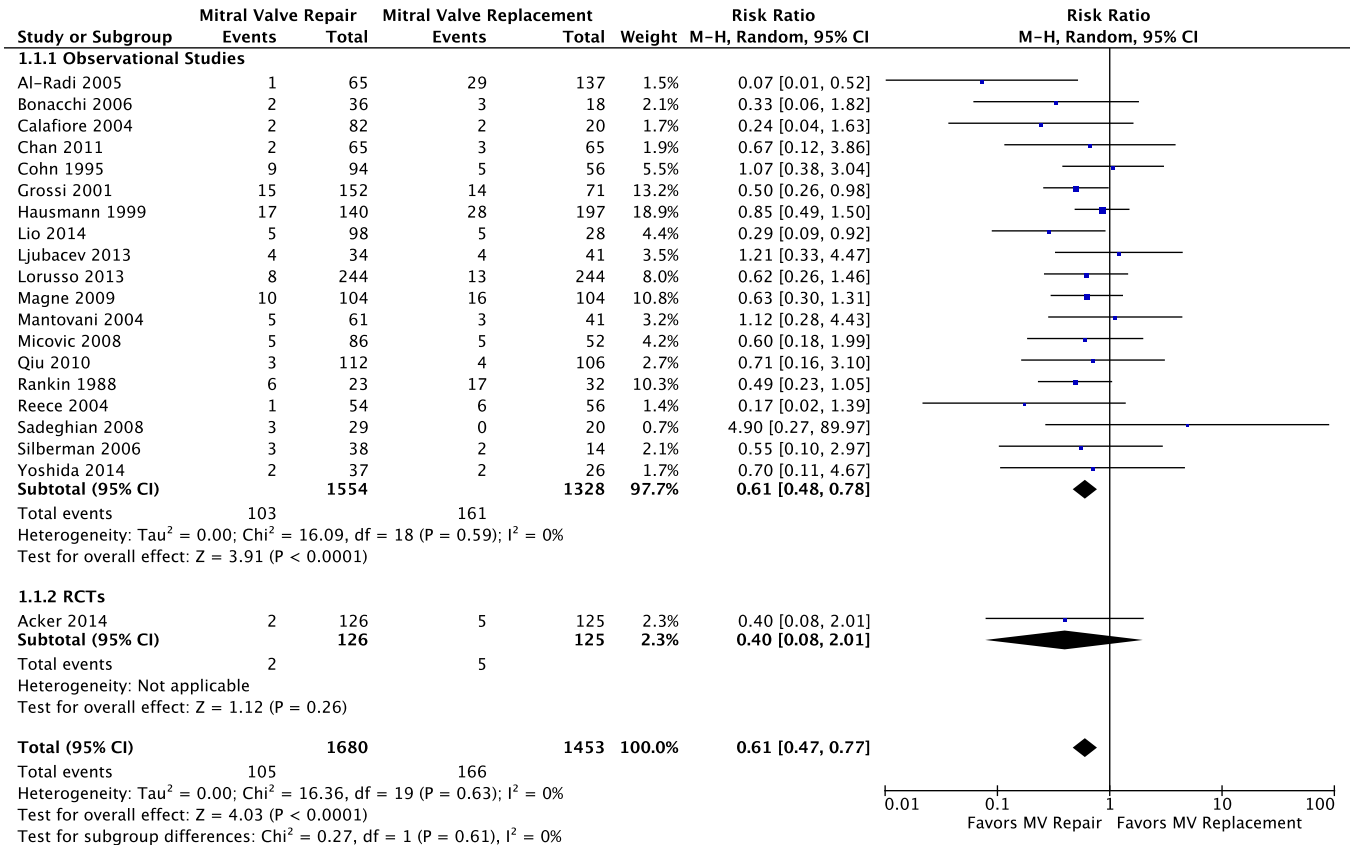

Figure 2 Forest plot displaying the relative risk (RR) of all-cause peri-operative mortality for mitral valve repair (MVr) versus replacement (MVR). The RR of individual studies correspond to the middle of the squares, the horizontal lines show the 95% confidence intervals (CI), and the pooled RR is represented by the middle of the solid diamond. A test of heterogeneity between studies is given below the summary statistics.

mitral valve re-operation following MVr (RR, 1.47; 95% CI, 0.95-2.26; I^2=0%; P=0.08).

Publication bias

Neither Begg's rank correlation test (P=0.40) nor Egger's linear regression method (P=0.29) suggested publication bias was a significant factor when peri-operative mortality was selected as an endpoint (*Figure S1*). Likewise, publication bias was not found to significantly influence results for late mortality (Begg's rank correlation test, P=0.82; Egger's linear regression method, P=0.89).

Discussion

In recent years, MVr has been increasingly performed in the surgical management of IMR (34). The Society of Thoracic Surgeons database from 2008-2012 reported that valve repair occurred in almost two-thirds of mitral valve surgeries in patients who underwent concurrent coronary artery bypass graft surgery (11). However, this trend of increased MVr has not been based on any conclusive evidence demonstrating superior outcomes for this approach.

To date, there has only been one RCT that has assessed clinical outcomes following MVr or MVR in patients with IMR. This RCT demonstrated similar 30-day and 12-month mortality between the two approaches (11). In contrast, our meta-analysis demonstrated significantly reduced peri-operative and late mortality in patients who underwent MVr. There are several possible reasons for this discrepancy. In clinical practice, high-risk patients with multiple co-morbidities and poor baseline function are often preferentially allocated to MVR over MVr. This

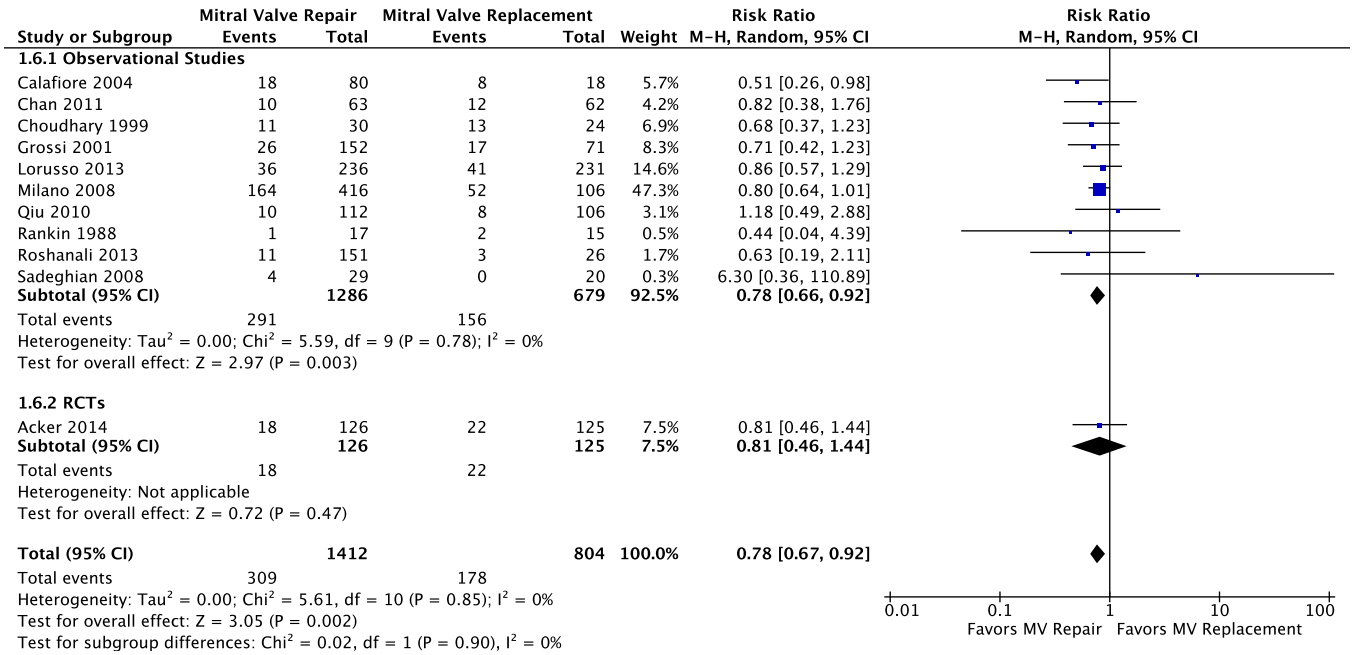

Figure 3 Forest plot displaying the relative risk (RR) of all-cause late mortality for mitral valve repair (MVr) versus replacement (MVR). The RR of individual studies correspond to the middle of the squares, the horizontal lines show the 95% confidence intervals (CI), and the pooled RR is represented by the middle of the solid diamond. A test of heterogeneity between studies is given below the summary statistics.

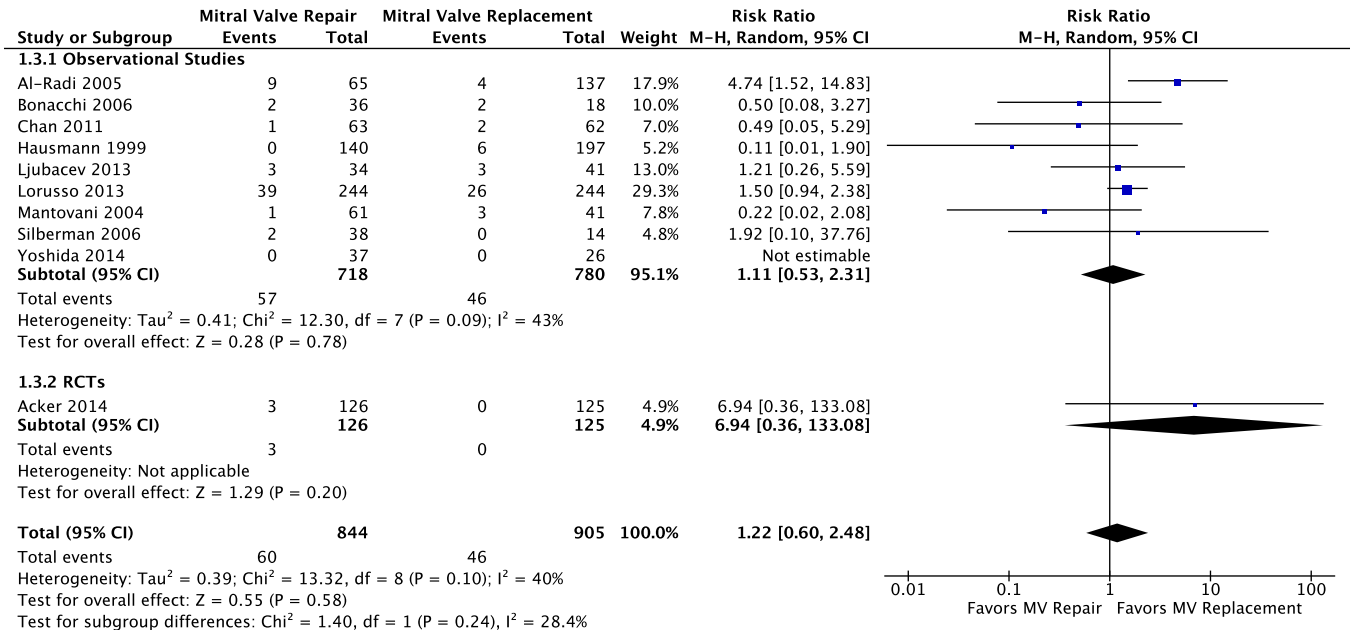

Figure 4 Forest plot displaying the relative risk (RR) of mitral valve re-operation for mitral valve repair (MVr) versus replacement (MVR). The RR of individual studies correspond to the middle of the squares, the horizontal lines show the 95% confidence intervals (CI), and the pooled RR is represented by the middle of the solid diamond. A test of heterogeneity between studies is given below the summary statistics.

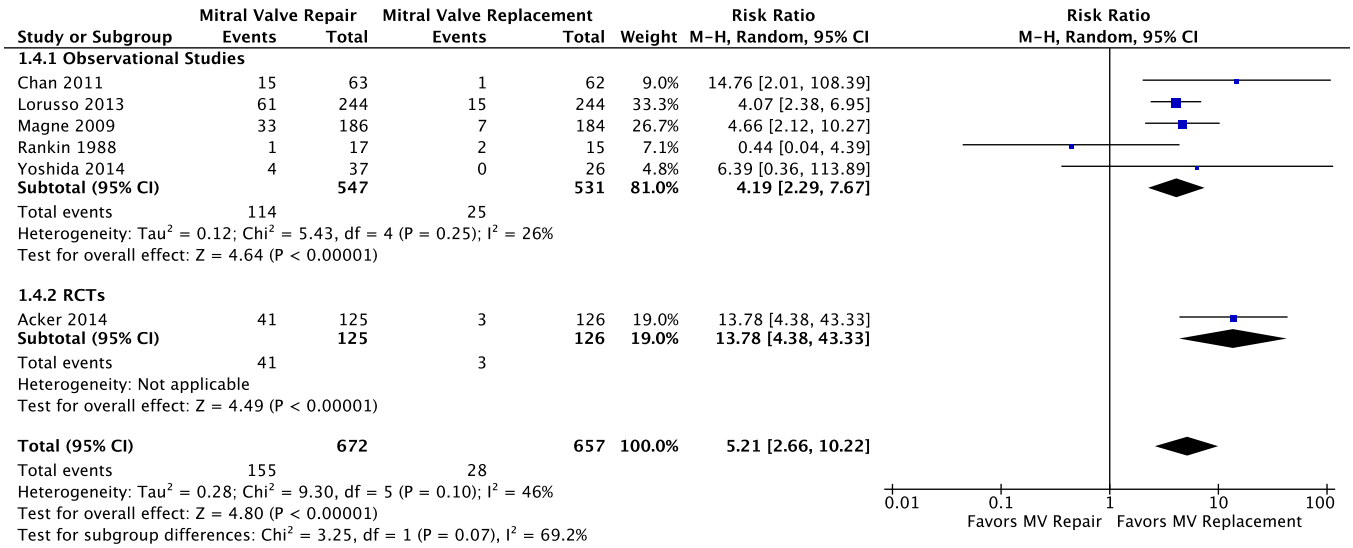

Figure 5 Forest plot displaying the relative risk (RR) of recurrence of mitral regurgitation (MR) (grade ≥2) for mitral valve repair (MVr) versus replacement (MVR). The RR of individual studies correspond to the middle of the squares, the horizontal lines show the 95% confidence intervals (CI), and the pooled RR is represented by the middle of the solid diamond. A test of heterogeneity between studies is given below the summary statistics.

was demonstrated by the patient characteristics of several included observational studies, in which patients within the MVR cohorts had significantly higher prevalence of baseline co-morbidities (*Table 2*) (19,33). Although several observational studies presented data for propensity-matched cohorts, these statistical methods are not a substitute for randomization, and key clinical confounders may have been omitted (35). It should also be noted that the only RCT to date had a relatively small sample size and follow-up was limited to 12 months. In the present meta-analysis, subgroup analysis demonstrated the reduction in late mortality following MVr to be most evident beyond 36 months, suggesting trials with shorter follow-up duration may be unable to detect potential mortality differences.

Both the randomized and observational data demonstrated a significantly higher rate of at least moderate MR following MVr (*Figure 3*). This represented an important finding as recurrence of MR >2 has been shown to be an independent predictor of poor long-term outcomes (36). Interestingly, the higher rate of recurrent MR did not translate to an increased incidence of mitral valve re-operation.

Several studies included in the present meta-analysis reported outdated surgical techniques, such as low rates of annuloplasty ring implantation with mitral repair (14,16,19,28). To account for this and ensure our results were relevant to contemporary surgical practice, we conducted sensitivity analyses excluding studies in which patients were mostly operated prior to 2000. These analyses did not significantly change the overall results obtained for peri-operative mortality, late mortality or recurrence of MR. However, in sensitivity analysis, there was a trend towards significantly higher rates of mitral valve re-operation following MVr. Of note, earlier studies tended to report lower preservation of both anterior and posterior leaflets during MVR (16,17). Bi-leaflet preservation has been shown to provide the greatest reduction in LV chamber size and systolic afterload, as well as maximal improvement in ventricular performance, and this may have contributed to a temporal effect on re-operation rates (37,38).

The findings of the present meta-analysis were limited by several key constraints. Firstly, the vast majority of included studies were single-center retrospective observational reports and thus had biases inherent to such study designs. Secondly, pre-operative and follow-up echocardiographic measurements were not reported in sufficient detail to enable meta-analysis, and could only be qualitatively summarized. This was a significant limitation as improvements in measurements such as LV volume index are significantly associated with improved clinical outcomes (39,40). Thirdly, quality of life endpoints and measures of functional status were also scarcely reported and thus could not be statistically

analyzed in the present meta-analysis. Finally, follow-up periods and protocols differed widely between institutions and some studies may have reported lower rates of MR recurrence or mitral valve re-operation due to incomplete follow-up. However, in studies with specified follow-up periods, the minimum duration was 12 months.

In conclusion, the present meta-analysis demonstrated significantly reduced peri-operative and late mortality following repair versus replacement for patients with ischemic mitral valve regurgitation. However, these findings should be considered within the context of the clinical variables driving patient selection for each approach. Recurrence of at least moderate MR was significantly higher following MVr but rates of mitral valve re-operation were not significantly different. Larger studies with longer follow-up duration are required to further assess overall survival and freedom from re-intervention, as well as the impact of both surgical approaches on quality of life and functional status.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Table S1 Summary of echocardiographic parameters in patients undergoing mitral valve repair versus replacement for ischemic mitral regurgitation

Study	LVEF (%)				LVEDD				LVESD			
	Pre-operative		Follow-up		Pre-operative		Follow-up		Pre-operative		Follow-up	
	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR	MVr	MVR
Acker *et al*. 2014 (11)	42.4±12.0	40.0±11.0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Yoshida *et al*. 2014 (33)	33.2±9.8	27.0±8.7	35.4±11.5	34.9±12.7	63	63	55	55	51	55	44	44
Lio *et al*. 2014 (20)	32.1±6.7	34.1±7.1	NR	NR	61.6±6.3	58.6±9.3	NR	NR	47±7.1	44.8±10	NR	NR
Roshanali *et al*. 2013 (30)	40.0±6.0	40.0±6.5	45.8+4.9	44.4±5.3	NR	NR	NR	NR	NR	NR	NR	NR
Lorusso *et al*. 2013 (22)	35.0±3.2	34.9±2.9	36.9±3.5	38.5±3.3	55.0±7.2	55.2±6.9	NR	NR	42.0±7.0	42.2±7.3	NR	NR
Ljubacev *et al*. 2013 (21)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chan *et al*. 2011 (15)	37.4±9.3	37.0±12.9	NR	NR	60.9±7.7	58.4±9.2	NR	NR	47.0±10.1	42.3±13.1	NR	NR
Qiu *et al*. 2010 (27)	34.6±5.5	35.1±4.3	54.2±3.1	55.1±3.6	66.3±6.4	65.4±6.3	49.0±4.6	50.2±4.4	50.2±11.1	51.1±11.5	39.1±7.5	40.1±7.8
Magne *et al*. 2009 (23)	45±15	40±14	NR	NR	57±7	58±7	NR	NR	42±9	42±8	NR	NR
Sadeghian *et al*. 2008 (31)	36.3±8.4	39.5±8.3	40.9 ± 9.7	39.1±8.5	56.1±15.2	53.5±13.6	NR	NR	42.5±9.4	40.5±13.5	NR	NR
Milano *et al*. 2008 (26)	35.0	42.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Micovic *et al*. 2008 (25)	29.0±11.0	35.9±11.0	29.9±11.0	37.8±11.0	NR	NR	NR	NR	NR	NR	NR	NR
Silberman *et al*. 2006 (32)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bonacchi *et al*. 2006 (13)	27.0±5	27.2±5	31.0±4	30.7±4	67.5±6	67.5±6	63.8±4	64.0±3	51.8±5	51.6±7	49.5±3	50.0±3
Al-Radi *et al*. 2005 (12)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Reece *et al*. 2004 (12)	43.9±1.2	40.0±1.7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Mantovani *et al*. 2004 (24)	44.9±14.1	44.5±13.9	49±NR	47±NR	58	58	NR	NR	NR	NR	NR	NR
Calafiore *et al*. 2004 (14)	38±12	33±9	40±16	31±9	NR	NR	NR	NR	NR	NR	NR	NR
Grossi *et al*. 2001 (18)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hausmann *et al*. 1999 (19)	43.5	40.2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Choudhary *et al*. 1999 (16)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cohn *et al*. 1995 (17)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Rankin *et al*. 1988 (28)	39±12	42±14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

LVEDD, left ventricular end diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end systolic diameter; NR, not reported; MVr, mitral valve repair; MVR, mitral valve replacement.

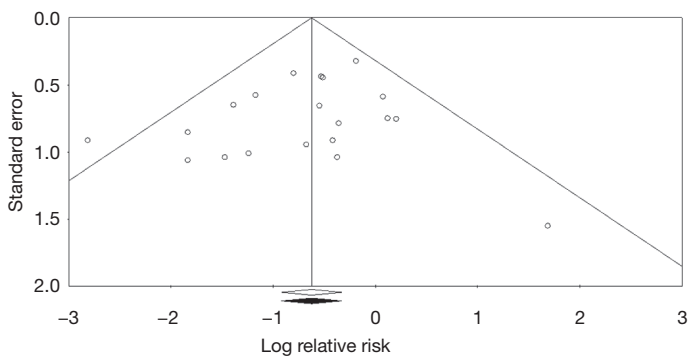

Figure S1 Funnel plot displaying assessment of publication bias for endpoint of peri-operative mortality following mitral valve repair (MVr) versus replacement. Open circles represent studies included in the present meta-analysis while black-filled circles represent potential missing studies. The white diamond represents the pooled logit risk estimate for periprocedural mortality in included studies while the black diamond represents the adjusted ratio after accounting for potential missing studies.