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Comparison of Port Access to Sternotomy in Tricuspid or Mitral/Tricuspid Operations

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ABSTRACT

Background: Outcomes for a port-access (PA) approach for tricuspid valve operations have not been reported or compared to those using median sternotomy (MS).

Methods: Retrospective analysis was performed for 88 consecutive patients undergoing tricuspid valve repair or replacement using port-access techniques (n = 27, 1997-2000) versus sternotomy (n = 61, 1990-1997). PA procedures were performed through a 6 cm right fourth interspace thoracotomy.

Results: PA patients had lower ejection fractions (46% ± 11% vs. 54% ± 10%, p = 0.02), but had a similar incidence of previous surgery (17/27 (63%) vs. 33/61 (54%), p = 0.4). PA patients had more frequent concurrent mitral valve operations (22/27 (82%) vs. 37/61 (61%), p <0.05) and more tricuspid repairs versus replacement (24/27 (89%) vs. 29/61 (48%), p <0.01). PA patients had longer pump times (254 min. ± 82 vs. 162 min. ± 61, p = 0.001) but comparable clamp times (65 min. ± 15 vs. 63 min. ± 41, p = 0.9), lengths of stay (14 days ± 14 vs. 16 days ± 16, p = 0.6), mortality (2/27 (7%) vs. 9/61 (15%), p = 0.3), strokes (3/27 (11%) vs. 4/59 (7%), p = 0.9), and need for new pacemaker implantation (5/27 (19%) vs. 12/61 (20%), p = 0.9).

Conclusions: PA provided excellent short-term results comparable to MS in relatively high-risk tricuspid valve patients. For tricuspid operations, PA may have the advantage of avoiding sternotomy or reoperative sternotomy at the expense of longer pump times.

INTRODUCTION

Port access (PA) has been applied as a technique to perform aortic or mitral valve operations using cardiopulmonary bypass and a small right thoracotomy with or without endovascular aortic occlusion [Pompili 1996, Colvin 1998, Gulielmos 1998, Mohr 1998, Galloway 1999, Reichenspurner 1999, Vanermen 1999, Glower 2000]. Although isolated applications of port access to tricuspid valve operations have been reported [Robin 1999], the results of tricuspid valve operations using port access have not been described. In addition, no studies have directly compared the results of port access or thoracotomy to median sternotomy (MS) for tricuspid operations. Several reports have suggested potential advantages to port access as an approach for mitral operations. It is thought that the port-access approach to the tricuspid valve may have similar advantages over sternotomy, including better cosmesis, earlier patient mobilization [Glower 1998, Ferdinand 2001, Grossi 2001], lower infection and sepsis [Grossi 2001], less pain [Walther 1999], and less bleeding and transfusion [Glower 1999a, Grossi 2001]. This study was designed to compare an initial experience with port access to median sternotomy for tricuspid valve operations.

MATERIALS AND METHODS

A retrospective analysis was performed of 100 consecutive patients undergoing tricuspid valve operations at Duke University Medical Center from January 1990 through December 2000. Of these 100 patients, 12 patients were excluded from analysis for other concurrent coronary or aortic valve operation (n = 2), age <20 years (n = 6), or standard right thoracotomy (n = 4). Patients undergoing concurrent mitral valve operations were included. All data were obtained by chart review and from prospective data collection. Patient demographic and operative data were summarized as mean ± standard deviation or prevalence, as appropriate. Perioperative morbidity and mortality incidence was analyzed on an intention-to-treat basis.

Port-access procedures were performed as previously reported for mitral valve operations [Pompili 1996, Boova 1998, Glower 1998, Gulielmos 1998, Mohr 1998, Reichenspurner 1999, Vanermen 1999] through a 6-cm right anterolateral thoracotomy in the fourth intercostal space. Patients considered for femoral arterial cannulation were screened by preoperative abdominal aortography and intraoperative transesophageal echocardiography. Once on cardiopulmonary bypass, the mitral operation was performed through a left atriotomy. After the left atrium was closed, the heart adequately de-aired, and the myocardium reperfused, the tricuspid valve procedures were performed on a beating heart. A 28 Fr. angled cannula was placed in the superior vena cava

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Table 1. Demographic Characteristics of Patients Who Underwent Port-Access (PA) Versus Median Sternotomy (MS) for Tricuspid Valve Surgery. Data Are Presented as Means ± SD.

	PA (n = 27)	MS (n = 61)	p-value
Age (yrs)	60 ± 11	58 ± 16	0.40
Gender (% male)	48	25	0.03
Reoperation (%)	63	54	0.40
EF (%)	46 ± 11	54 ± 10	0.02
PA systolic pressure (mmHg)	52 ± 26	47 ± 18	0.40
PA diastolic pressure (mmHg)	25 ± 12	22 ± 8	0.30

EF = ejection fraction, PA = pulmonary artery pressure

and the femoral venous cannula was withdrawn into the inferior vena cava. The caval tapes were secured, and the right atrium was opened with a linear vertical right atriotomy. Standard tricuspid valve repair or replacement techniques were employed using direct vision, video assistance, and endoscopic instruments as previously reported for the mitral valve [Pompili 1996, Glower 1998, Mohr 1998].

Median sternotomy procedures were performed in the standard fashion. In sternotomy patients, the tricuspid valve was generally repaired or replaced during cardioplegic arrest.

Statistical analysis was performed using NCSS statistical software [Hintze 1987]. Continuous variables were analyzed by the Student's t-test and categorical variables by the Chi-squared test or Fisher's exact test. Non-parametric testing was performed with the Mann-Whitney test. To correct for baseline differences between PA and MS patients, independent predictors of mortality (in-hospital or 30-day), stroke, and new pacemaker implantation were determined using multivariable logistic regression analysis. Independent variables that were examined included surgical approach (PA versus MS), age, gender, year of operation, previous cardiac operation, ejection fraction, tricuspid valve repair versus replacement, concurrent mitral procedure, and femoral versus aortic arterial cannulation. A p value of less than 0.05 was considered significant. Odds ratios are shown with 95% confidence intervals.

RESULTS

Port access was the approach used in 27 patients between 1997 and 2000, while median sternotomy was the approach in 61 patients from 1990 through 1997. Port-access and sternotomy patients were demographically similar (see Table 1 ◎) except that port-access patients were more likely to be male (PA 13/27 (48%) vs. MS 15/61 (25%), p = 0.03) and had significantly lower ejection fractions (PA 46% ± 11% vs. MS 54% ± 10%, p = 0.02). Tricuspid valve disease etiology differed significantly between port access and sternotomy (p = 0.04, Figure 1 ◎), with a higher percentage of ischemic etiology in the port-access group (PA 6/27 (20%) vs. MS 2/55 (4%), p = 0.01) and a trend for higher incidence of rheumatic disease in the sternotomy group (MS 26/55 (47%) vs. PA 9/27 (33%), p = 0.17). The tricuspid valve pathology also tended to differ between PA and MS, with the most common tricuspid pathology being annular dilation in 23/27 (85%) of PA patients versus 36/55 (66%) of MS patients (p = 0.06). Port-access and sternotomy patients did not differ significantly in the incidence of previous cardiac procedures (PA 17/27 (63%) vs. MS 33/61 (54%), p = 0.4).

Concurrent procedures did not differ significantly between port access and sternotomy (p = 0.3, Figure 2 ◎), with the majority of patients in both groups undergoing concurrent mitral valve procedures (PA 22/27 (82%) vs. MS 37/61 (62%)). The tricuspid procedure performed was more likely to be tricuspid repair in PA patients (PA 24/27 (89%) vs. MS 29/61 (48%), p <0.01), with one sternotomy patient undergoing tricuspid valve excision for active endocarditis due to intravenous drug abuse.

Cardioplegic arrest was used significantly less often in the port-access group (PA 15/27 (56%) vs. MS 45/57 (79%), p = 0.03). While the aortic clamp times were not significantly different between port access and sternotomy (PA 65 ± 15 min. vs. MS 63 ± 41 min., p = 0.9), the cardiopulmonary bypass

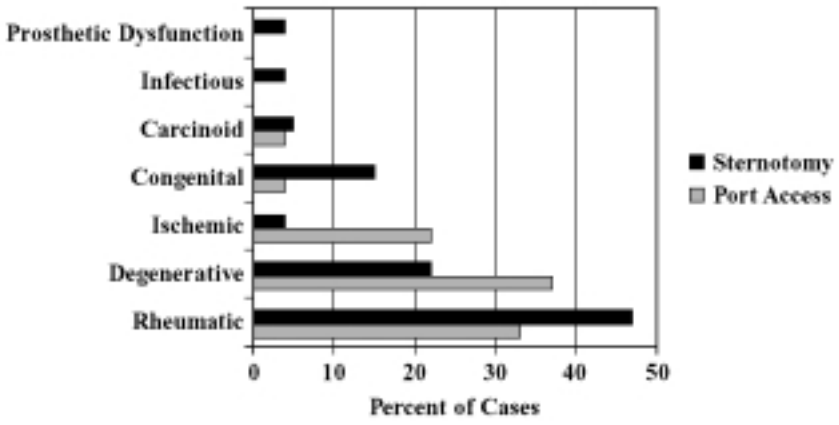

Figure 1. Etiology of tricuspid valve disease. Note the higher incidence of rheumatic disease in the sternotomy group and the higher incidence of ischemic disease in port-access patients. These differences were significant (p = 0.04).

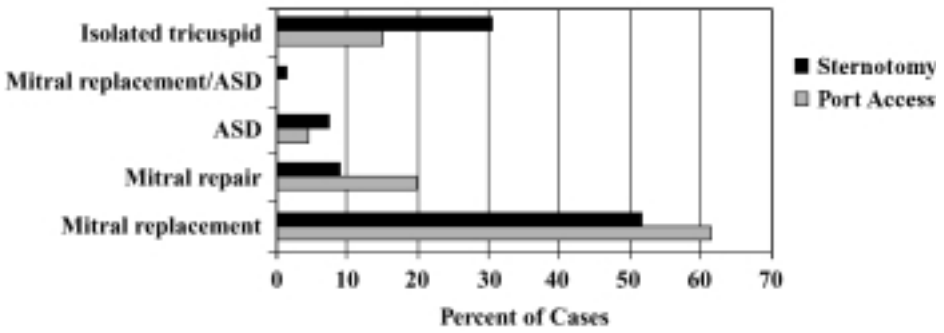

Figure 2. Concurrent Procedures. The port-access and sternotomy groups did not differ significantly (p = 0.3). Most patients in each group underwent concurrent mitral procedures. ASD = atrial septal defect closure.

time (PA 254 ± 82 min. vs. MS 162 ± 61 min., p = 0.001), skin to skin surgical time (PA 443 ± 119 min. vs. MS 316 ± 94 min., p = 0.001), and anesthesia time (PA 520 ± 177 min. vs. MS 404 ± 97 min., p = 0.001) were significantly longer for port access than for sternotomy (Table 2 ◎).

Chest tube output (PA 1039 ± 783 ml vs. MS 1566 ± 1670 ml, p = 0.08) tended to be less in PA, but red cell transfusion, intubation time, and hospital stay were not significantly different between PA and MS (Table 2 ◎). Note that median red cell transfusion was four units for both PA and MS, and median length of stay was nine days (PA) versus ten days (MS). Operative mortality and the incidence of stroke, reoperation for bleeding, new pacemaker placement, and wound infection were not significantly different between approaches (Table 3 ◎). One of the three strokes in the PA group occurred postoperatively, presumably from left atrial thrombus. One patient in the PA group required conversion to MS due to a left ventricular tear resulting from adhesions to a previous left thoracotomy. The two mortalities in the PA group were from stroke and pneumonia, respectively, while for the sternotomy group causes of death were cardiogenic shock (4), respiratory failure (1), stroke (2), intraoperative hemorrhage (1), and massive postoperative coagulopathy with carcinoid syndrome (1).

Table 2. Intraoperative Characteristics and Operative Results in Port-Access (PA) and Median Sternotomy (MS) Patients Undergoing Tricuspid Valve Procedures. Data Are Presented as Percentages or Means ± SD.

	PA (n = 27)	MS (n = 61)	p-value
Cardioplegic arrest (%)	56	79	0.03
AXC (min.)	65 ± 15	63 ± 41	0.9
CPB (min.)	254 ± 82	162 ± 61	0.001
Surgery time (min.)	443 ± 119	316 ± 94	0.001
Anesthesia time (min.)	520 ± 177	404 ± 97	0.001
Chest tube output (ml)	1039 ± 783	1566 ± 1670	0.08
Intubation time (hrs)	61 ± 163	87 ± 216	0.6
RBC (units)	6 ± 5	7 ± 11	0.6
Length of stay (days)	14 ± 14	16 ± 16	0.6

AXC = aortic cross-clamp time, CPB = cardiopulmonary bypass times, RBC = packed red blood cell transfusion

Logistic regression analysis showed the independent determinant of mortality to be older age (odds ratio = 1.11 (1.03-1.19), p = 0.008). Although the only independent predictor of stroke was lower ejection fraction (odds ratio = 0.92 (0.85-0.99), p = 0.03), there was a definite trend towards femoral (versus aortic) cannulation (odds ratio = 5.2 (1.0-26.4), p = 0.049) to be associated with stroke. By chi-squared analysis, femoral arterial cannulation was found to be associated with increased risk of stroke over central aortic cannulation (3/12 (25%) vs. 4/75 (5%), p = 0.02). The occurrence of stroke also tended to be associated with ischemic heart disease (2/8 (25%) vs. 5/80 (6%), p = 0.06). By logistic regression analysis, tricuspid valve replacement (versus repair) was a strong predictor of need for new pacemaker implantation (odds ratio = 7.5 (2.2-26.3, p = 0.002). Logistic regression analysis did not find port access (versus sternotomy) to be associated with the incidence of death, stroke, or new pacemaker placement.

DISCUSSION

Tricuspid valve procedures traditionally have been associated with high operative mortality and morbidity due to the presence of multivalvular and systemic disease and the high incidence of prior cardiac procedures [Kratz 1985, McGrath 1990, Cobanoglu 1993, Duran 1994, Glower 1995]. In the past two decades the indications for tricuspid valve surgery, and its surgical techniques, have become more standardized

Table 3. Perioperative Morbidity for Patients Who Underwent Port-Access (PA) Versus Median Sternotomy (MS). Data Are Presented as Percentages.

	PA (n = 27)	MS (n = 61)	p-value
Mortality	2/27 (7%)	9/61 (15%)	0.3
Stroke	3/27 (11%)	4/59 (7%)	0.9
Reop for bleed	3/27 (11%)	4/57 (7%)	0.9
New pacer	5/27 (19%)	12/61 (20%)	0.6
Wound infection	0/27 (0%)	2/61 (3%)	0.5
Convert to sternotomy	1/27 (4%)	NA	NA

[Cobanoglu 1993]. Thoracotomy has been used as an alternative approach to the tricuspid valve, particularly in cases of previous sternotomy [Berreklouw 1984]. Given the relative infrequency of tricuspid procedures, no studies have directly compared the results of thoracotomy to sternotomy for tricuspid operations. By far the vast majority of previous thoracotomies for tricuspid operations have been full right anterolateral thoracotomies with standard cardiac cannulation and no aortic endoclamp [Berreklouw 1984]. Data from reoperative mitral valve patients suggest that a full standard thoracotomy may be associated with significantly higher morbidity and perhaps higher mortality than the smaller right thoracotomy with port access [Glower 1999a]. For mitral valve operations, several studies have found port access using a small right thoracotomy to have significantly more rapid return to normal activity [Glower 1998, Ferdinand 2001, Grossi 2001], less pain [Walther 1999], less sepsis and wound infections [Grossi 2001], less new atrial fibrillation [Ferdinand 2001], shorter hospital stay [Glower 1998, Grossi 2001], and less transfusion requirements [Glower 1999a, Grossi 2001] than sternotomy, but at the expense of longer operation times [Glower 1998, Grossi 1999]. Because of the relatively small number of patients in this study (although a large series for tricuspid valve patients), the study either did not examine or could not confirm the relative morbidity of port access versus sternotomy but observed trends toward lower chest tube output and lower mortality with port access.

This study shows that using port access to approach the tricuspid valve can provide results at least comparable to those from sternotomy, even in relatively high-risk patients. The disadvantages of port access in this study were longer cardiopulmonary bypass and operation times and an increased need for special instrumentation and disposable catheters. While not examined numerically, port-access patients in this study did obtain the benefit of a smaller chest wall incision, as well as the avoidance of median sternotomy in 96% of cases.

This study is limited in being a nonrandomized comparison of two different surgical techniques used over different time periods. Differences in year of operation and in other patient characteristics could have biased the results. However, an attempt to correct for differences in baseline patient characteristics using logistic regression analysis suggested equivalent results between PA and MS in the outcomes of mortality, stroke, and new pacemaker placement. Nevertheless, while this study is one of the largest published series of tricuspid valve operations of any kind, the numbers are sufficiently small to have low statistical power to detect improvement in low incidence outcomes such as mortality in this population. It is possible that a larger study might yield further significant differences in morbidity and mortality as has been seen with mitral patients [Glower 1998, Glower 1999a, Grossi 2001], particularly in reoperative patients due to avoidance of redo sternotomy [Glower 1999a]. Unfortunately, prospective, randomized trials comparing port access to sternotomy in tricuspid patients are unlikely to be undertaken, leaving the current study as the only available source of data to address this issue.

No previous studies have shown an association between femoral arterial cannulation and stroke, but several studies have shown an association between femoral cannulation and morbidity such as vascular or wound complications [Glower 1999b]. The higher stroke rate with femoral cannulation found in this study might result from embolization of abdominal and descending thoracic debris, but further corroboration of this finding is necessary. Because port access can be applied with central aortic cannulation (as has been the practice at this institution since 1998), any disadvantages of femoral artery cannulation do not limit the port-access technique. The incidence of perioperative stroke has not been documented for tricuspid valve procedures [Kratz 1985, McGrath 1990, Cobanoglu 1993, Duran 1994, Glower 1995]. The 8% overall stroke rate for both sternotomy and port-access patients in this study may reflect the many risk factors of long-standing mitral valve disease, chronic atrial fibrillation, left ventricular dysfunction, and older age present in most patients.

Similarly, few previous studies have found the incidence of new pacemaker implantation to be increased by tricuspid valve replacement instead of repair [Kratz 1985]. This finding could result simply from more significant disease associated with the need for tricuspid valve replacement, or from the fact that tricuspid replacement prostheses require circumferential suture placement closer to the conduction system than with noncircumferential tricuspid annuloplasty techniques.

CONCLUSION

Port access is a new and viable alternative approach to the tricuspid valve in patients not requiring coronary bypass grafting or aortic or pulmonary valve procedures. For tricuspid valve operations, port access yields results comparable to sternotomy but avoids the larger incision and avoids sternotomy. Port access has the drawback of additional procedure time and the need for special surgical instrumentation. Further study is needed to clarify additional specific advantages and disadvantages of port access in tricuspid valve operations, especially in those patients who have previously had median sternotomy.

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