

## SCIENTIFIC LETTER

## Preoperative left ventricular end systolic dimension as a predictor of postoperative ventricular dysfunction in children with mitral regurgitation

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The timing of surgery has been a major problem in the management of chronic severe mitral regurgitation (MR). In adults, because of poor prognosis of postoperative left ventricular (LV) dysfunction, sequential echocardiographic assessment of LV function for optimal operation time is recommended.<sup>1,2</sup> However, in children, therapeutic guidelines of chronic MR are less well defined and severe symptoms are often used as the indication for surgery. Furthermore, report on the change of LV function after mitral valve (MV) surgery is very limited.<sup>3</sup> Therefore we analysed the records of children who had MV surgery for severe MR to evaluate the change of LV function and to identify any potential risk variable for late postoperative LV dysfunction.

## METHODS

A retrospective study was done in 40 consecutive patients (20 boys, 20 girls) who had MV surgery for isolated severe MR. Fourteen patients with residual MR after correction of other cardiac defects were included (atrioventricular septal defects in 10, ventricular septal defect in 3, double outlet right ventricle in 1). Surgery for MR was done after a mean (SD) of 3.9 (3.1) years (range 5 months to 8.4 years) since the previous operation. Fourteen patients had rheumatic MR; 8, congenital isolated MR; 2, Marfan syndrome with MR; 1, endocarditic MR with William's syndrome, and 1, unidentified cause. Mean (SD) age at operation was 9.1 (4.9) years (range 6 months to 18 years). Sixteen (40%) were in New York Heart Association (NYHA) functional class III or IV. Valve repair was performed in 23 (57.5%) patients and valve replacement in 17 (42.5%). All survived and were followed for a mean (SD) of 4.6 (3.4) years (range 6 months to 12 years) after surgery. Three patients with moderate to severe residual MR following previous valve repair had subsequent valve replacement 6, 12, and 14 months after, respectively, and were included in the replacement group.

Echocardiographic LV internal dimensions and shortening fractions (SF) were analysed in each patient: preoperatively (median 12 days, range 1-139 days) and late postoperatively (the most recent available echocardiogram at least 6 months after surgery, median 2.6 years, range 6 months to 8.9 years). The LV dimensions were indexed to the body surface area and expressed as Z score (Z score = observed - expected mean dimension of normal populations/SD of mean).<sup>4</sup>

## RESULTS

Operative complications were complete atrioventricular (AV) block in one patient and transient atrial flutter in three. Residual MR at late follow up was less than mild in all.

The mean (SD) LV end diastolic dimension Z score (LVEDZ), LV end systolic dimension Z score (LVESZ), and LV shortening fraction (LVSF) were reduced significantly at follow up study (preoperative v late postoperative: LVEDZ, 8.9 (5.9) v 2.2 (3.7),  $p < 0.001$ ; LVESZ, 5.8 (4.1) v 2.8 (3.7),  $p < 0.001$ ; LVSF, 0.33

(0.07) v 0.30 (0.07),  $p = 0.001$ ). Late LV dysfunction (LVSF  $< 0.28$ ) was observed in 15 (37.5%), including six symptomatic patients (NYHA functional class II in 4, class III in 2). Preoperative variables were compared between patients with and without late LV dysfunction (table 1). The preoperative LVSF, LVEDZ, and LVESZ were significantly different between two groups and showed good individual correlation with late postoperative LVSF. Multivariate analysis revealed that only LVESZ was an independent predictor of late LVSF ( $p = 0.001$ ) (fig 1). The relative risk of late LV dysfunction according to the preoperative LVESZ  $\geq 6$  was 9.75 (95% confidence interval 2.5 to 37.5). No difference was found between the two groups in regard to age at operation, the preoperative NYHA functional class, cases of previous open heart surgery, and the causes of MR. The patients who had MV replacement had a tendency to have late postoperative LV dysfunction.

## DISCUSSION

Because isolated, significant MR in children is uncommon, surgical experience is relatively limited. Furthermore, mitral valvuloplasty in the young children has evolved slowly and valve replacement is an unattractive option because of the limitations of body size, need for anticoagulation, and expectation for early reoperation as the patient grows. Therefore, in many centres surgery has often been delayed, if possible, until symptoms become evident.

In a study on the change of LV function after surgery in children, LV function became normal late postoperatively in all 32 survivors except one, despite early postoperative LV dysfunction.<sup>3</sup> The authors suggested that surgery could be delayed until the onset of severe symptoms without increased risk for late ventricular dysfunction in children. In our study, however, late LV dysfunction was not uncommon (37.5%, 15/40). Preoperative LV dimension Z scores in our study are much higher than those in the study of Krishnan and colleagues (mean (SD) LVEDZ, 4.0 (3.2); LVESZ, 2.0 (2.1)). This implies that children in their study might have had better preoperative LV functional reserve compared to those in our study. Therefore, we can speculate that there may be a critical point at which LV dysfunction from chronic volume overloading becomes irreversible even in asymptomatic children. Surgery should be performed earlier in these children.

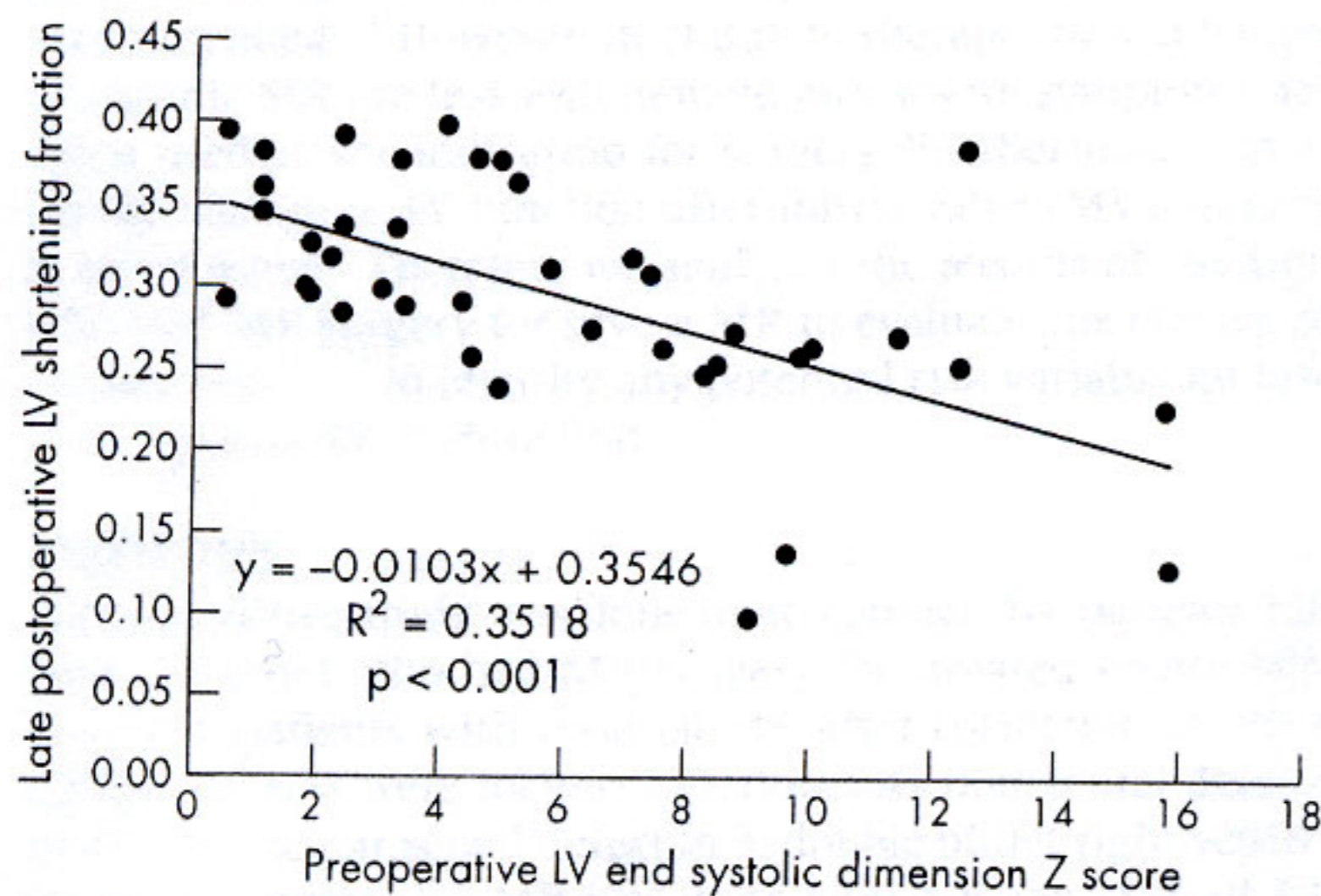
The assessment of LV function in MR is complex because of modified loading conditions, and significant LV dysfunction can be masked even in the setting of normal LV ejection

**Abbreviations:** LV, left ventricular; LVEDZ, LV end diastolic dimension Z score; LVESZ, LV end systolic dimension Z score; LVSF, LV shortening fraction; MR, mitral regurgitation; MV, mitral valve; NYHA, New York Heart Association; SF, shortening fraction

**Table 1** Preoperative potential risk variables: comparison in patients with and without late postoperative left ventricular dysfunction and correlations with late postoperative shortening fraction

Preoperative variables	Postoperative left ventricular dysfunction		p Value	Correlation with late postoperative LVSF	
	Present (n=15)	Absent (n=25)		r Value	p Value
LVSF, mean (SD)	0.30 (0.04)	0.36 (0.07)	0.001	0.47	0.002
LVEDZ, mean (SD)	13.5 (4.6)	6.3 (4.8)	<0.001	-0.45	0.004
LVESZ, mean (SD)	9.5 (3.3)	3.6 (2.6)	<0.001	-0.59	<0.001
Age at operation (years)	9.1 (5.4)	9.1 (4.6)	NS	-	-
Number FC III or IV	8 (53%)	8 (32%)	NS	-	-
Number MVR cases	9 (60%)	8 (32%)	0.08	-	-
Number previous OHS	4 (27%)	12 (48%)	NS	-	-
Number rheumatic MR	6 (40%)	8 (32%)	NS	-	-
Number AVSD	3 (20%)	7 (28%)	NS	-	-

AVSD, atrioventricular septal defect; FC, functional class; LV, left ventricular; LVEDZ, LV end diastolic dimension Z score; LVESZ, LV end systolic dimension Z score; LVSF, left ventricular shortening fraction; MR, mitral regurgitation; MVR, mitral valve replacement; NS, not significant; OHS, open heart surgery; SF, shortening fraction.



**Figure 1** Correlation between the late postoperative left ventricular (LV) shortening fraction and the preoperative LV end systolic dimension Z score.

fraction.<sup>1</sup> The LVESZ is a simple, reproducible echocardiographic parameter that is a relatively load independent measure of LV function, and has been accepted as a good predictor of postoperative LV function in adult.<sup>1,2</sup> Our study shows that the preoperative LVESZ is a good predictor of late LV function in children. The relative risk of late LV dysfunction according to a preoperative LVESZ  $\geq 6$  was high. This indicates that surgery should be considered in children with an LVESZ approaching 6, regardless of symptoms, to avoid irreversible LV dysfunction. If valve repair rather than replacement is likely, an operation can be undertaken earlier with low mortality and a relatively low reoperation rate.<sup>5</sup>

In conclusion, late LV dysfunction is not uncommon in children after surgery for MR, and preoperative LV end systolic dimension may be a good predictor of postoperative LV function. These results should be considered in the clinical decision making process when planning surgery for MR in children.

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#### REFERENCES

- 1 Cooper HA, Gersh BJ. Treatment of chronic mitral regurgitation. *Am Heart J* 1998;**135**:925-36.
- 2 Enriquez-Sarano M, Tajik AJ, Schaff HV, et al. Echocardiographic prediction of left ventricular function after correction of mitral regurgitation: results and clinical implications. *J Am Coll Cardiol* 1994;**24**:1536-43.
- 3 Krishnan US, Gersony WM, Berman-Rosenzweig E, et al. Late left ventricular function after surgery for children with chronic symptomatic mitral regurgitation. *Circulation* 1997;**96**:4280-5.
- 4 Henry WL, Ware J, Gardin JM, et al. Echocardiographic measurements in normal subjects. Growth related changes that occur between infancy and early adulthood. *Circulation* 1978;**57**:278-85.
- 5 Yoshimura N, Yamaguchi M, Oshima Y, et al. Surgery for mitral valve disease in the pediatric age group. *J Thorac Cardiovasc Surg* 1999;**118**:99-106.