

Single-Suture Neochorda-Folding Plasty for Mitral Regurgitation

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The single-suture neochorda-folding plasty technique is a modification of existing mitral valve repair techniques. In the authors' experience, its simplicity, reliability, and versatility make it a useful technique for mitral valve repair, especially when a minimally invasive approach is used.

Key words: 1. Mitral regurgitation
2. Repair
3. Minimally invasive

TECHNIQUE

All three patients described in this report had isolated severe symptomatic degenerative mitral regurgitation (MR), as described in Table 1. This single-suture neochorda-folding plasty technique was performed using a minimally invasive approach via right anterolateral thoracotomy whenever possible.

The patients were placed on their left side in a supine position at a 30° angle, with the right arm slightly flexed to expose the mid-axillary line, and general anesthesia was induced with a single-lumen endotracheal intubation tube. After confirming that the femoral vessels were appropriate for cannulation, a 6-cm incision was made along the fourth intercostal space; all of our patients were male, but the incision could be made along the submammary skin crease in females. Peripheral cannulation through the right femoral artery (16F, 17F, 19F) and vein (23F, 25F) was performed using the Seldinger technique. After the initiation of cardiopulmonary bypass, the pericardium was longitudinally opened 3 cm anterior to the phrenic nerve. After transthoracic aortic

cross-clamping through the third intercostal space, cardioplegic arrest was induced with antegrade cold blood cardioplegia. Following dissection of the interatrial groove, left atriotomy and exposure of the mitral valve (MV) were performed. After careful examination of the prolapsed portion of the MV, a CV5 Gore-Tex suture (W. L. Gore & Associates Inc., Flagstaff, AZ, USA) was placed into the papillary muscle underneath the prolapsed segment as a neochorda. This double-armed suture was then used to fold the prolapsed segment of the leaflet into the left ventricle, creating a smooth, broad and non-prolapsed coaptation surface on the leaflet with preserved mobility (Fig. 1) The area of leaflet folding was decided based on careful testing of the MV with a nerve hook, and the amount of folding was equivalent to the resected area during conventional triangular resection. The length of the neochorda was determined based on adjacent healthy chordae or the length to the adjacent annulus. Ring annuloplasty using a Cosgrove band (Edwards Lifescience, Irvine, CA, USA) was performed in all patients to remodel the annulus and reinforce the repair.

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Received: January 5, 2015, Revised: March 31, 2015, Accepted: April 7, 2015, Published online: February 5, 2016

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Table 1. Preoperative patient data

No.	Age (yr)	Gender	Ejection fraction	New York Heart Association class	Mitral regurgitation	Euroscore II	Location
1	49	M	63	2	+4	0.71	A3, P3
2	50	M	74	2	+4	0.5	P1, P2
3	60	M	60	3	+4	0.56	P1, P2

M, male.

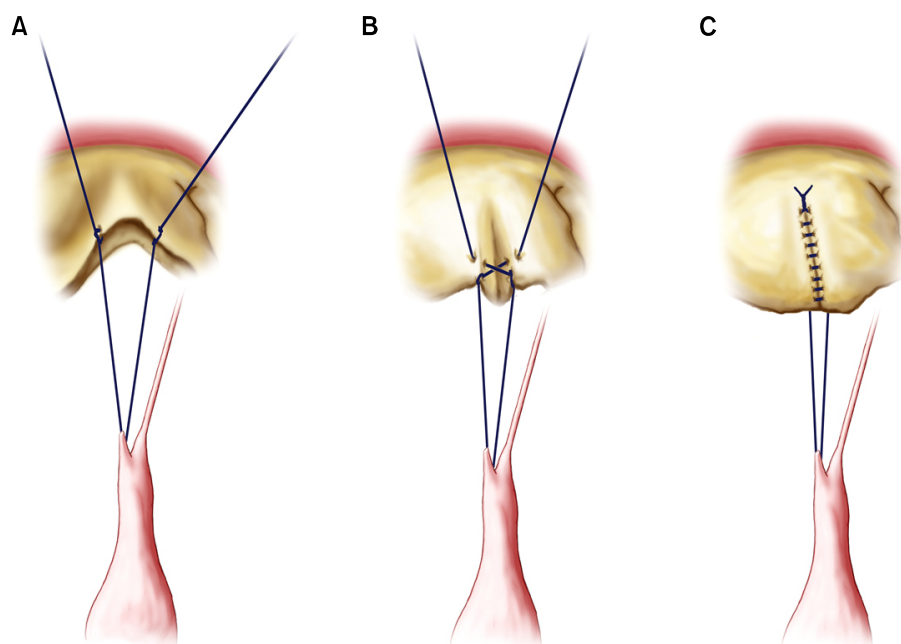


Fig. 1. (A) A CV5 Gore-Tex suture (W. L. Gore & Associates Inc., Flagstaff, AZ, USA) was placed into the papillary muscle underneath the prolapsed segment as a neochorda. (B) This double-armed suture was then used to fold the prolapsed segment of the leaflet into the left ventricle, (C) creating a smooth, broad, non-prolapsed coaptation surface on the leaflet with preserved mobility.

Table 2. Postoperative data

No.	Cardiopulmonary bypass time (min)	Aortic cross-clamp time (min)	Intensive care unit stay (hr)	Length of hospital stay (day)	Ventilation time (hr)	Blood transfusion (unit)	Tube drainage ^{a)} (mL)	Mitral regurgitation	Complications
1	71	48	24	2	0	0	104	0	None
2	84	56	22	3	0	0	217	0	None
3	86	59	22	4	0	0	69	0	None

^{a)}At postoperative day #0.

RESULTS

MV repair with the single-suture neochorda-folding plasty technique described above was successful in three patients, in whom a minimally invasive approach was used. Neither sternotomy conversion nor second cardiopulmonary bypass for further repair was needed. Each patient was extubated on the operating table and recovered without any complications, in-

cluding transfusion. Detailed postoperative data for each patient are presented in Table 2. During follow-up, no residual MR above grade 1 was observed. Moreover, no complications associated with this technique, including mortality, occurred.

COMMENT

Since the introduction of the leaflet resection technique by

Carpentier [1] and the new chorda formation technique by David [2] for the treatment of prolapsed MVs, these techniques have become the gold standard for the treatment of degenerative MR. However, both techniques include complicated processes, such as reattachment of the leaflet following extensive resection and precise measurement of the length of the neochorda. In order to overcome these drawbacks, techniques involving simplified folding valvuloplasty without leaflet resection have been reported [3,4]. Previously reported folding valvuloplasty techniques have several advantages over quadrangular resection, such as reversibility in cases of sub-optimal repair, a simplified technique, the presence of a smooth coaptation surface following repair, and maintenance of the mobility of the posterior leaflet. Most of these folding valvuloplasty techniques were designed to fold the mid-portion of the posterior leaflet (P2 scallop) to the left ventricle, but the remodeled posterior leaflet is not supported by any chordae or is supported by potentially diseased native chordae. Due to concerns regarding the long-term durability of this unsupported P2 scallop and the possibility of systolic anterior motion (SAM) of the MV, a recent publication presented a folding plasty with posterior ventricular anchoring neochordal repair, which provided some additional chordal support. The authors suggested that this technique could ensure a posteriorly positioned, yet functional posterior leaflet devoid of the risk of SAM [5].

Although these techniques have overcome some drawbacks of resection and neochordal formation, previously reported folding plasty techniques are exclusively applicable for P2 prolapse and myxomatous degeneration with severely excessive leaflet tissue. In the current single-suture neochorda-folding plasty, we modified the neochorda to be anchored toward the anatomically oriented head of the papillary muscle. This modification provides this technique with versatility, allowing it to be applied to non-P2 prolapsed disease and in the repair of the early phase of fibroelastic deficiency, which involves a very fragile leaflet.

In recent guidelines, MV repair is considered to be reasonable in asymptomatic patients with chronic severe primary

MR in whom the likelihood of a successful and durable repair without residual MR is $>95\%$, with an expected mortality rate of $<1\%$. Moreover, MV repair using a less invasive approach has gradually become more common. Since longer cardiopulmonary bypass and cross-clamping time, as well as difficulties in the repair procedures, are the most significant drawbacks of minimally invasive MV repair, simpler and more reliable repair techniques are required to overcome these obstacles. In our experience, the current single-suture neochorda-folding plasty technique can facilitate MV repair, especially using a minimally invasive approach.

CONCLUSION

As indicated by our results, the simplicity of the technique presented here is expected to reduce the cross-clamping time, and its versatility extends the indications of the current technique, especially when a minimally invasive approach is used.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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