

CASE REPORT

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# Tricuspidization: repair of a quadricuspid aortic valve

Wenzong Luo<sup>1\*</sup>, Peng Hu<sup>1</sup> and Liang Ma<sup>1</sup>

## Abstract

Quadricuspid aortic valve (QAV) is rare. However, to repair a quadricuspid aortic valve is not as easy to realize as in bicuspid aortic valve. The surgical design is crucial to rebuild the stable structure. Here we present a case of repair of quadricuspid aortic valve using the strategy of tricuspidization.

**Keywords** Quadricuspid aortic valve, Repair

## Introduction

Quadricuspid is extremely rare compare with other morphological abnormalities of the aortic valve such as bicuspid or unicuspid. In recent years, many surgeons are struggling to preserve the aortic valve. We share a case of QAV associated with severe aortic regurgitation and mild aortic stenosis. Repair of the aortic valve was successfully performed.

## Case report

A 58-year-old woman was admitted to our institute because of an occasional chest pain. A diastolic murmur was detected during the physical exams. The transthoracic echocardiogram (TTE) shown a quadricuspid aortic valve with severe aortic regurgitation due to malcoaptation of the leaflets. The left ventricle end systolic diameter was measured as 44 mm while the ejection fraction was 53%. The aortic root and ascending aorta were measured on the pre-operative CT scan: the aortic annulus was 21 mm, the aortic root was 30 mm while the ascending aorta was 39 mm. This young patient denied

mechanical valve. The surgery was then scheduled later on.

In the OR, the morphology of the aortic valve was revealed by the transesophageal echocardiogram (TEE): a smaller accessory cusp was attached to the right coronary cusp (Fig. 1, a and b). The cardio-pulmonary bypass was established by aortic and right atrium. The heart then was arrested by the protection of the del Nido cardioplegia. The ascending aorta was transected, the relationship of the leaflets was carefully analyzed: the left and non coronary cusps were almost intact, good mobilization without any calcification, both effective height were measured to 9 mm by caliper (MSS-1, Fehling Instruments, Karlstein, Germany). As for the right coronary leaflet, a false commissure formed a fused leaflet. The false commissure was released from the aortic wall. The geometric height of the right coronary cusps was measured larger than 18 mm. Thus aortic valve repair was designed by the strategy of tricuspidization. 6 subvalvular fixing points were implanted symmetrically without touching the cusps preparing to stabilize the basal aortic ring. The fused part of the right coronary cusp was resected in triangular fashion using a number 11 blade. The two half cusps were then sutured together using interrupt polyethylene (5–0) in order to minimize the chance of cusp retraction. The effective height of the neo-leaflet was assured over 9 mm. The aortic annulus was measured as

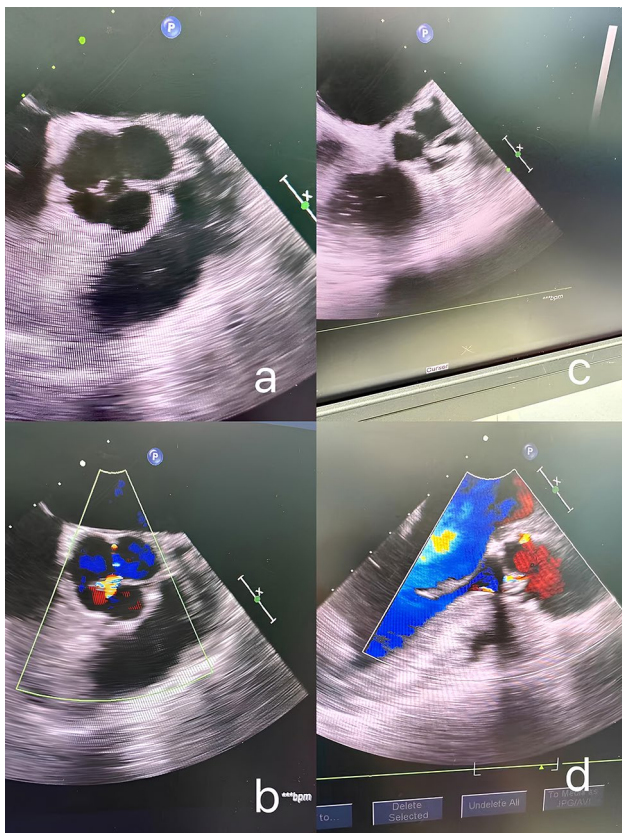
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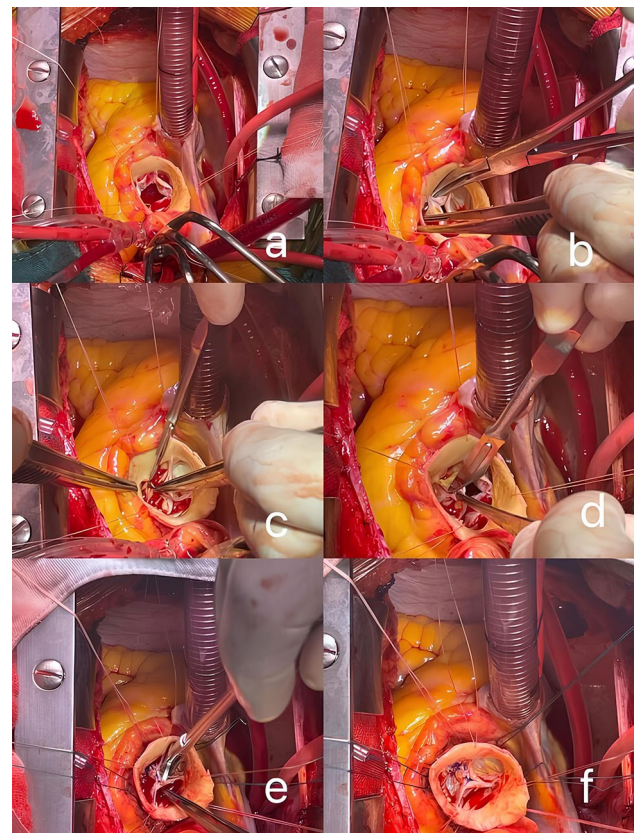


**Fig. 1** Intra-operative TEE found quadricuspid aortic valve with central aortic regurgitation (**a** and **b**) before and tricuspid aortic valve without aortic regurgitation (**c** and **d**) after the surgery

21 mm. A number 20 hegar could freely pass through the aortic orifice. Then the aortic root was dissected carefully to the level of the basal ring, a subcoronary tunnel was created for passing the Dacron ring as annuloplasty. A 2 mm wide Dacron ring (Terumo, Vascutek Limited, United Kingdom) of 28 mm was trimmed, passed through the subcoronary tunnel, rejoined and fixed to the aortic basal ring by the 6 points prepared earlier. (Fig. 2) The aortic incision was closed by two layers running suture of 4-0 prolene. Intraoperative TEE shown that trivial regurgitation of the aortic valve, the aortic annulus was 22 mm, the aortic valve was found tricuspid, the effective height was 10 mm, the coaptation was measured as 6 mm, the peak velocity of the valve was 2.17 m/s, and the mean transvalvular gradient was 11.4 mmHg (Fig. 1c, d).

The patient was extubated 2 h right after the surgery and discharged 6 days after the surgery without complications.

Up to now, her 1 month, 3 months, 6 months and 1 year follow-up shown an excellent cardio-echography result with only mild aortic regurgitation without any stenosis.



**Fig. 2** Principal surgical steps: surgical view of the QAV (**a**); release the false commissure (**b, c**); triangular resection of the fused part of the leaflets (**d**); Effective height was measured as 9 mm by caliper (**e**); neo-tricuspid aortic valve after the correction (**f**)

## Discussion

Quadricuspid aortic valve (QAV) is not common. Different from bicuspid aortic valve, morphologically QAV is more variable. There are two classifications for QAV. Based on the different size of the supranumerary cusp, Hurwitz & Roberts [1] divided QAV into 7 subgroups, among which the first three subgroups, four equal-sized cusps, three equal-sized cusps with one smaller cusp, two relative larger sized cusps with two relative smaller cusps, were found as more frequent types (85%). Nakamura et al. [2] designed another simplified classification by focusing on the position of the supranumerary cusp: type I, supranumerary cusp located between the left and right coronary cusps; type II, supranumerary cusp located between right and non coronary cusps; type III, supranumerary cusp located between the non and left coronary cusps; type IV, unidentified supranumerary cusp as of two equal-sized smaller cusps.

Based on the awareness of the morphological features, our center tried different surgical strategies in treating with QAV. We used to try the strategy of bicuspidization in early years, mid-term result was not so good. The idea of bicuspidization is to suture the two relative

smaller cusps together to form a larger neo-leaflet. However, in case of quadricuspid, there are 4 commissures, real or false. The cusps were retracted to the aortic wall by the commissures, the length of the tissue should be shortened when the commissures were deformed. Therefore, the tension of the neo-leaflets increased under the diastolic pressure. On the other side, the hemodynamics is different in case of quadricuspid, the aortic annulus dilatation was not common. The surgeon has to make plication of the two cusps in order to regain a sufficient coaptation, this can create postoperative aortic stenosis. All these facts potentially contribute to the early failure of the repair. Therefore, tricuspidization may be the preferred technique. In our case, the left and non coronary cusps were intact, which was quite important. Otherwise, precise measurements and delicate movements were also crucial, to eliminate the false commissure and suture the accessory cusp to the neighbor cusp to restore the tricuspid fashion of the valve.

Another consideration is to repair or to replace the dysfunctional valve. As the technique of transcatheter aortic valve replacement evolves, a new conception of lifetime management of the aortic valve becomes a hot topic. In our opinion, to repair a repairable valve means far beyond preserve its function close and open, the native valve has larger efficient open area, more resistance to infections, low incidence of thrombosis and bleeding. Reports of long term outcomes after bicuspid aortic valve repair were encouraging, at 15 years after the repair surgery, the survival was 94.8%, freedom from aortic valve reoperation was 86.8% [3]. As for quadricuspid aortic valve, repair surgeries were reported separately because of its rarity. Therefore, to control the quality of the repair is quite important. More than trivial residual aortic regurgitation when the patient leaves OR is known to be an isolate risk of reoperation in long term consideration. So it is important to check the characteristics of the valve by TEE during the operation. Make sure the coaptation should at least be as long as 4 mm, the residual regurgitation is less than mild, and the diameter of the aortic annulus is less than 27 mm.

## Conclusion

Quadricuspid aortic valve can be repaired under appropriate surgical design and tricuspidization is the preferred strategy.

## Author contributions

Dr. Wenzong Luo did the operation and was the writer of this article, Dr. Peng Hu prepared the figures, Dr. Liang Ma reviewed this article.

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## Data availability

No datasets were generated or analysed during the current study.

## Declaration

## Ethics approval

The ethics approval and consent to participate were done. All of the data and materials that referred to this article were real. Dr. Wenzong Luo was the operator and writer of this article, Dr. Peng Hu prepared the figures, Dr. Liang Ma reviewed this article. All of the authors have no conflict of interest and consent for publication. The patient mentioned in this report signed consent to publish.

## Consent for publication

The patient mentioned in this report signed consent to publish.

## Informed consent

We have obtained the informed consent from the patient.

## Competing interests

The authors declare no competing interests.

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