Despite the loss of cytoplasmic filaments and Z-band disruption, other cytoplasmic organelles like nuclei and mitochondria were well preserved thus differentiating it from myocyte necrosis. Deposition of collagen fibers, the only irreversible change seen in this study, was found mostly in patients with regressed LV. Deposition of large amounts of collagen results in thinned out and stiff LV wall, which can also be substantiated by the echocardiography. Muscle fibers grow in size by addition of sarcomeres both in series and in parallel as seen in physiological hypertrophy. It is important that the number of sarcomeres is regulated throughout life, so that the mean sarcomere length, and hence filament overlap, is optimized for maximum force. This is achieved by addition or removal of sarcomeres in response to any prolonged change of force [13]. Thus, the addition of sarcomeres leading to myocardial hypertrophy as well as disruption of Z bands leading to atrophy, both are reversible processes.

The heart in TGA children is exposed to two adverse factors

1. Chronic hypoxia which leads to mitochondrial dilatation and vacuolation and cytoplasmic fat vacuoles.
2. Decreased LV after-load which leads to loss of cytoplasmic filaments and deposition of collagen. Loss of cytoplasmic filaments being a reversible process, can be restored to normal once optimal loading conditions are attained.

As the age of the child presenting for surgery increases, more and more ultrastructural changes have taken place, which in turn make more time to revert to normal after an ASO, thus delaying their recovery in the postoperative period. Thus, histological features may guide a surgical procedure, but obtaining an LV biopsy before surgery seems practically difficult. One possibility is that during balloon atrial septostomy a small LV biopsy can be taken which may help in decision-making in children with TGA and regressed LV. It is logical to believe that children with TGA who have extensive collagen deposition develop features of LV failure after ASO. However, the critical amount of collagen is yet to be defined and further studies are required to determine that amount of collagen which may herald a prolonged and stormy postoperative course following ASO.

5. Conclusion

We propose that LV regression is a reversible phenomenon associated with histological changes which revert back to normal after the ASO, the time taken for which is directly proportional to the extent of LV regression. Some reports suggest that the upper limit for ASO in children with TGA-IVS can be extended beyond three weeks [6, 7, 14, 15] and also beyond six weeks [8]. Unfavorable LV geometry which was considered to be a contraindication for ASO, is a transient and reversible change and can be managed successfully with pharmacological means and ECMO support. This study highlights the histological basis of reversibility of LV regression in TGA and the encouraging outcome of ASO in this subset of patients.

References


eComment: Re: An electron microscopic study of left ventricular regression in children with transposition of great arteries

Authors: Leo A. Bockeria, Bakoulev Scientific Center for Cardiovascular Surgery, Roublevskoye Sh. 135, 121552 Moscow, Russian Federation; Alexey I. Kim

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Late diagnosis of transposition of the great arteries causes regression of the left ventricle (LV), which is manifested by some ultrastructural changes. The study demonstrates that some of them can be restored to normal [1] but performing late arterial switch operation (ASO) delays restoration and thus postoperative recovery. However, there are no conclusive criteria to evaluate the LV regression before surgery. In this situation, a biopsy remains the most reliable method. The main problem is the need for express biopsy for intraoperative assessment of the LV functionality. This will determine the surgical strategy and can be initially applied on integrated extra-coroporeal membrane oxygenator-
cardiopulmonary bypass circuit, as was required in five of seven patients in the study. Regression of the LV is the consequence of low resistance and systemic hypoxemia. The presented approach allows determination of the level of LV regression and predicts the follow-up. Application of the method described and further development of biopsy techniques can predict indications for ASO and improve the results.

Reference