The Atrial Level Switch Operation: Lessons Old and New

Running title: Tweddell; Lessons learned from the atrial switch operation

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The atrial level switch operation was a breakthrough in treatment of individuals with D-transposition of the great arteries (D-TGA). The Senning and Mustard procedures were widely performed in the 1970s and into the 1980s, they relieved cyanosis and established an in-series circulation. It could be argued that the Mustard/Senning procedures heralded the era of radical correction of complex congenital heart disease. In this issue of Circulation, Vejlstrup and colleagues summarize the entire experience with atrial level correction of D-TGA in Sweden and Denmark. The story is remarkable from an historic perspective and provides a window into the early years of congenital heart surgery but there are also important lessons for the current era not just related to transposition corrected with a Mustard/Senning procedure but also regarding congenital heart surgery in general. From this experience we can learn from the lessons of: access to care; transparency as well as the limits of physiologic correction of transposition of the great vessels and the systemic right ventricles.

Most surprising was the finding that the majority individuals with transposition did not undergo a Mustard/Senning procedure. Based on epidemiologic data the authors estimate that less than half of affected individuals underwent surgical correction. The Mustard/Senning procedure was not performed in the neonatal period and enlargement of the atrial septal defect was necessary to improve saturations until corrective surgery was performed generally between 1 and 3 years of age. Certainly one could imagine that diagnosis and access to atrial septectomy/septostomy may be challenging in large countries with remote populations especially during the winter. The message for the current era is the benefit of prenatal diagnosis combined with immediate access to treatment for individuals with complex congenital heart disease.

The mortality for the Mustard/Senning procedure in Denmark and Sweden was 20% in addition the authors found a high variability in outcome between centers. The mortality is higher
than single center series and due in part to publication bias. It is likely that the complete follow-up available in Denmark and Sweden provides a “real-world” picture of the learning curve and outcome of the Mustard/Senning procedures. The authors correctly point out that the high variability of outcome between centers would not be well tolerated today. In the current era multi-institutional registries such as the Society of Thoracic Surgeons Congenital Heart Database provide “real-world” results for our current surgical strategies. Transparency of results combined with public reporting could provide realistic expectations as well as identify underperforming centers. Combined with a collaborative, non-punitive approach underperforming centers could benefit through knowledge transfer and identification of inadequate resource allocation.

This is the largest series of long-term follow-up of the Mustard/Senning procedure. In contrast to other large series of atrial switch procedures there does not seem to be a survival advantage to the Senning operation. The authors found that era of surgery and the presence of associated defects impacted early survival but after the early postoperative period the survival curves are remarkably parallel. Only implantation of a pacemaker was associated with decreased late survival and is probably a reflection of worsening systemic right ventricular function. The lack of additional factors impacting survival itself demonstrates that long-term outcome of individuals undergoing the Mustard/Senning procedure is dependent on systemic right ventricular function and reflects the limits of physiologic correction. The survivors of the Mustard/Senning procedure will disappear in the next decades but we will continue to care for individuals with systemic right ventricles including those with corrected transposition and an increasing single ventricle population. This analysis by Vejlstrup and colleagues shows us that our efforts should be targeted at preserving systemic ventricular function. We can continue to
learn from this population, particularly the relationship between systemic right ventricular function and the development of tricuspid regurgitation as well as the trajectory of right ventricular failure compared to left ventricular failure.

The paper by Vejlstrup and colleagues provides an historic look at early efforts at the treatment of individuals with transposition. Within this experience are lessons and challenges that apply to us today and into the future.

**Conflict of Interest Disclosures:** None.

**References:**


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