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Outcomes after corrective surgery for congenital dextro-transposition of the great arteries using the arterial switch technique: a protocol for a scoping systematic review

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ABSTRACT

Introduction: Dextro-transposition of the great arteries (d-TGA) is a life-threatening congenital health defect that requires rapid surgery. The most widely used approach is the arterial switch operation (ASO) developed by Jatene in the 1970s. The first set of children who received this intervention are now adults. The objective of this scoping review of the literature was to document the short-term (less than 1 year), medium-term (1–20 years) and long-term (more than 20 years) outcomes in children who underwent the ASO. Our primary income is survival, but we will explore other secondary surgical, cardiovascular, reproductive and quality-of-life outcomes.

Methods and analyses: Using a systematic scoping review approach, we will conduct a systematic search of the published literature for experimental and observational studies published on children who received the ASO intervention for classic d-TGA. We will search MEDLINE, Excerpta Medica Database (EMBASE), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Literatura Latino Americana em Ciências da Saúde (LILACS) from 1973 (date of the first successful ASO) to February 2014. Identified articles will be screened in duplicate and full text for selected articles will be retrieved. Data extraction will be carried out in duplicate. Discrepancies will be resolved by consensus or by consulting a third author. Where possible, proportions will be pooled using the inverse variance method. Our findings will be reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Meta-analysis Of Observational studies in Epidemiology (MOOSE) guidelines.

Ethics and dissemination: The results of this paper will be disseminated as peer-reviewed publications, at conferences and at clinical rounds. Our findings may answer important questions for surgeons who perform the ASO intervention and for clinicians who take care of patients after surgery and throughout their lifespans.

Trial Registration number: Prospero/CRD42014007590.

Strengths and limitations of this study

- One strength is our comprehensive and exhaustive search strategy.
- Another strength of this study is the novelty of the research question: the first set of children who received the arterial switch operation (ASO) are now entering late adulthood.
- One limitation is that it is unlikely that we will find experimental studies.

INTRODUCTION

Dextro-transposition of the great arteries (d-TGA) is a rare but severe congenital heart defect. It affects 5 in 10 000 live births in the USA. If left untreated, it is the first cause of cardiac-related death in newborn babies and infants.[1]

In this condition, the two main arteries (the pulmonary artery and the aorta) leaving the heart are switched or transposed. Under normal circumstances, systemic blood from the rest of the body enters the right part of the heart and is pumped to the lungs for oxygenation through the pulmonary artery. From the lungs, this oxygenated blood enters the left part of the heart and is pumped to the rest of the body through the aorta. In children born with TGA, the systemic (non-oxygenated) blood is pumped back to the rest of the body without oxygenation. Non-oxygenated blood is insufficient to support the body's oxygen demands, making this condition rapidly fatal without intervention, unless there is enough intracardiac and extracardiac mixing and mild obstruction to pulmonary blood flow.

Infants born with d-TGA most often present with symptoms in the first few hours

after birth, as the ductus arteriosus closes. Currently, the diagnosis of congenital heart disease is frequently carried out during fetal life, which facilitates arrangements for delivery closer to a paediatric cardiac care centre. d-TGA seems to occur more often in Caucasian babies than others.[2] Definitive management of d-TGA is surgical. The procedures employed have evolved over the years, from 'physiological' corrections to more stable 'anatomical' corrections. In 1973, Jatene *et al*[3] conducted and reported the first case using the arterial switch operation (ASO) or technique which provided anatomical correction. It proved to be a superior alternative to the 'physiological' corrective techniques employed in the previous years which were associated with risks of dysrhythmia, tricuspid insufficiency and right ventricular failure, along with pulmonary or systemic venous channel obstruction. Since then, this technique has become the standard management for d-TGA.[4] The ASO is not without limitations. It can be technically challenging and even more so in children with complex TGA anatomic substrates, where this operation may not even be indicated.[4] Despite the challenges, early and late postoperative outcomes for ASO are excellent.[4–7] Abnormal neurological development has also been noted in some patients.[8] Given the above, it is unlikely that the ASO will be compared with any of the older techniques in a trial, as it would be unethical to randomise children to suboptimal care.

Over the years, as the first set of babies who received this intervention are in their mid-40s, a significant amount of literature has been published. There has also been significant improvement and refinement in the technique, which reflects in better outcomes as the specialists 'learnt' the new technique.[9] It is necessary to summarise the short-term, mid-term and long-term outcomes for this widely used technique.

The purpose of this review was to inform surgeons, clinicians, policymakers and researchers on the outcomes associated with the ASO. The objectives of this review were to document the short-term (less than 1 year), medium-term (1–20 years) and long-term (more than 20 years) outcomes in children who underwent the ASO.

METHODS AND ANALYSES

We will adopt a systematic scoping review approach. This differs from the standard systematic review approach in that we do not seek to answer a specific research question, but rather to appraise a broad body of evidence, identify gaps in knowledge and make recommendations for practice and research.[10]

Criteria for including studies in this review

Types of studies

Experimental (randomised and non-randomised) and observational studies (longitudinal, cross-sectional and systematic reviews) will be considered. For inclusion, the ASO must be described either exclusively or in comparison with another intervention, at least one short-term (less than 1 year), mid-term (1–20 years) or long-term (20 years to end of life) outcome must be assessed at follow-up; and the follow-up period must be at least 1 year.

Studies that describe the ASO as corrective therapy for patients experiencing complications of a prior atrial baffle operation will be excluded.

Types of participants

We will include studies with children born with classic d-TGA (atrioventricular concordance and ventriculoarterial discordance, with intact ventricular septum or a ventricular septal defect (VSD)) diagnosed before or at birth. We will include papers reporting the usual form of heart with transposition of the great arteries, including the following descriptors: heart in the left chest, usual atrial arrangement (situs solitus), morphologically right ventricle if on the right side and the morphologically left ventricle is on the left side, with right-hand topology or ventricular d-loop, the aorta anterior and to the right of the pulmonary artery (atrioventricular concordance and ventriculoarterial discordance).

We will exclude papers focusing on children with 'corrected' transposition of the great arteries (atrioventricular and ventriculoarterial discordance), double outlet right ventricle with subpulmonary stenosis; visceral heterotaxy and ambiguous atrial situs, right or left atrial isomerism, dextrocardia and situs inversus totalis and superoinferior ventricles. The heart with 'corrected' transposition or l-TGA represents a completely different heart from the ones with d-TGA, which are the focus of our study. L-TGA hearts have the morphological right ventricle on the left side pumping oxygenated blood to the aorta and the morphological left ventricle on the right side pumping less oxygenated blood to the pulmonary artery. The main reasons for exclusion of reports on children with heterotaxy and ventriculoarterial discordance are related to the more complex anatomical malformations and haemodynamic consequences for the patients, who require a more complex type of surgical repairs or palliation.

Interventions/exposure

The intervention/exposure of interest is ASO with or without the Lecompte manoeuvre, with or without VSD closure, atrial septal defect or patent foramen ovale closure and ductus arteriosus ligation. Catheter balloon atrial septostomy (BAS) is usually performed in patients with poor mixing and significant desaturations after birth, to allow for weaning from prostaglandin and ventilator support. We will include patients who did or did not have the BAS procedure.

The following interventions will be excluded:

- The atrial switch operations (Mustard and Senning)[11];
- The Rastelli operation[12];

- Complex d-transposition or its repair operations ('réparation à l'étage ventriculaire' and Nikaidoh procedures)[13 14];
- Interventions for l-transposition, double outlet right ventricle with subpulmonary VSD.

Outcomes

Our primary outcome is:

- Survival rate.

Our secondary outcomes are:

- Reoperations (cardiac surgery within the first year)
- Early mortality (<30 days postoperatively)
- Late mortality from cardiac cause (>30 days postoperatively)
- Aortic insufficiency
- Pulmonary stenosis
- Coronary anomaly
- Perfusion defects
- Neuropsychiatric development
- Obesity or metabolic syndrome
- Other cardiovascular risk factors, such as obesity, smoking, alcohol, exercise capacity, substance addiction, diabetes, etc
- Employment/insurability
- Pregnancy outcomes in women
- Quality of life (as reported by authors).

Search strategy for identification of studies

We will conduct an exhaustive search for published studies in all languages reporting the outcomes of children who underwent the ASO.

Electronic searches

We will search MEDLINE, Excerpta Medica Database (EMBASE), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and LILACS (Literatura Latino Americana em Ciências da Saúde) from 1975 (date of the first successful ASO) to May 2014. The following search terms and their MESH equivalents will be used in various combinations: ASO, arterial switch procedure, Jatene procedure, transposition of the great vessels, transposition of the great arteries, complete transposition, simple transposition, dextro-transposition, d-transposition ventriculoarterial discordance, discordant ventriculoarterial connection, intact ventricular septum, heart septal defects, outcomes. Box 1 is a proposed search strategy for MEDLINE via Ovid.

Reference lists

The reference lists of relevant citations will be searched for articles of interest.

Grey literature

Authors, experts, research organisations and foundations will be contacted for any relevant material.

Box 1 Proposed search strategy for Ovid

Database: Ovid MEDLINE(R)
Search strategy:
1. arterial switch operation.mp.
2. arterial switch procedure.mp.
3. jatene.mp.
4. exp 'Transposition of Great Vessels'/
5. transposition of the great arteries.mp.
6. complete transposition.mp.
7. simple transposition.mp.
8. dextro-transposition.mp.
9. d-transposition.mp.
10. ventriculoarterial discordance.mp.
11. discordant ventriculoarterial connection.mp.
12. intact ventricular septum.mp.
13. exp Heart Septal Defects, Ventricular/
14. lecompte.mp.
15. outcomes.mp.
16. 1 or 2 or 3
17. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
18. 16 and 17
19. 18 and 'Humans'.sa_suba.

Data collection and analyses

Screening

Two authors (LM and DF-K) will independently screen citations and abstracts for relevance. Duplicate citations will be removed. Full text for relevant articles will be downloaded for a second round of screening if the study meets our inclusion criteria. Article eligibility will be evaluated using a pretested form. Arbitration for disagreements will be carried out by consulting a third author (RD or LT). In the event that the reports are unclear, the corresponding authors may be contacted for clarification or missing information. Corresponding authors will be contacted in the following circumstances: (1) if the report does not permit us to decide whether it should be included or excluded from our review; (2) if reports are ambiguous and may be subject to multiple interpretations; or (3) if data relevant to our review were collected but not reported.

Data extraction

Data extraction will be conducted independently in duplicate by LM and DK. Data such as study design, setting, participant characteristics, duration of follow-up, details of surgery and outcomes will be included in the data extraction form.

Assessment of methodological quality

Two authors will independently appraise the methodological quality of the included studies. Randomised trials will be appraised using the Jadad scale,[15] while non-randomised/observational studies will be appraised using the Newcastle-Ottawa scale,[16] and systematic reviews will be appraised using the Assessing the

Quality of Systematic Reviews (AMSTAR) criteria.[17] Discrepancies will be resolved by consensus and by consulting a third author (LT or RD) if no consensus is reached.

Agreement on screening, data abstraction and methodological quality will be measured using the κ statistic.[18]

Analyses and reporting

For randomised trials, only data from the intervention arm (ASO) will be used. If the randomised controlled trial is comparing different technical aspects of the ASO procedure, outcomes from both arms will be used. For outcomes reported as rates or proportions, a pooled estimate of the proportion will be estimated by weighting the studies according to their sample sizes (inverse variance). When inconsistency is high (I^2>75%), we will report a random effects meta-analysis of proportions. For similar continuous outcomes measured on the same scale, the mean difference (SD) will be reported. If the scales are different or not readily convertible (eg, length of time), we will report the standardised mean difference. Survival curves will be pooled by meta-analysis of failure-time data.[19] Data will be analysed using Statistical Analysis Software (SAS) V.9.3 (SAS Institute, Cary, North Carolina, USA, 2009). Our findings will be reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and Meta-analysis Of Observational studies in Epidemiology (MOOSE) guidelines.[20 21] Narrative synthesis will be conducted when statistical data pooling would not yield meaningful results, for example, in the presence of considerable clinical heterogeneity or irreconcilable outcome measures.

DISCUSSION

A rich body of literature is developing on the outcomes in children who received ASO.[4–8] This literature is going to continue growing as the first set of children who received this intervention get older. In this review, we will answer important questions related to their survival, quality of life and other risk factors which arise as a result of their surgery. These findings will have implications for surgeons who perform this intervention and for clinicians who take care of patients after surgery and throughout their lifespans. For the many interventions in paediatric cardiac surgery in which it is inappropriate or unethical to conduct randomised trials,[22] an objective summary of reports may be the best available source of evidence.

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Contributors AC, LT and RD conceived of the study. All authors revised the research question, and provided content to the design. All authors read and approved the final version of the manuscript.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The results of this paper will be disseminated as peer reviewed publications, at national and international conferences and at clinical rounds.

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Correction

Mbuagbaw L, Forlemu-Kamwa D, Chu A, *et al*. Outcomes after corrective surgery for congenital dextrotransposition of the great arteries using the arterial switch technique: a protocol for a scoping systematic review. *BMJ Open* 2014;4:e005123. The surname of the last author of this paper was misspelt; the correct spelling is 'Rejane Dillenburg.'

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