The congenital heart disease

Does an Exercise Program following Cardiac Surgery for Congenital Heart Defects improve a Child's Cardiopulmonary Response to Exercise and Increase Exercise Tolerance?

Introduction

Paediatric Cardiac Problems are prevalent throughout the world with 1. 5 million new cases diagnosed each year. Congenital Heart Disease (CHD) is the most common diagnosis of heart problems at birth. Between four and nine per one thousand live births each year are diagnosed with the condition (Draper 2008). In 2007, 989 live births were recorded of babies with cardiovascular abnormalities (National Statistics 2007). Congenital Heart Disease is an umbrella term which encompasses all heart defects that are present when a child is born. The child may have one or multiple defects at birth which can either be detected by a scan ante-natally or are diagnosed soon after birth. Although the diagnosis of CHD is now becoming easier, some diagnoses of the condition do not happen till later on in life. Statistics show that around 60% of congenital heart disease are diagnosed in babies aged from birth to one year, 30% in children aged one to fifteen, and 10% in adulthood (16 years and over) (BHF 2003). Many common conditions include a Ventricular Septal Defect (VSD), an Atrial Septal Defect (ASD), Pulmonary Artery Stenosis, Tetralogy of Fallot (TOF) (Fig. 1) and Transposition of the Great Arteries (TGA) (Fig. 2).

Congenital Heart Disease is now not just a problem of the child, many people with the condition are now living into adulthood. It is predicted that by 2010, 185, 000 people will be living in the UK with CHD (Deanfield (BHF) 2003). Treatment for Congenital Heart Conditions has changed rapidly over the last

50 years. Now surgical management is needed in most cases however some defects will either resolve themselves or require medication. Surgical treatment has changed in recent times, fewer patients are requiring open heart surgery and more are receiving a catheterisation technique. Around 3, 100 operations and 725 interventional cardiac catheterisations are performed each year on babies and children with CHD (BHF 2003).

The effects of surgical interventions on cardiopulmonary function have been thoroughly researched in the past. The studies have concluded that surgery does improve lung and cardiac function and reduces secondary complications (Picchio 2006).

Exercise is widely known as the best treatment for most musculoskeletal problems but its effects on the cardiopulmonary system has only recently been researched into (Cullen 1991). Pulmonary and Cardiac Rehabilitation have now been shown to have an effect in adults but the research into paediatric rehabilitation classes is not widely known about.

Other studies have looked at exercise training or a cardiac rehabilitation programmes following surgery and the effect of this on the patient’s exercise tolerance. I am going to use this review to assess these studies which look at both cardiac rehabilitation programmes and also levels of exercise tolerance following surgery. I want to discuss whether there are any gaps in the knowledge base surrounding the effects of exercise in cardiac surgery of paediatrics. I also want to conclude whether the assumption that exercise is positive, can be correctly justified.

Method

After deciding a topic I was able to start researching into the background area of paediatric cardiology. I started by using a combination of terms including, Exercise, Sports, Physical Activity, Paediatrics, Children, Post-Cardiac Surgery, Congenital Heart Disease, Congenital Heart Defects and Cardiac Rehabilitation. The search pages I found highlighted articles of relevance and then I used the link to related articles to find the studies (see appendix 1). I also searched on individual journal websites including, Paediatric Cardiology and Cardiology in the Young. I used databases such as Pubmed, Medline, Ovid, Sciencedirect and Springerlink to read abstracts of articles and decide their relevance to my review. I then selected the most relevant and used excel to compile a table where I could easily see the differences in the studies under headings (see appendix 4).

The studies I am looking at are all based on paediatrics and are randomised controlled trials dating from 1981 to 2009. Although some of the studies are nearly thirty years old, they hold some strong evidence compared to present day studies and therefore I have not discounted older studies from this review.

Other reviews have assessed whether exercise has an impact on cardiopulmonary performance and have been shown that an exercise rehabilitation class does provide benefits in cardiopulmonary performance and exercise capacity. Some of the studies that are being reviewed however are concluding with insignificant findings. The reviews have stated that research lacks long-term effects of training and also a clear understanding as to which exercise type is best (Tomassoni 1996). In this review I will try look

at newer studies and see if the areas of knowledge that were found to be omitted after previous reviews have now been researched into.

Review of Studies

Firstly I am going to discuss the testing of the participants. All of the studies completed two exercise tests to assess the participant's ability before and after either the cardiac rehabilitation program or surgery. Exercise testing is very difficult to reproduce. Many studies have problems with ensuring the test is accurate and reliable and many struggle, causing results and testing to be different and therefore not comparable. If the results are not accurate and cannot be compared to other studies the results can cause a change in average results and therefore may mislead readers into a false positive result.

Each of the studies used either a treadmill test or a cycle ergometer to test their participant's cardiopulmonary function and exercise tolerance. Using these two tests is the most common technique of testing function as it is very reliable. (Washington 1994) All studies used a specific protocol outlined in the Washington Guidelines with all of the studies using a treadmill test with five of the thirteen studies using Bruce's protocol. Bruce's protocol is where the grade of exercise is increased every 3 minutes until the participant has reached their maximum capacity and cannot continue. The bicycle ergometer tests are where the participants are required to cycle continuously at approximately 50-60rpm where the grade of exercise is increased by 10-20 watts/ minute every three minutes. This is also completed until the participant can no longer continue (Washington 1994).

Exercise testing using a treadmill or a cycle ergometer causes problems because the task they are undertaking in the test are is not functional and do not relate to daily tasks. Running and cycling is functional but not to that grade of exhaustion. Many children normally will stop an exercise when they are tiring and will never push themselves to the level that these exercise tests are pushing them. The tasks are also not fun for the participants and I feel that it should be fun otherwise children will get bored. This is the same with the intervention as well and the programmes should be child orientated and individual to each child.

Outcome Measures are the basis to the results of a study and therefore its effectiveness. A lack of certain outcome measures may show large flaws in a study as many can be used to assess different parts of function and physiological activities. In the studies looking at the effects of cardiovascular surgery, there were a limited number of outcome measures that were looked at. Sarubbi (2000) only looked at heart rate and blood pressure as outcome measures and this limits results. The main outcome measures were heart rate, blood pressure and maximum work rate in all the studies. These outcome measures although very limited are values that help us to understand cardiovascular activities. Other helpful measures would have been oxygen saturations, which only Rhodes' studies (2005/6) looked into. Saturations are helpful to assess whether a change in heart rate or blood pressure affects saturations or whether a change in these may be due to a ventilation problem. (Rivers 2001)

The outcome measures of the cardiac rehabilitation studies are all different but all have similarly looked at exercise capacity after the intervention. This

is shown by all the studies using VO2 as a measure and that all the participants improved their VO2 maximum to allow for a greater exercise capacity. The only study that did not prove an increase in VO2 max was Goldberg's study (1981) which only showed an improvement in maximum work rate. This could have been due to the date in which the study was undertaken. This was one of the earlier studies done in 1981 and therefore technology may not have been as accurate or as reliable as some of the later studies done since 2000. However Goldberg's study was the one that had the most intervention time of all the studies with exercise of up to 45 minutes completed on alternate days with a strict regime to increase grade of exercise over the 6 weeks. This leads me to believe that maybe it was inappropriate testing or inaccurate technology that changed the results of the study as previous reviews have shown that an increase in exercise time has shown to have positive effects on health. As technology has developed since the early eighties, this may be why more accurate testing is used and therefore making results more positive to the outcome we wish.

Another problem in trials of this sort is compliance. Compliance is always an issue when completing studies (Burke 1997). Initially recruiting people to participate is difficult and many people with either choose not to participate or may drop-out early in the study. Many people will not participate because of exercise testing being too invasive or because of geographical implications as the distance to the base of the study being an issue. Some of the studies had large drop-out rates with almost 30% decrease in patients initially viable for the treatment plan and those who undertook the tests in the study (Arvidsson 2009). I think this could be explained by that the

studies involved child participants that are less compliant to long term programmes and who tire easily to an activity. Also due to the nature of the surgery that they have all completed, many parents will be protective over their children and be pushing the participant's exercise tolerance will make many parents worried about their child's health. Much of this can be avoided by specifically explaining the procedures and answering any questions that the parent or participant may have to educate them that this a treatment plan and is not going to hinder their child's recovery or health.

Also intervention time is a major issue when looking at trials. Some may be days long and others have follow-ups of years once the intervention has finished. The studies that focus on Cardiac rehabilitation all have various time scales of their intervention with the shortest program being six weeks (Goldberg 1981) and the longest around twenty weeks (Opocher 2005). The difference in timescale and the different number of sessions that the participants attend makes it difficult to assess whether it is the content of the program that affects the patients or whether just exercising over a longer, more sustained period of time effects the participants in the same way. I think studies that look at different contents of treatment programmes but have a fixed intervention time may be beneficial in deciding the aim of this review.

When looking at the studies, all of the cardiac rehabilitation programs only assess the patients exercise performance straight after the program and only one study looks at the effects of the program long term. Rhodes et al 2005 firstly looked at the immediate effect of a cardiac rehabilitation program and then in 2006 did another study looking at the same participants

of the previous study six months after the original program. The studies that look at exercise capacity before and after surgery also do not look at the effects of the cardiovascular system in response to exercise on a long term scale. Long term effects are the best indicator to say that function and exercise capacity has improved (Miller 2005).

Sociodemographics of the subjects in a study are also important to review as to its involvement in accuracy of results. Different age ranges or male to female ratios cause studies to be inaccurate in trying to generalise the population group. Many of the studies had a very large age range within their participant groups with the largest difference being 17. 6 years in Marino et al's study in 2005. I feel that the exercise difference between a seven year old is very different to that of a twenty-four year old. I feel that a large age range is used to increase subject numbers. Male: Female ratios are also important and that a large majority in these studies had male participants. The biggest ratio of male to female was in Opocher's (2005) study where there were nine male participants and only one female participants. The best ratio of male: female was either Moalla (2006) study with 44 males and 39 females. This is important as I believe men and women react differently to exercise.

Subject numbers is also a large problem with these studies. Due to most of the studies only looking at the children that have had surgery in their trust or hospital they have decreased their subject numbers and none of the studies look at the effects on large number of subjects on a national scale. The studies that looked at cardiac rehabilitation all have subject numbers under 16 which is a very big limitation. The only studies that have larger numbers

are the ones that look at exercise capacity after surgery. By having participants that are only from the immediate area of the study base also means you do not get a generalised view of everyone nationally and you may not cover different children from different backgrounds socially and economically and so may have different attitudes to rehabilitation, treatment and self-management.

Studies with participants that are not generalised to their population group can therefore produce a bias result to that specific population group. Also having different backgrounds of participants is important in assessing their compliance and what individual exercise programme they should be given. Having a specific age range is particularly important as many of the subjects may be inappropriate for the programme due to their age. Some of the subjects may be too young and using subjects that are under six years old would be inappropriate due to the subjects being too young to understand the instructions of the study. Using older subjects may also cause different results as their bodies have had longer to regain independent function and the body has had time to compensate for a lack in cardiopulmonary function. I think it is important to keep variables as succinct as possible and trials should be able to based on one variable alone and truly work on whether surgery or exercise has an effect on that variable independently.

Effects of Cardiac Rehabilitation

The studies looking at cardiac rehabilitation all have an exercise programme set up for their patients either at home (Moalla 2006) or in an outpatient setting (Ruttenberg 1983). These sessions ranging in therapy time from one hour alternate days to one hour once a week, all show an increase in either

cardiopulmonary performance or in exercise tolerance. This shows that a rehabilitation programme is appropriate for these patients and does have a positive effect on the participant's life. Rhodes' studies (2005/6) had the greatest effect on the patient's final outcome. Not only did most of the testing result in significant effects but the large range of outcome measures used means that we can assess not only the cardiovascular performance of the participant but also look at the pulmonary effects of the exercise and their effects of the heart and the cardiac system.

What we can also see from this review is that the cardiac rehabilitation programmes are becoming more significant in results as the studies get newer. This is a good indicator that current programmes are being effective in their rehabilitation (Opocher 2005, Rhodes 2005/6, Moalla 2006) and that newer techniques and more knowledge on exercise has lead to better run classes which not only improve results more consistently than the older studies and that the effects from an initial programme can also be maintained for 6months after intervention (Rhodes 2006).

Effects of Cardiovascular Surgery

Two of the studies looking at effects of surgery only have exercise testing after the surgery. The study by Arvidsson only used the number of sports sessions a week that the participant goes to after the surgery. Therefore a direct comparison between their before and after the surgery ability cannot be done and so the study is only looking at their sports participation after surgery and not the effects of the surgery. However these studies do show that after surgery children's exercise tolerance increases to the level that

healthy participants are achieving (Zaccara 2003) and they are participating in equal amounts of sports participation following surgery (Arvidsson 2009)

Future ideas

In future studies, long term effects of cardiac rehabilitation should be researched, with a follow-up test of a least a year after their rehabilitation to see if the participant is now more active. I also think a control group should be used in the study to look at the effects of non-surgical patients that also participate in cardiac rehabilitation. This is to assess whether the improvement seen during cardiac rehabilitation is not just a response to any exercise and that if a child went back to normality and participating in sports then they will just be as exercise tolerant as children who do not have CHD. Also I would suggest that an exercise programme for the patients that is more functional but also fun and exciting for the patient should be used to increase compliance and also enjoyment for the participants and their parents.

Conclusion

In conclusion, Cardiac surgery is a commonly used form of reducing congenital heart defects and has been shown by these studies that the surgery does have an improvement on the patient’s cardiopulmonary performance. I have also found that a cardiac rehabilitation programme is beneficial for paediatric patients after cardiac surgery for congenital heart defects.

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