Partial Venticulectomy for Diameter Heart Surgery

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Abstract

This most innovative surgical approach derives from the evaluation of the impact of the physical low of Laplace on ventricular wall stress and contraction. A cubic relationship between the cavity radium and the muscular mass is assumed as mandatory condition to maintain heart compensation. This theory is confirmed by comparative anatomic studies of different animal hearts, by laboratory experimentation and by computer model calculations. During the last two years, a quite extensive clinical experimentation has been carried on by the proponent surgeon. More selected experiences have been initiated in some centres of South and North America and more recently in Europe. Precise information about its results in stratified groups of patients are needed to assess the value of the procedure as simple and cheap alternative to more complex and expensive approaches. In western developed countries, good experience and facilities for heart transplantation tend to restrict the selection of patients for heart diameter surgery to patients who have heavy contraindications for it. In severe dilated cardiomyopathy, the original technique has been recently modified by mitral valve replacement, allowing enlargement of ventricular resection to include the papillary muscle area. A prophylactic anticoagulant and an anti arrhythmic therapy may improve the present quite high overall mortality.

Key words: dilated cardiomyopathy, partial ventriculectomy, diameter heart surgery, Batista cardiomyoplasty, surgery of end-stage heart failure.

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take into account size (Figure 1). If by computer graphics snake heart is increased and the buffalo heart is decreased, it became very difficult to distinguish which is which: the ratio mass/diameter is the same. By examining all hearts in nature, from snake to whale, all of them have the same mass/diameter ratio. Is the formula to calculate the volume of a cube different from that of a bigger or smaller cube? No the formula is only one to all them. Lets go back to our high school years. I worked that time in a farm and so I remember that the front wheel of a farm tractor has 30 pounds of pressure. The back wheel of the same tractor which have a much bigger diameter only has 5 pounds. Indeed with 30 pounds it will burst. Why? The reason is that the front wheel has a small diameter while the back is much bigger. The back wheel looks thinner in section, but it is not, it is bigger; if you measure the width of the tire it is the same as the other, but it looks thinner because the diameter is bigger. Why not to put 30 pounds here as there. It is because, in order to sustain 30 pounds this tire would require so much rubber that the tire would be more expensive than the tractor. It is cheaper to keep lower pressure that more rubber. So, how much more rubber this tire has to have to sustain the same pressure? Let me ask you it is twenty times more? No, it is ten times more. So, as a heart increases diameter, it should have more muscle, to sustain the same pressure. Indeed, the formula is: the muscle mass a heart requires is about four times radios to the cubic. This is a constant to any heart. Any heart that is not in this formula is in some kind of heart failure. In order to perform a normal heart function, that heart would require this. It is not me saying this, it is nature. "Nature wrote the universe with mathematics. The fact that we do not know the formula, does not mean that it did not exist, it means we do not know". This was said by Galileo Galilei, in Italy once a time.

A Chagas' disease heart looks similar to a buffalo heart. We call it ox heart, because on X-ray it looks as big as an ox heart. Comparing the Chagas heart to the ox heart, it is easy to understand while the patient is in heart failure. The external diameter is the same, but muscle thickness is different. There are two solutions for this heart: we either fill it with muscle, that is we give muscle to the heart, or we excise diameter. If I hit your head with a stick, or if you hit your head to my stick, the pain is the same. These are the only two things we can do for this heart. If muscle is added, as cardiomyoplasty does, or if the diameter is decreased, as ventriculectomy does, the end result should be the same. By decreasing diameter, how this heart is looking better compared to the normal heart! If you chop a little bit more excising more muscle, this is what it looks, and if you chop another piece it is looking as a normal heart (Figure 2).

To test my hypothesis I did some experiments in sheep. In a series of sheep we opened the ventricle in two and added a patch of pericardium to increase their diameter. We found that before increasing the diameter the ejection fraction was normal, about 50%, and the heart was beating normal. After increase of diameter I expected the muscle continue beats, but the myocardium in such a tremendous dilatation it did not beat at all, it stopped. The ejection fraction fall down to 9-10% and all the sheep dead. Well, you would say that I cut the coronary arteries, and after devascularisation the heart can not sustain his work and the
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Table 1. Partial ventriculectomy for diameter heart surgery: The four most of the 320 patients operated during the last two years.

The oldest 95 year old,
The youngest a 8-month baby,
The fattest 230 kilos
The tallest 2 meter and 10 cm.

Table 2. Partial ventriculectomy for diameter heart surgery. Post-operative morbidity

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percent of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal failure</td>
<td>22</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>15</td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>10</td>
</tr>
<tr>
<td>Bleeding</td>
<td>10</td>
</tr>
<tr>
<td>Cardiac failure</td>
<td>5</td>
</tr>
<tr>
<td>Infections</td>
<td>2</td>
</tr>
</tbody>
</table>

Post-operative morbidity.

Table 3. Partial ventriculectomy for diameter heart surgery: Survival rates

<table>
<thead>
<tr>
<th>Survival Rates</th>
<th>Percent of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operatory room</td>
<td>95</td>
</tr>
<tr>
<td>Hospital</td>
<td>85</td>
</tr>
<tr>
<td>Late (one year)</td>
<td>65</td>
</tr>
</tbody>
</table>

Table 4. Partial ventriculectomy for diameter heart surgery: Conclusions

- It improves patient's NYHA class
- It can be used as bridge to heart transplantation
- It is reproducible
- It is a low cost procedure
- It offers hope to patient and to the doctor
- It remains to be established if it increases patient's life span

Ejection fraction fall down. But this interpretation is not true, because later I excised the patch and putting the ventricle walls back to the original position, the heart started beating again with a normal ejection fraction back to value previous of the opening of the heart. The heart is devascularized, but the ejection fraction return to normal value. In other words, the heart diameter is of foremost importance.

Another question is related to the importance of muscle pattern. A drop on earth has its shape because of gravity. If the drop would be in the far sky, it would be round because there is no gravity there. Our heart has its shape because of muscle pattern. If we would not have patterned muscle and a prosthesis instead, the shape of our heart would be round, a ball of muscle mass. All it would matter to us would be ratio mass/diameter. In experimental ventriculoplasty in sheep the muscle pattern is excised and the mitral valve too, but ejection fraction and all other parameters of heart function go up. So, I guess that these results challenge the concept of the importance of muscle pattern.

Now the fundamental question where to excise, where to decrease diameter. If we open the ventricle the same way as we open a world map, the ALD is on the left, the PD on the right, and in between the marginal artery, the papillary muscles, anterior and posterior. So as far as I can see, there is only a place we have to excise, that is near the marginal

% SURVIVAL

Transplant or Cardiomyoplasty (mean data in Brasil)
Ventriculectomy (mean data in Campina Grande do Soul)
No procedures (mean data in Brasil)
No procedures (mean data in Campina Grande do Soul)

Figure 3. Partial ventriculectomy for diameter heart surgery: mean survival of heart failure patients in Brasil or in Campina Grande do Soul.
artery, where all the vessels from PD and circumflexes meet together. I think the marginal artery just serve as a spare for our coronaries. If an obstruction occurs to ALD, marginal artery will give collaterals. In other words, if it is excised, it would not matter, it is just losing a spare tire of your car. Therefore, that is the area where excise, and after excising if can show that all the muscle fiber get together again. It is like to cut a zebra skin. Take a piece out of zebrin, the straights have to meet again together at the end of the surgery.

Probably surgeons will really appreciate a surgical specimen if it shows patient's papillary muscles and the mitral valve leaflet, and I can show a surgical specimen, not a necropsy one, from one of the patients we operated in the last two years.

Almost three years ago I did the first operation. The patient was a truck driver in transplant list with a low ejection fraction. We offered him the procedure because it was a difficult blood type to have a chance for transplant. His heart was very big, but now it is small. Before surgery his ejection fraction was low, around 15%. A week later the ejection fraction increased to 40%, three months later it was 50% and nowadays the ejection fraction is around 60%. He lives a normal life, he takes no medications, and every time someone come to visit him and takes an echo, it is normalized. He can even play soccer. Anyway, his X-ray before surgery showed a big heart, which is now small.

Table 1 shows the four most in our list of patients, they are: the oldest 95 year old, the youngest a 8-month baby, the fattest 230 kilos, and the tallest 2 meter and 10 cm. During the last two years we operated about 320 patients. Most of them where males, and they where all in NYHA class four, with ejection fraction from 7 to 18 percent. Post-operatively, 50% are in class one, 35% are in class two, and 15% are in class three. One thing I have to call attention is that it is unfair to call class four patients, that requires by-pass. My patient who had arrhythmia before surgery, but even post-operatively, we associated amioderon at least for six months, since almost all of them have some kind of tricuspidal insufficiency. We either added mitral plasty or mitral replacement when we had to excise papillary muscles. We had about twenty per cent of patients with associated coronary by-pass, aortic aneurism and other procedures. Mortality most commonly was arrhythmia. Most of the patient who had arrhythmia before surgery, but even post-operatively, we associated amioderon at least for six months, since the arrhythmia went quite down. Renal failure too is a problem post-operatively, because we keep these patients with beta-blockers post-op, to keep their pressure down to at least not more than 100 mm of mercury, and this causes some kind of renal failure. Table 2 shows that additional causes of post-operative morbidity were respiratory failure, cardiac failure, bleeding, and infection. Table 3 shows the results of the operative and post-operative mortality, that I like to express as "survival", because most of these patients die in the hospital, at least in my environments. Anyway, the hospital survival rate amounts to 85%. Figure 3 shows that in Brasil of the patients waiting for transplantation only about 20% survive if they are not transplanted. If they have a heart transplantation more than 80 percent survive, likewise for cardiomyoplasty that is in terms of 78%. Patients operated with ventricular reduction have about a 60% chance to survive the first year, but please compare this with the true survival chance of end-stage cardiac failure in Campina Grande do Sul, there patients survive less that six months.

Critics of the procedure agree that the hypothesis is very attractive, but they suggest that the procedure could work in those dilated hearts that are still got healthy muscles, but not in an ischemic heart where most of the muscle is lost and replaced by fibrotic tissue. I have no the final answer to this criticism, but I can be say that around 20% of ventriculectomy patient operated in Campina Grande do Sul belongs basically to ischemic cardiomyopathy; indeed, only 15% of them had Chagas cardiomyopathy, 30% idiopathic cardiomyopathy, 20% dilated heart due to valvulopathies, 10% were post-viral cardiomyopathies, and 5% of other cardiac diseases. Everything in life is offer and demand. Let me give an example, at Cleveland Clinic a patient required a by-pass to ALD. Instead, I resected that part of myocardium and decreasing heart diameter I decreased oxygen demand. If a by-pass is performed in a dilated heart, oxygen supply is increased, but the heart continue to ask for a lot, while if ventricle size is reduced, oxygen demand decreases. Anyhow, after surgery his angina disappeared. I do not know if it was because we decreased demand of oxygen or because we excised innervation of the heart that would cause pain. Angina is pain, basically. Anyway, I think that by decreasing the diameter of the heart, oxygen demand will drop much more, than the oxygen supplied by a by-pass. Ventriculoplasty is routinely performed in Campina Grande do Soul in ischemic patients, excising the artery who requires by-pass. My principle is to decrease diameter. Of course, it is a difficult work in a difficult area with difficult patients, but it is a really wonderful approach, which needs experience and follow-up, but I think that it is a very interesting approach.

Of course, it is true that we are learning a lot, and that the technique has been changed many times, as anything else. I think we have to go through the learning curve and I believe I am still in the learning curve because new ideas come and new ways of doing the same procedure come, but the important thing is to realize the principle. As far the way I see it, it is to have a good mass/diameter ratio. Once we accomplish that, whatever method is used, I think we should improve the patient's cardiac function and quality of life.

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