Shortened Conditioning and Lighter Stimulation Regimen for Dynamic Cardiomyoplasty: Preliminary Results

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Abstract
In dynamic cardiomyoplasty the actual prudent management of the clinical stimulation protocol suggests a LD conditioning period of two months, reducing the potential benefit during the critical post-operative period. We are implementing a shortened conditioning period with two goals: i) to decrease such a waste of potential benefits; and ii) to avoid full transformation of the wrapped muscle. Partial transformation of LD could increase power output by taking advantage of a faster contraction-relaxation cycle. To avoid full fast-to-slow transformation of LD, we chronically stimulate the LD every third cardiac cycle with bursts lasting less than suggested by the clinical protocol. Results of six-month follow up of two patients operated in June 1996 at the Institute of Cardiovascular Surgery of the University of Padova are superior to the more optimistic prediction. After a prudent starting but reassured by the preliminary results, Cardiomyoplasty Group at the University of Padova plans additional Transform Systems to have two patients operated every two months during 1997.

Key words: dynamic cardiomyoplasty, heart failure, latissimus dorsi, muscle conditioning to fatigue resistance, skeletal muscle cardiac assistance, dynamic contractile characteristics.

To many authors, cardiomyoplasty is a clinical reality, which founds its basis on a girdle effect which limits and/or reverse the progressive dilatation of a failing heart, since load independent measurements demonstrate a real amelioration of the heart energetic when analyses are compared before and after cardiomyoplasty [13, 15]. One of the factors limiting systolic assistance of cardiomyoplasty is muscle performance after full conditioning. After a few weeks of stimulation, LD mitochondrial content and capillary/myofiber ratio increase, but intracellular calcium handling becomes less efficient and therefore the contraction-relaxation cycle significantly slows; finally slow myosin substitutes fast myosins, so that a fast, powerful (but early fatiguing) LD is transformed in a slow contracting muscle which is fatigue resistant at moderate power [7]. Furthermore, in the actual prudent management of the clinical stimulation protocol of dynamic cardiomyoplasty, the conditioning period of latissimus dorsi (LD) lasts two months, reducing the potential benefit during the critical post-operative period.

Clinically, it is fully accepted that LD benefits the patient's quality of life only if its activation is critically delayed after sensed QRS to avoid mitral regurgitation [11, 12, 15]. Since maximum instant power of a fully conditioned LD is smaller than the peak power of the left ventricle [1-6, 8, 10], we share the opinion [5] that the grafted muscle could assist the heart principally during mid and late systolic phases. Of course, such a short window asks for a fast, powerful contraction which is not delivered by a fully transformed LD.

Actual clinical protocol make the LD very resistant to fatigue, but meanwhile its dynamic characteristics ask for improvements. The contraction-relaxation cycle of a fully conditioned LD may last longer than the heart systole with a 185 msec stimulation train of six impulses [9, 14], so that correct timing of flap contraction frequently becomes a challenge.

Thanks to experimental results in sheep of the Arpella's team [3-5], we planned in the setting of our first clinical procedures a "lighter" regimen of LD stimulation after a shortened conditioning periods. We chose to select and operate the patients in pair, unaware of what Dr. Silver and the Lajolla group did, but the goal is the same. We
encourage patients to meet during screening and pre- and post-operation muscle training. It proved to be an excellent tool of mutual support, especially in the post operative period. In June 1996 two patients (a 48 year man and a 46 year old woman) have been operated. After the healing period their LD flaps were stimulated with single impulse, and every next week one impulse up to four was added to the burst stimulation of the wrapped LD. By a non invasive method we are able to follow the changes of the dynamic contractile characteristics of the flap.

Usually LD contraction timing is based on delay between sensed QRS and spikes of the electrical impulses delivered by the muscle stimulator [11, 12, 15]. Our simple non invasive method allows to synchronize cardiac cycle and the dynamic mechanical effect of the muscle stimulation, so avoiding any interference of the muscle relaxation phase on cardiac diastole. While the fast to slow transformation is evident, its extent is very limited during the conditioning period. Up to six months, patients’ quality of life is substantially improved with significant reduction of heart failure symptoms from N.Y.H.A. class 3 to 1.

If these very preliminar results will be substantiated by long-term data in these patients and in those planned to be treated during 1997, we are confident that Cardiomyoplasty could offer long-standing benefits to manage pharmacologically-intractable heart failure.

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