Sinus node function in patients operated for mitral valve disease. Indirect evaluation with epimyocardial electrodes[1]

Função do nó sinusal em pacientes submetido a correção cirúrgica da valvopatia mitral. Avaliação indireta com eletrodos epimiocárdicos

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ABSTRACT

Purpose: To study the interatrial conduction times and atrial node performance in patients submitted to mitral valve surgery with the aid of temporary atrial epicardic electrodes. **Methods:** The atriograms were carried out in the first postoperative day and before the hospital discharge of ten consecutive patients. **Results:** Sixty percent of the patients could complete the post-operative study protocol. The main results were: a) Post-operative arrhythmias were detected in 50% of the patients; b) There were no statistical differences between the pre and post-operative 12 lead EKGs. c) The interatrial conduction time (IACT) ranged from 90 to 140ms in the first post-operative day, and from 110 to 130ms at hospital discharge; d) The sinus node recovery time (SNRT) ranged from 250 to 560 ms in the first post-operative day and from 180 to 360ms at hospital discharge; e) The sinus atrial conduction time (SACT) remained between 70 and 140ms, both in the first post-operative day and at hospital discharge, and; f) The IACT was normal in patients whose left atrium (LA) was less than 50mm in diameter but supra normal in the remaining cases. **Conclusions:** Sinus node function and inter-atrial conduction are not altered by mitral valve operation. Post-operative programmed epicardic atrial stimulation is easy and safe.

Key words: Epicardial. Atriograms. Atrial Arrhythmias. Mitral Valve Disease. Cardiac Surgery.

RESUMO

Objetivo: Estudar os tempos de condução interatrial e a função do nó sinusal em pacientes submetidos a tratamento cirúrgico. **Métodos:** Foram estudados 10 pacientes adultos consecutivos submetidos à operação de correção de valvopatia mitral. Registraram-se atriogramas usando eletrodos epimiocárdicos cirurgicamente implantados. Os atriogramas foram obtidos no primeiro dia do pós-operatório e antes da alta hospitalar. **Resultados:** Os principais achados foram: a) A incidência de arritmias atriais até alta hospitalar foi de 50 %; b) O tempo de condução interatrial (TCIA) variou de 90 a 140 ms no 1°PO e 110 a130 ms antes da alta hospitalar; c) O tempo de recuperação do nó sinusal (TRNS) variou de 250 a 560 ms no 1°PO e180 a 360 ms antes da alta hospitalar; d) O tempo de condução sinoatrial (TCSA) variou de 70 a 140 ms tanto no 1ºPO, como antes da alta hospitalar e; d) O tempo de condução interatrial (TCIA) foi normal em pacientes com átrio esquerdo menores do que 50 mm e supranormal nos outros casos. **Conclusão:** As funções do nó sinusal e a condução interatrial não foram alteradas pelo tratamento cirúrgico da valvopatia mitral. A estimulação atrial epicárdica programada é segura de fácil realização.

Descritores: Epicárdio. Atriogramas. Arritmias Atriais. Valvopatia Mitral. Cirurgia Cardíaca.

1. Investigation carried out at the Division of Thoracic and Cardiovascular Surgery, Department of Surgery and Anatomy, Ribeirão Preto Faculty of Medicine, University of São Paulo, Brazil.

Introduction

Susceptibility to new onset post-operative atrial fibrillation (AF) after major, and in particular, heart surgery is related to different risk factors. In the general population, old age stands up as the strongest pre-operative risk factor, while degenerative tissue alterations including nodal fiber loss, increased sinus node fatty and fibrous tissue, atrial dilatation, atrial fibrosis and focal amyloidal interstitial deposit in the atria constitute other important predisposing markers.[1-3]

When heart valve disease is considered, the structural and atrial electromechanical alterations generated by dilation, fibrosis, loss of muscular mass and normal tissue architecture secondary to the hemodynamic overload account for an increased risk for post-operative AF[4]. In addition, the diagnosis of mitral stenosis emerges as an independent risk factor for post-operative AF[3].

Investigation of the propensity for post-operative atrial arrhythmias, although very important, is challenging mostly on account of the multi factorial mechanisms involved and patient selection.[1,5] In this study, temporary atrial epicardic electrodes were employed to gather electrophysiological information concerning the interatrial conduction times and atrial node performance in mitral stenosis patients submitted to mitral valve surgery.

Methods

Patients: Ten consecutive adult patients (6 males), operated on for mitral valve disease treatment, over a 14 month period, at the Hospital das Clinicas of the Ribeirão Preto School of Medicine of the University of São Paulo were prospectively evaluated. Inclusion criteria were adult age, elective, first heart operation for isolated mitral valvulopathy; predominant sinus rhythm or intermittent AF or atrial flutter pre-operatively; left ventricle ejection fraction higher than 35%; end diastolic left ventricle diameter less than 55mm; avoidance of vasoactive amines and anti-arrhythmic drugs for the last 48h pre-operatively, and no electrolytic imbalance. Informed consent according to the Ethics Committee was always obtained.

The pre-operative evaluation and anesthetic protocols, as well as the operative technique and the post-operative treatment were standardized.

Surgery: The patients were operated on by the same surgeon (WVAV), via median sternotomy, with bi-caval-ascending aorta full cardiopulmonary by-pass at 32°C. The caval veins were snared, intermittent antegrade cold blood cardioplegia was given at 20min intervals and the mitral valve was exposed by subseptal atriotomy. After by-pass discontinuation, two right atrium (RA) electrodes were implanted one cm apart, and perpendicular to the interatrial groove, one cm below the superior vena cava-right atrium connection, in order to avoid damaging the sinus node (Figure 1). Another similar pair of electrodes was implanted in the mid-lateral border of the left atrium. One additional electrode was implanted in the right ventricle diaphragmatic wall.

The surgical procedure, and in hospital morbid-mortality was evaluated.

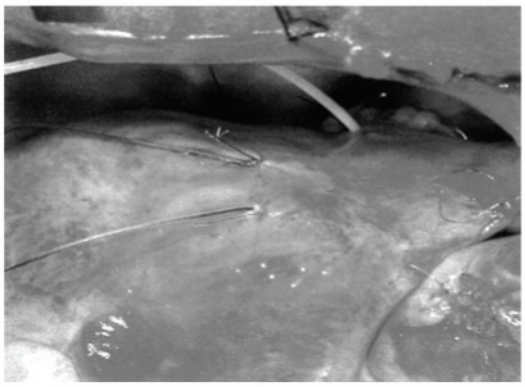

FIGURE 1 - Intra-operative view. The right atrial electrode pair is positioned one cm below the superior vena cava-right atrium junction. A left atrium manometric catheter is inserted in front of the left atrial suture line.

Atriogram record protocol: Twelve lead surface EKGs were registered pre-operatively, after chest closure, on admission to the intensive care unit (ICU), and when arrhythmias were detected on continuously monitoring in the ICU, and daily, until discharge from the hospital.

Sinus node function and interatrial conduction times were evaluated according to a modified Narula cardioestimulation test protocol with a cardio-stimulator device.

The first test was performed in the first post-operative day with the patient extubated, hemodinamically stable and in sinus rhythm. The surface EKG was recorded at 25mm/s and the basal rate was calculated by measuring the P-P interval with a calibrated rule. The right and left arm EKG cables were then hooked to the RA electrodes in order to register the bipolar right atriogram, and the same procedure was repeated with the LA electrodes. While recording the left atriogram, right atrial stimulation was started at a frequency 10 bpm higher than the patient's basal heart rate, and interrupted two min later. Care was taken to keep the stimulation amplitude and pulse width just above atrial capture in order to warrant good patient's tolerance. The largest of the first eight P-P intervals was considered the test sinus node recovery time (SNRT). The test was repeated at 20 bpm increments until a limit frequency of 110 bpm. The largest P-P interval in the test series was considered the patient's SNRT[6-8] (Figure 2).

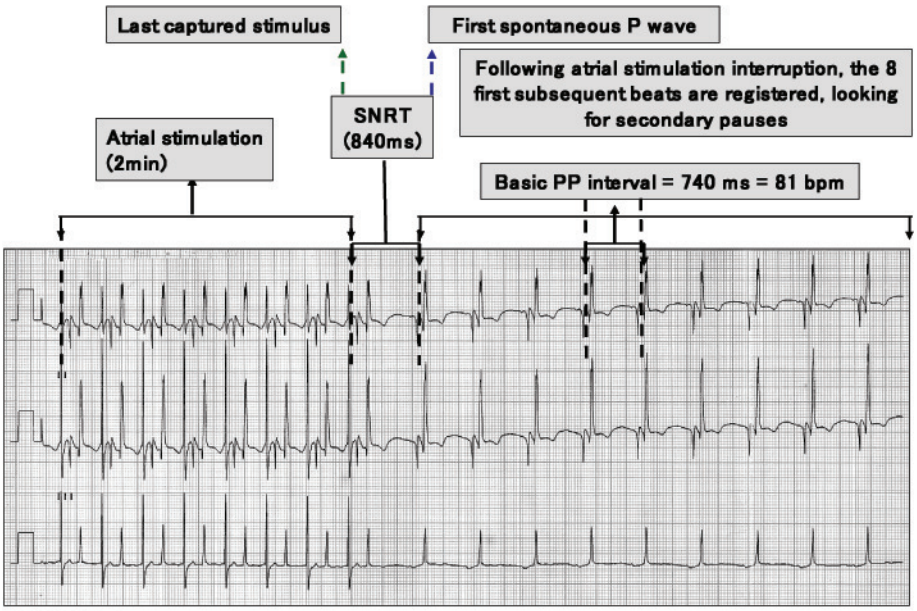

FIGURE 2 - Atriogram by DII derivation sino-atrial node recovery time (SNRT) Programmed right atrium stimulation was initiated (left hand side vertical dotted line), and maintained for two min (second vertical dotted line). The 8 first subsequent spontaneous beats are registered in order to look for eventual secondary pauses and to measure the basic PP interval (two last vertical dotted lines). The latter allows for the calculation of the corrected SNRT (SNRT – basic PP interval = 100 ms)

The left atriogram recording speed was then increased to 50mm/s. RA stimulation was re-initiated at a rate 10 bpm higher than the patient's and the interatrial conduction time (IACT) was measured as the interval between the RA stimulus artifact and the onset of the LA atriogram second convexity. This procedure was repeated thrice (Figure 3).

In order to determine the sinus atrial conduction time (SACT), RA overdrive was initiated and maintained for 8 beats with a frequency three to 5 bpm higher than baseline. Once pacing was turned off, the eight subsequent p-p intervals were measured and the longest one was taken as the SACT (Figure 4).

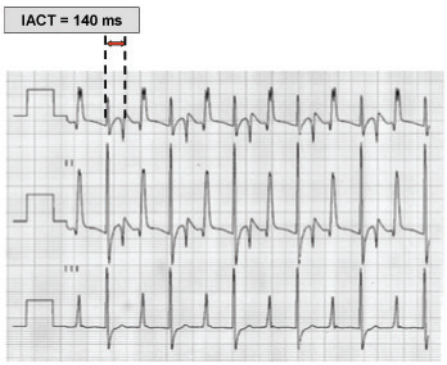

FIGURE 3 - Left atriogram (upper tracing), and surface EKG (50mm/s). The interatrial conduction time is measured as the time interval between the right atrial epicardic stimulation (first vertical dotted line) and the beginning of left atrium depolarization (second vertical dotted line).

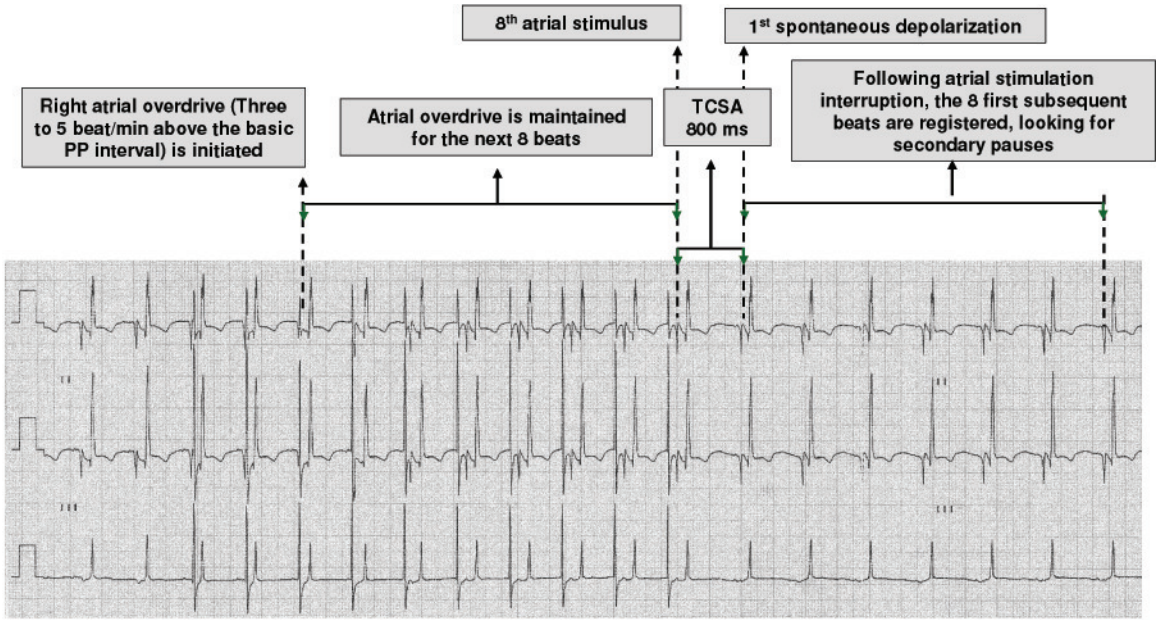

FIGURE 4 - EKG Programmed right atrial overdrive (three to 5 beat/min above the basic PP interval). Measurement of theSACT is depicted in between the red and blue vertical dotted lines). The first 8 spontaneous beats following the overdrive period are registered in order to detect or primary pause in the first either eventual secondary pauses.

Corrected SNRT and SACT were calculated by subtracting the respective p-p intervals. A final EKG recording was made to document the cardiac rhythm. The study was repeated one day before hospital discharge, on post-operative day 6.

Statistical analysis: The mean and standard deviation, as well as the median and lower and higher limits were analyzed by the Wilcoxon test a significance level of 5%.

Results

The mitral valve was preserved in 70% of the cases, and a prosthetic valve was implanted in the remaining patients. There were no deaths. Post-operative complications comprised one case of each, seizures, hypertensive pneumothorax and gout crisis, in different patients.

Post-operative arrhythmias were detected in 50% of the patients (Table 1). Four patients needed temporary RA stimulation for junctional rhythm management. One patient needed electric cardioversion for AF on post-operative day one.

TABLE 1 - Post-operative arrhytmias.

	Incidence	
	Nº	%
SB P.O.I./AR 2º-4º	1	10
JR/AF – 1º - 5	1	10
SVPT / AF P.O.I.	1	10
JR P.O.I.	1	10
AF 2º	1	10
Arrhythmias	5	50

SB-synus bradicardia; AR-atrial rhythm; JR-junctional rhythm; svpt-supraventricular paroxistic tachycardia; AF- atrial fibrillation.

At hospital discharge, 8 patients were in sinus rhythm, seven of them continued to show EKG pattern of left atrial overload, two patients presented new onset first degree atrioventricular block. Two patients presented in hospital post-operative AF. The arrhythmia was transient in one patient and persistent in the other.

Sixty percent of the patients could complete the post-operative study protocol. There were no statistical differences between the pre and post-operative 12 lead EKGs (Table 2). The IACT ranged from 90 to 140ms in the first post-operative day, and from 110 to 130ms at hospital discharge (Table 3). The SNRT ranged from 250 ms to 560 ms in the first post-operative day and from 180 ms to 360ms at hospital discharge (Table 4).

TABLE 2 - Pre and post-operative patient ECK p and QRS wave duration; mean p-R and Q-T intervals and left atrium diameter (Echocardiogram).

	Pre-operative			Post-operative		
Patient	P wave	P-R interval	LA	P wave	P-R interval	LA
1	0.16	0.19	61	0.15	0.21	54
2	0.12	0.18	68	0.12	0.16	55
3	0.12	0.16	53	0.1	0.16	42
4	0.12	0.16	62	0.12	0.22	54
5	FA	-	60	FA	-	50
6	FA	-	60	0.09	0.2	55
7	FA	-	59	FA	-	55
8	0.12	0.18	56	0.1	0.15	47
9	0.1	0.16	47	0.008	0.16	44
10	0.13	0.16	52	0.1	0.14	48
Mean	0.12429	0.17	57.8	0.10625	0.175	50.4
SD	0.01813	0.01	5.95912	0.01923	0.03	4.9261209
Median	0.12	0.16	59.5	0.1	0.16	52

The SACT remained between 70 and 140ms, both in the first post-operative day and at hospital discharge (Table 5), while the IACT was normal in patients whose LA was less than 50mm in diameter but supra normal in the remaining cases.

TABLE 4 - The corrected sinus node recovery time (SNRT), in ms, on the first post-operative day and at hospital discharge

	SNRT	
	PO day 1	at discharge
	320	
	230	280
	360	360
	560	
	250	240
	250	180
Mean ± SD	328.33 ± 19.64	265.00 ± 75.50
Median	285.00	260.00

Discussion

Rheumatic heart disease is associated with, respectively, 9.9 to 27.5 times and 7.6 to 24.3 times greater incidence of chronic AF and paroxystic AF than in the normal population. This is explained by the presence of intermixed long and short refractory period atrial myocardium areas known to fragment the front wave of depolarization thus providing the substratum for incessant wave propagation or reentry that deflagrates AF.[9,10] As this background is particularly found in the atrial myocardium of longstanding mitral valve stenosis, a sound pre and post-operative arrhythmogenic basis is present in these patients.

The clinical applicability of post-operative cardiostimulation studies like herein reported relates to their potential to identify heart surgery patients at risk for post-operative arrhythmias, particularly the sustained ones, like persistent AF. This would open the possibility to improve patient prognosis by starting prophylactic measures. In this investigation, pre-operative EKG findings were characteristic of mitral valvulopathy.[11] Although supraventricular extrasystoles are considered a frequent first post-operative day finding post mitral valve operations[4,12] this is in odds with the present study for no such arrhythmias were found. Notwithstanding, our patients p wave and p-R interval duration were increased, findings that according to PASSMAN et al.[13] are markers for post-operative supraventricular arrhythmias. On the other hand, the 50% incidence of cardiac rhythm disorders in the first post-operative week was similar to previous reported data.

These conflicting findings certainly resulted from a weakness in the study design. As only one EKG recordings was obtained from each patient pre operatively, they probably failed to detect the usually great number of atrial electric disturbances present pre-operatively.

Even though our test protocol had relatively low sensitivity, it is considered highly specific for sinus node disease detection.[8,10] On other words, a normal test does not exclude the diagnosis, but an abnormal one is strongly suggestive of sinus node disease.[8] In fact, HOGUE et al., in 2000,[10] used a transesophageal electrode and a protocol similar to ours to demonstrate that a normal SNRT along with an altered SACT predispose to post-operative AF.

Interestingly, the sensitivity and specificity were both similar to those obtained by STEINBERG, 1993[14] and KLEIN, 1995[15] for p wave duration measured by high resolution EKG. Among the four patients presenting with SACT longer than 96ms in this study, only one had documented post-operative AF. On the other hand, one patient with intermittent pre-operative AF who evolved in sinus rhythm with augmented SATCc (140 ms) during the first post-operative day had the AF recurring five days later. In this patient the FA was irresponsive to drug and electric cardioversion, and the patient was discharged home on post-operative day 10.

There was significant positive correlation between LA size and IACT in our study. The increased interatrial conduction time of these patients, most certainly a surrogate for the atrial dilation should have potentialized the pre-existing atrial refractory dispersion thus providing the electrophysiological substratum for sustained reentry pathways and AF.[16-20]

Conclusion

Sinus node function and inter-atrial conduction are not altered by mitral valve operation. Post-operative programmed epicardic atrial stimulation is easy to perform, well tolerated and does not induce arrhythmias on its own.

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Comments:
Postoperative atrial arrhythmias after cardiac surgical procedures are common, with a reported overall incidence of approximately 50%. Post-operative cardiostimulation studies aim to identify patients at risk for post-operative arrhythmias which would open the possibility to start prophylactic measures and to improve patient prognosis. In spite of the small number of patients investigated, the results reported by the authors suggest that conduction delay has a low sensitivity and a high specificity for prediction of AF as reported previously by others using alternative methods. Based on these data the altered SACT should not be used as a marker to start preventive measures for AF in patients undergoing elective, first heart operation for isolated mitral valvulopathy, with predominant sinus rhythm or intermittent AF.

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