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心房隔間術對心房電生理特性的影響

Effects of Atrial Compartment Operation on Atrial Electrophysiologic Characters

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Effects of Atrial Compartment Operation on Atrial Electrophysiologic Characters

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Running Title: Experimental atrial compartment operation

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Abstract

Objectives: To investigate the electrophysiologic effects after atrial compartment operation in dogs.

Methods: Eighteen mongrel dogs of either sex underwent atrial compartment operation on the right atrium(RA) through thoracotomy and inflow occlusion method. The operation was performed through a longitudinal incision on the right atrium 1mm lateral and parallel to the sulcus terminalis extending along the interatrial septum, and a cryolesion put at the atrium between upper incision margin and the tricuspid annulus. Electrophysiologic studies were performed before and 6 mo after the operation. The technique of the electrophysiologic studies consisted of rapid atrial pacings and programmed extrastimulation technique in 5 RA and 3 left atrial (LA) sites.

Results: Sustained atrial fibrillation (>1min) was inducible in 14 dogs before operation, which became non-inducible in 11 of them after the operation ($p<0.05$).

Six months after the operation, absolute refractory periods were prolonged in the atrial tissues inside the RA compartment (C), but showed no changes outside the compartment(O) (RA(c): 102.1± 12ms to 131.6± 26.6ms, $p<0.05$; RA(o): 99.2± 14.7ms to 100.9± 20ms, $p>0.05$; LA: 85± 14.7ms to 88.7± 16.1ms, $p>0.05$). Sinus nodal functions were not affected by the surgery.

Conclusions: Our results showed that atrial compartment operation not only reduces the mass but also prolongs the refractory periods in the compartmentalized atrium, which attributes to the elimination of atrial fibrillation.

Full Text

Atrial fibrillation is the most common tachyarrhythmias in human. In the longterm follow-up, it increases the risks of thromboembolism and death. In 1988, atrial compartment operation was designed based on Moe's multiple wavelet hypothesis for elimination of atrial fibrillation and restoration of sinus rhythm. The early clinical reports showed the feasibility of the surgical idea, however the real mechanism of the atrial compartment operation remains not clear.

In this study, the electrophysiologic effects after atrial compartment operation were investigated in 18 adult dogs.

Methods

Surgical Preparation. Eighteen mongrel dogs of either sex, weighing 12 to 18 kg were anesthetized with thiopental sodium 25mg/kg intravenously. Additional doses were injected as needed to maintain anesthesia during the study. All animals were intubated and ventilated with room air by Harvard respiratory apparatus. A right thoracotomy through the 5th intercostal space was performed and the heart cradled in the pericardium.

Electrophysiologic studies. A quadripolar electrode with interelectrode distance of 10 mm was inserted via right carotid artery to the aortic root for His bundle recordings. Bipolar epicardial electrodes were sutured to both the high right atrium

and the lower left atrium. All electrodes were connected to a 4-channel recording system (Model RS 3400, Gould Inc, Cleveland, Ohio). The His electrogram were recorded at a filter band width of 30-1,000 Hz, and atrial electrogram at 30-300 Hz. Standard electrocardiographic lead II was recorded simultaneously with bipolar leads from the high right atrium, the mid left atrium and the His bundle region. Paper speed was 100 mm/s.

The technique of electrophysiologic studies consisted of burst pacings either the right atrium (RA) or the left atrium (LA) at 500/min and 600/min, and extrastimulus techniques using thc cycle length at 300ms or as close as possible. The coupling intervals of extrastimuli (S2) were shortened in 2ms decrements until atrial refractoriness. The stimulation was performed with square impulses 2ms in duration, and intensity five-times threshold, delivered by a programmable stimulator (Medtronic 5325). There were 5 sites of the right atrium (the appendage, high RA, mid RA, mid-low RA, and low RA) and 3 sites of the left atrium (the appendage, mid LA and low LA) selected for the stimulation program (Figure 1). After the baseline study, atropine 0.2mg/kg and propanolol 0.4mg/kg were slowly injected intravenously as sympathetic and parasympathetic blocking agents. A similar burst pacings and extrastimulation were carried out at the 8 stimulation sites as described above.

Electrophysiologic studies were carried out before the operation as a baseline data and repeated at 6 months after surgery.

Operative method. The operation was performed under moderate hypothermia (30oC) with blanket cooling. Under temporary occlusion of the venae cavae and the azygous vein, a longitudinal incision was performed on the right atrium at 2mm lateral and parallel to the sulcus terminalis extending along the interatrial septum to 2cm (upper incision) and 0.5cm (lower incision) distant to the atrioventricular(AV) junction. Then a cryolesion at -60oC for 120 sec was put at the atrium between upper incision margin and the tricuspid annulus (Fig.2), The cryolesions were delivered with a longitudinal cryoprobe (Cryounit 142, Spembly Medical Corp, U.K.). The incision was carefully placed to avoid injury to the sinoatrial(SA) node, and was sutured immediately with 5-0 prolene. After the procedure, the atrium was divided into two compartments: a right atrial compartment and another septo-left atrial compartment wich comprised the SA and AV nodes. The atrial bridge between the lower incisional

wound and the tricuspid annulus served as a connection between the two compartments. When the clamps released, the heart was resuscitated with massage and epinephrine injection. After rewarming with blankets, the wound was closed in layers. The animals were allowed to recuperate with appropriate antibiotic prophylaxis.

Statistical analysis. All values are expressed as mean values ± 1 standard deviation (SD). Data were compared before and after operation by using Student's t test and Fisher's probability test. A p value <0.05 was considered a significant difference.

Results

Definition. Atrial fibrillation is defined as sustained in this study when the arrhythmia persists for >1 min, as non-sustained when it persists for >1 sec but < 1min. Repeated atrial responses is defined when the arrhythmia lasts only <1 sec.

Conclusions:

Our results showed that atrial compartment operation not only reduces the mass but also prolongs the refractory periods in the compartmentalized atrium. Both effects attribute to the termination of an atrial fibrillation. The prolongation of refractory period might be due to interruption of the autonomic nervous system by the atrial compartment operation.

Table 1. Refractoriness and af inducibility before and after atrial compartment op with autonomic blocking agents

Dog	RA1		RA2		RA3		RA4		RA5		LA1		LA2		LA3	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2	98 af>1	200	87	98	87	113					88	94	93 af>1	99	83	103
3	93 af	114	72 af>1	86	93 af>1	122					83 af>1	59 r	91	82 r	86	94
4	128	171	106 r	84 r	109 r	94					93 r	85	83	82 r	102	86
5	128	116	118	91	138	111					96	82	132	110	96 af>1	93 af>1
7	97	126	87	89 r	93 af>1	111	91	128	93	144	74 r	63 r	74 af	56 af	95 af	78 Af
Drug		133		134		133		142		138		113		114		108 r
8	114	167	114	100	107 af>1	137	111	119	121	145 af	73	99 af>1	97	109	95	125
Drug		197		149		161		175		158		119		131		149
9	94 af>1	107	122	103	119	123	114 r	124	103 r	141	89 af>1	91 r	68 af>1	83 r	91 r	103
Drug		133		147		144		139		127		126		129		126
11	108 af	111	88 r	50 af	87 r	102	96 af	99	84 af	80 r	62 af	94	47 af>1	79 af	78 Af	80
Drug	127	122	127	117	119	112	128	123	131	151	116 r	127	121	116 af>1	113 af>1	102

Table 2. Refractoriness and af inducibility before and after atrial compartment op without autonomic blocking agents

RA1	RA2		RA3		RA4		RA5		LA1		LA2		LA3			
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2	98 af>1	180	87	98	87	113					88	94	93 af>1	99	83	103
3	93 af	114	72 af>1	86	93 af>1	122					83 af>1	59 r	91	82 r	86	94
4	128	171	106 r	84 r	109 r	94	85	160	91	165	93 r	85	83	82 r	102	86
5	108	116	98	91	118	111	100	116	112	118	86	82	122	110	86 af>1	93 af>1
7	97	126	87	89 r	93 af>1	111	91	128	93	144	74 r	63 r	74 af	56 af	95 af	78 Af
8	114	167	114	100	107 af>1	137	111	119	121	145 af	73	99 af>1	97	109	95	125
9	94 af>1	107	122	103	119	123	114 r	124	103 r	141	89 af>1	91 r	68 af>1	83 r	91 r	103
11	108 af	111	88 r	50 af	87 r	102	96 af	99	84 af	80 r	62 af	94	47 af>1	79 af	78 Af	80
Mean	105	136.5	96.8	87.6	101.6	114.1	99.5	124.3	100.7	132.2	81	83.4	84.4	87.5	89.5	95.3
SD	12	30.6	16.5	16.7	13.3	13.3	11.3	20.1	14.0	29.6	10.4	14.8	22.3	17.9	7.7	15.2

Sustained atrial fibrillation (>1min) was inducible in 14 dogs before atrial compartment operation became non-inducible in 11 of them after the operation ($p<0.05$). **Sustained and non sustained AF was induced in 14 dogs at sites in the atrial compartmentalized areas before surgery, while only one remained inducible at the same areas. ($p<0.05$) In the right atrium outside the compartment, 10 vs 3 dogs were AF inducible before and post the operation, respectively. ($p>0.05$) In the left atrium, there were 5 dogs have AF induced before operation, and 4 of them still inducible 6 months after surgery.**

Six months after the operation, absolute refractory periods were prolonged in the atrial tissues inside the RA compartment (C), but showed no changes outside the

compartment(O) (RA(c): 102.1± 12ms to 131.6± 26.6ms, $p<0.05$; RA(o): 99.2± 14.7ms to 100.9± 20ms, $p>0.05$; LA: 85± 14.7ms to 88.7± 16.1ms, $p>0.05$). Sinus nodal functions were not affected by the surgery.

Table 3. Atrial refractory periods 6 mo after op

	Before	Postop	P
RA (com)	101.2±12 ms	131.6±26.6 ms	<0.05
RA (non)	99.2±14.7 ms	100.9±20 ms	>0.05
LA	85±14.7 ms	88.7±16.1 ms	>0.05

Table 4. Sinus nodal function after atrial compartment op

	Preop	Postop	P
SNRT	61.1±37.3 ms	95.8±39.7 ms	>0.05
SACT	42.4±8.2 ms	46.5±14.7 ms	>0.05