

Effect of Some Drugs Affecting Nervous System on Heart Rate Variation of Rats

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Abstract We have clarified the changes of spectral and non-spectral indices of heart rate variation (HRV) when drugs exciting and depressing the autonomic nervous system were induced under the central nervous system comprising autonomic nervous system by injection to the abdominal cavity of rats of thiopental sodium and ketamine hydrochloride was depressed. Very low frequency (VLF), low frequency (LF), high frequency (HF), total frequency (TF) and ratio of low frequency to high frequency (L/H) as spectral indices of HRV were used. Mean R-R(mRR), mode(Mod), percentage of mode(Mod%), variation coefficient of R-R (CVRR), percentage of R-R interval that is longer than ten milliseconds (pR-R10) and percentage of R-R interval that is longer than five milliseconds (pRR5) as non-spectral indices of HRV were used. The spectral indices were significantly reduced as compared with normal and control group when above drugs were induced to rats($p < 0.01$). Non-spectral indices were changed differently according to the drugs. When thiopental sodium was injected, mRR, Mod, Mod% values were significantly increased ($p < 0.01$) and CVRR, pRR10, pRR5 significantly decreased ($p < 0.01$). When ketamine hydrochloride was injected, Mod% was elevated and mRR, Mod, CVRR, pRR10, pRR5 significantly decreased ($p < 0.01$). Spectral indices such as Mod% and CVRR were increased by drugs exciting sympathetic nervous system. Spectral indices such as LF, HF and TF and non-spectral indices such as mRR, Mod, pRR5 were increased and Mod% significantly decreased by drugs depressing sympathetic nervous system. Spectral indices such as LF and HF, non-spectral indices such as mRR and Mod were increased and Mod% decreased by drugs exciting parasympathetic nervous system. Mod% was increased and mRR and Mod were decreased by drugs depressing parasympathetic nervous system.

Key words heart rate variation (HRV), autonomic nervous system, heart pulsation.

Introduction

The great leader Comrade **Kim Jong Il** said as follows.

“Medical scientists and technicians must establish Juche thoroughly in scientific research and study great and important scientific and technological problems appropriate to the specific conditions of our country.”(“ON THE FURTHER IMPROVEMENT OF THE HEALTH SERVICE” P. 19)

After it was firstly found in 1973 that variation of R-R intervals of electrocardiogram (ECG) in patients with diabetic nervous disorder disappeared [10], the research to diagnose many diseases such as sudden cardiac death, congestive heart failure, chronic nephrosis, and etc by using HRV indices is being widely progressed [8, 9].

Recently research to evaluate the function of autonomic nervous system using the HRV analysis method was extensively progressed in and outside the countries [3, 6, 7]. In our country as well, the research data on the rational design of algorithm for the spectral analysis of HRV was proposed in 1999 and the research data on change HRV in patient with cardiovascular system diseases, alimentary system diseases and autonomic nervous system diseases were proposed [1, 2].

The evaluation of autonomic nervous system function in experimental animals need the preparation of imbalance model of autonomic nervous system function and the development of drugs affecting autonomic nervous system [4, 5]. To resolve this problem, the HRV analysis method that has been applied to the human must be also applied to the experimental animal. We have examined the effect on HRV spectral and non-spectral indices when the drugs influencing to autonomic nervous system were injected to rats under the function of central nervous system was depressed.

1. Research Materials and Method

1.1. Drugs, experimental animals and apparatus

1.1.1. Drugs

1% thiopental sodium (5mL/kg), 0.5% ketamine hydrochloride (2mL/kg), 0.1% noradrenalin, 0.1% propranolol, 0.1% pilocarpine and 0.1% atropine were used as drugs.

1.1.2. Experimental animals

Body weight 130~150g, male and female “Wistar” rats 80 heads as experimental animals were used.

1.1.3. Apparatus

Potable electrocardiograph “Cardiostat”, Computer, 16bit A/D translator “ADLINK NuDak 9111” were used.

1.2. Electrocardiography

Electrode that was made of diameter 0.8mm stainless steel line with 0.8mm in diameter were inserted in subcutaneous point on the right scapular region, right and left back and ECG recorded with standard lead [1].

Normal ECG was recorded without anesthesia. After electrodes were put on the subcutaneous point and rats accommodated to environment for 5~10 min, ECG was recorded for 2min when animals become steady. ECG was recorded in room temperature of 18~24°C, 9~12 a.m.

1.3. Administration

Drugs were injected in abdominal cavity [2].

1.4. Analysis of HRV

When R-R interval of ECG is measured, the shifting mean method was used for removal of baseline oscillation and the weighted shifting mean method used for removal of noise mixed in ECG.

When HRV spectrum is separated, fast Fourier translation (FFT) algorithm were used for the spectral analysis of serial data of R-R interval.

VLF as HRV spectral indices was the spectral definite integral of 0.1~0.19Hz zone, LF was 0.195~0.74Hz zone, HF was 0.78~2.5Hz zone and TF was 0.78~2.5Hz zone and L/H was ratio of LF to HF.

HRV non-spectral indices were calculated before re-exampling of R-R interval for FFT. mRR is the sum of R-R intervals. Mode is the most frequent values among the total R-R interval and Mod% is percentage of Mode among the total R-R interval. CVRR is percentage of standard error of R-R interval to mean R-R interval. pRR10 is one that reminder between the continuous R-R intervals is more than 10ms and pRR5 5ms

2. Result and Consideration

2.1. The changes of HRV indices when the drugs influencing on autonomic nervous system were injected to rats under the narcosis by thiopental sodium

2.1.1. The changes of HRV indices when the drugs influencing on sympathetic nervous system were injected under the narcosis by thiopental sodium

Changes of HRV spectral indices when noradrenalin was injected under the narcosis by 1% thiopental sodium are same as table 1.

Table 1. The changes of HRV spectral indices when noradrenalin was injected under the narcosis by thiopental sodium

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L : H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Thiop	20	1.62*±1.14	0.98*±0.53	4.68±*0.90	0.25*±0.04	8.71*±2.48
Noradrenalin	20	1.64*±0.32	1.41*±0.30	4.27*±0.56	0.32*±0.04	10.08*±1.42

* $p < 0.05$ (comparison with normal)

As seen in table 1, all HRV spectral indices significantly reduced than normal group when thiopental sodium was injected ($p < 0.01$). Under this condition, there were no significant changes of all indices when noradrenalin was injected.

Changes of HRV non-spectral indices when noradrenalin was injected under the narcosis by 1% thiopental sodium are same as table 2.

Table 2. The changes of HRV non-spectral indices when noradrenalin was injected under the narcosis by thiopental sodium

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37±1.00	130.58±1.09	11.51±0.34	5.40±0.17	0.06±0.004	0.26±0.01
Thiop	20	145.87*±3.25	146.03*±3.26	27.00*±1.13	1.82*±0.11	0.005*±0.002	0.13*±0.02
Nor	20	151.83*±9.76	152.80*±9.79	33.02* [△] ±2.83	2.74* [△] ±0.59	0.01*±0.001	0.05*±0.01

* $p < 0.01$ (comparison with normal), [△] $p < 0.01$ (comparison with thiop), thiop: thiopental sodium, nor: noradrenalin

As seen in table 2, mRR, Mod and Mod% were significantly increased and conversely CVRR, pRR10 and pRR5 were decreased than normal group when thiopental sodium was injected (p

<0.01). Under this condition, Mod% and CVRR significantly increased than thiopental sodium group when noradrenalin was injected ($p < 0.01$).

Changes of HRV spectral indices when propranolol was injected under the narcosis by 1% thiopental sodium are same as table 3.

Table 3. The changes of HRV spectral indices when propranolol was injected under the narcosis by thiopental sodium

Division	Individual /Head	VLf/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Thiop	20	1.62*±1.14	0.98*±0.53	4.68*±0.90	0.25*±0.04	8.71*±2.48
Propranolol	20	1.72*±0.21	3.65*, △±0.39	10.38*, △±0.57	0.34*±0.02	18.23*, △±1.22

*: $p < 0.01$ (comparison with normal), △: $p < 0.01$ (comparison with thiop), thiop: thiopental sodium.

As seen in table 3, all indices significantly decreased than normal group when thiopental sodium was injected ($p < 0.01$). Under this condition, LF, HF and TF significantly increased than thiopental sodium group when propranolol was injected ($p < 0.01$).

Changes of HRV non-spectral indices when propranolol was injected under the narcosis by 1% thiopental sodium are same as table 4.

Table 4. The changes of HRV non-spectral indices when propranolol was injected under the narcosis by thiopental sodium

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37±1.00	130.58±1.09	11.51±0.34	5.40±0.17	0.06±0.004	0.26±0.01
Thiop	20	145.87*±3.25	146.03*±3.26	27.00*±1.13	1.82*±0.11	0.005*±0.002	0.13*±0.02
Prop	20	194.35*,△±8.94	192.88*,△±8.95	15.62*,△±0.30	1.82*±0.08	0.01*±0.001	0.41*,△±0.003

*: $p < 0.01$ (comparison with normal), △: $p < 0.01$ (comparison with thiop), thiop: thiopental sodium, prop: propranolol

As seen in table 4, mRR, Mod and Mod% significantly increased and conversely CVRR, pRR10 and pRR5 decreased than normal group when thiopental sodium was injected($p < 0.01$). Under this condition, mRR, Mod and pRR5 significantly increased than thiopental sodium group and Mod% significantly decreased when propranolol was injected($p < 0.01$). There were no significant changes of CVRR and pRR10.

2.1.2. The changes of HRV indices when the drugs influencing on parasympathetic nervous system were injected under the narcosis by thiopental sodium

Changes of HRV spectral indices when pilocarpine was injected under the narcosis by 1% thiopental sodium are same as table 5.

As seen in table 5, all indices significantly decreased than normal group when thiopental sodium was injected($p < 0.01$). Under this condition, LF and HF significantly increased than thiopental sodium group and there were no significant changes of other indices when pilocarpine was injected ($p < 0.01$).

Table 5. The changes of HRV spectral indices when pilocarpine was injected under the narcosis by thiopental sodium

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Thiop	20	1.62*±1.14	0.98*±0.53	4.58*±0.90	0.25*±0.04	8.71*±2.48
Pilocarpine	20	1.61*±0.22	2.43*, △±0.83	8.49*, △±0.36	0.24*±0.04	13.66*±3.09

* $p < 0.01$ (comparison with normal), △ $p < 0.01$ (comparison with thiop), thiop: thiopental sodium.

Changes of HRV non-spectral indices when pilocarpine was injected under the narcosis by 1% thiopental sodium are same as table 6.

Table 6. The changes of HRV non-spectral indices when pilocarpine was injected under the narcosis by thiopental sodium

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37±1.00	130.58±1.09	11.51±0.34	5.40±0.17	0.06±0.004	0.26±0.01
Thiop	20	145.87*±3.25	146.03*±3.26	27.00*±1.13	1.82*±0.11	0.005*±0.002	0.13*±0.02
Pil	20	193.53*, △±6.28	193.88*, △±6.01	19.26*, △±1.54	1.53*±0.11	0.03*, △±0.02	0.21*±0.55

* $p < 0.01$ (comparison with normal), △ $p < 0.01$ (comparison with thiop), thiop: thiopental sodium. pil: pilocarpine

As seen in table 6, mRR, Mod and Mod% significantly increased and conversely CVRR, pRR10 and pRR5 decreased than normal group when thiopental sodium was injected. ($p < 0.01$) Under this condition, mRR, Mod and pRR10 significantly increased than thiopental sodium group and Mod% significantly decreased when pilocarpine was injected ($p < 0.01$). There were no significant changes of CVRR and pRR5.

Changes of HRV spectral indices when atropine was injected under the narcosis by 1% thiopental sodium are same as table 7.

Table 7. The changeS of HRV spectral indices when atropine was injected under the narcosis by thiopental sodium

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Thiop	20	1.62*±1.14	0.98*±0.53	4.58*±0.90	0.25*±0.04	8.71*±2.48
Atropine	20	1.08*±0.38	0.74*±0.19	3.74*±0.78	0.20*±0.02	7.01*±1.41

* $p < 0.01$ (comparison with normal), △ $p < 0.01$ (comparison with thiop), thiop: thiopental sodium.

As seen in table 7, all indices significantly decreased than normal group when thiopental sodium was injected ($p < 0.01$). Under this condition, there were no significant changes of all indices when atropine was injected.

Changes of HRV non-spectral indices when atropine was injected under the narcosis by 1% thiopental sodium are same as table 8.

As seen in table 8, mRR, Mod and Mod% significantly increased and conversely CVRR, pRR10 and pRR5 decreased than normal group when thiopental sodium was injected. ($p < 0.01$) Under this

condition, mRR, Mod and Mod% significantly increased than thiopental sodium group ($p < 0.01$) and there were no significant changes of other indices when atropine was injected.

Table 8. The changes of HRV non-spectral indices when atropine was injected under the narcosis by thiopental sodium

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37 \pm 1.00	130.58 \pm 1.09	11.51 \pm 0.34	5.40 \pm 0.17	0.06 \pm 0.004	0.26 \pm 0.01
Thiop	20	145.87* \pm 3.25	146.03* \pm 3.26	27.00* \pm 1.13	1.82* \pm 0.11	0.005* \pm 0.002	0.13* \pm 0.02
Atropine	20	125.35* Δ \pm 2.52	125.85* Δ \pm 2.31	37.11* Δ \pm 3.98	1.70* \pm 0.27	0.004* \pm 0.001	0.13* \pm 0.05

* $p < 0.01$ (comparison with normal), Δ $p < 0.01$ (comparison with thiop), thiop: thiopental sodium.

2.2. The changes of HRV indices when the drugs influencing on autonomic nervous system were injected to rats under the narcosis by ketamine hydrochloride

2.2.1. The changes of HRV indices when the drugs influencing on sympathetic nervous system were injected under the narcosis by ketamine hydrochloride

Changes of HRV spectral indices when noradrenaline was injected under the narcosis by 0.5% ketamine hydrochloride are same as table 9.

Table 9. The changes of HRV spectral indices when noradrenaline was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90 \pm 0.59	5.50 \pm 0.30	10.48 \pm 0.50	0.58 \pm 0.02	31.25 \pm 1.30
Ketamine	20	0.52* \pm 0.07	0.56* \pm 0.06	3.26* \pm 0.41	0.23* \pm 0.02	5.51* \pm 0.60
Noradrenalin	20	0.59* \pm 0.14	0.85* \pm 0.18	3.58* \pm 0.94	0.26* \pm 0.02	5.98* \pm 1.25

* $p < 0.05$ (comparison with normal), Δ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride

As seen in table 9, all HRV spectral indices significantly reduced than normal group when ketamine hydrochloride was injected ($p < 0.01$). Under this condition, there were no significant changes of all indices when noradrenaline was injected.

Changes of HRV non-spectral indices when noradrenaline was injected under the narcosis by 0.5% ketamine hydrochloride are same as table 10.

Table 10. The changes of HRV non-spectral indices when noradrenaline was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37 \pm 1.00	130.58 \pm 1.09	11.51 \pm 0.34	5.40 \pm 0.17	0.06 \pm 0.004	0.26 \pm 0.01
Ketamine	20	119.13* \pm 1.61	118.93* \pm 1.69	39.96* \pm 1.69	1.56* \pm 0.08	0.002* \pm 0.001	0.10* \pm 0.02
Nor	20	139.14* Δ \pm 4.07	138.75* Δ \pm 4.01	32.30* Δ \pm 1.33	1.58* \pm 0.10	0.01* \pm 0.002	0.17* \pm 0.05

* $p < 0.01$ (comparison with normal), Δ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride, nor: noradrenaline

As seen in table 10, other indices except of Mod% significantly decreased than normal group when ketamine hydrochloride was injected ($p < 0.01$).

Under this condition, mRR and Mod% significantly increased and CVRR was decreased than ketamine hydrochloride group when noradenaline was injected ($p < 0.01$).

Changes of HRV spectral indices when propranolol was injected under the narcosis by 0.5% ketamine hydrochloride are same as table 11.

Table 11. The changes of HRV spectral indices when propranolol was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Ketamine	20	0.52*±0.07	0.56*±0.06	3.26*±0.41	0.23*±0.02	5.51*±0.60
Propranolol	20	1.02*, △±0.16	3.06*, △±0.37	11.07*, △±0.73	0.28*±0.03	18.04*, △±1.26

* $p < 0.01$ (comparison with normal), △ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride

As seen in table 11, all indices significantly decreased than normal group when ketamine hydrochloride was injected($p < 0.01$). Under this condition, VLF, LF, HF and TF significantly increased than ketamine hydrochloride group when propranolol was injected($p < 0.01$).

Changes of HRV non-spectral indices when propranolol was injected under the narcosis by 0.5% ketamine hydrochloride are same as table 12.

Table 12. The changes of HRV non-spectral indices when propranolol was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37±1.00	130.58±1.09	11.51±0.34	5.40±0.17	0.06±0.004	0.26±0.01
Ketamine	20	119.13*±1.61	118.93*±1.69	39.96*±1.69	1.56*±0.08	0.002*±0.001	0.10*±0.02
Prop	20	179.93*△±8.06	175.00*△±8.44	19.27*△±1.07	1.86*±0.10	0.04*△±0.01	0.37*△±0.02

* $p < 0.01$ (comparison with normal), △ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride, prop: propranolol

As seen in table 12, mRR, Mod and Mod% significantly increased and conversely CVRR, pRR10 and pRR5 decreased than normal group when ketamine hydrochloride was injected($p < 0.01$). Under this condition, mRR, Mod, pRR10 and pRR5 significantly increased than ketamine hydrochloride group and Mod% significantly decreased when propranolol was injected($p < 0.01$). There were no significant changes of CVRR and pRR10.

2.2.2. The changes of HRV indices when the drugs influencing on parasympathetic nervous system were injected under the narcosis by ketamine hydrochloride

Changes of HRV spectral indices when pilocarpine was injected under the narcosis by 0.5% ketamine hydrochloride are same as table 13.

As seen in table 13, all indices significantly decreased than normal group when ketamine hydrochloride was injected($p < 0.01$). Under this condition, residual indices except for L/H significantly increased than ketamine hydrochloride group. ($p < 0.01$)

Table 13. The changes of HRV spectral indices when pilocarpine was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Ketamine	20	0.52*±0.07	0.56*±0.06	3.26*±0.41	0.23*±0.02	5.51*±0.60
Pilocarpine	20	2.99*, Δ ±0.68	3.03*, Δ ±0.93	11.55*, Δ ±3.58	0.21*±0.03	20.36*, Δ ±5.97

* $p < 0.01$ (comparison with normal), Δ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride

Changes of HRV non-spectral indices when pilocarpine was injected under the narcosis by 0.5% ketamine hydrochloride is same as table 14.

As seen in table 14, all indices except for Mod% significantly decreased than normal group when ketamine hydrochloride was injected($p < 0.01$). Mod% significantly increased than ketamine group. Under this condition, mRR, Mod, pRR10 and pRR5 significantly increased than ketamine hydrochloride group and Mod% significantly decreased when pilocarpine was injected($p < 0.01$). There were no significant changes of CVRR and pRR5.

Table 14. The changes of HRV non-spectral indices when pilocarpine was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37±1.00	130.58±1.09	11.51±0.34	5.40±0.17	0.06±0.004	0.26±0.01
Ketamine	20	119.13*±1.61	118.93*±1.69	39.96*±1.69	1.56*±0.08	0.002*±0.001	0.10*±0.02
Pil	20	143.12*, Δ ±7.63	142.63*, Δ ±7.02	27.20*, Δ ±5.50	2.57*±0.19	0.01*, Δ ±0.004	0.25*, Δ ±0.05

* $p < 0.01$ (comparison with normal), Δ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride. pil: pilocarpine

Changes of HRV spectral indices when atropine was injected under the narcosis by 0.5% ketamine hydrochloride are same as table 15.

Table 15. The changes of HRV spectral indices when atropine was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	VLF/ms ²	LF/ms ²	HF/ms ²	L:H	TF/ms ²
Normal	20	11.90±0.59	5.50±0.30	10.48±0.50	0.58±0.02	31.25±1.30
Ketamine	20	0.52*±0.07	0.56*±0.06	3.26*±0.41	0.23*±0.02	5.51*±0.60
Atropine	20	0.33*±0.13	0.55*±0.14	2.55*±0.90	0.21*±0.04	4.45*±1.28

* $p < 0.01$ (comparison with normal), Δ $p < 0.01$ (comparison with ketamine), ketamine: ketamine hydrochloride.

As seen in table 15, all indices significantly decreased than normal group when ketamine hydrochloride was injected($p < 0.01$). Under this condition, there were not significant changes of all indices when atropine was injected.

Change of HRV non-spectral indices when atropine was injected under the narcosis by 0.5% ketamine hydrochloride is same as table 16.

Table 16. The changes of HRV non-spectral indices when atropine was injected under the narcosis by ketamine hydrochloride

Division	Individual /Head	mRR/ms	Mod/ms	Mod%/%	CVRR/%	pRR10/%	pRR5/%
Normal	20	132.37±1.00	130.58±1.09	11.51±0.34	5.40±0.17	0.06±0.004	0.26±0.01
Ketamine	20	119.13*±1.61	118.93*±1.69	39.96*±1.69	1.56*±0.08	0.002*±0.001	0.10*±0.02
Atropine	20	114.60*±1.00	114.63*±1.13	33.77*±1.02	1.67*±0.12	0.003*±0.002	0.07*±0.01

* $p < 0.01$ (comparison with normal), ketamine: ketamine hydrochloride.

As seen in table 16, all indices except for Mod% significantly increased than normal group when ketamine hydrochloride was injected ($p < 0.01$). Mod% significantly increased. Under this condition, there were no significant changes of all indices than ketamine group when atropine was injected.

Conclusion

Spectral indices such as Mod% and CVRR were increased by drugs exciting sympathetic nervous system. Spectral indices such as LF, HF and TF and non-spectral indices such as mRR, Mod, pRR5 increased and Mod% significantly decreased by drugs depressing sympathetic nervous system.

Spectral indices such as LF and HF, non-spectral indices such as mRR and Mod% decreased and Mod% increased by drugs exciting parasympathetic nervous system. Mod% increased and mRR and Mod significantly decreased by drugs depressing parasympathetic nervous system.

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