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Communication

[*Comunicação*]

Comparison between conventional and computerized electrocardiography in cats

[*Comparação entre registros eletrocardiográficos convencional e computadorizado em gatos*]

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The electrocardiogram (ECG) provides a representation of the electrical activity of the heart and is a fundamental part of a clinical evaluation. Thus, the ECG is commonly used in small animal practice to diagnose conduction disturbances such as cardiac arrhythmias. These disorders are considerated alterations during the development of the electrical impulse and may occur in face of specific cardiac affectations such as valve, ischemic, or traumatic diseases; cardiomyopathies (Ware and Christensen, 1999); and systemic illness (electrolytic, neurological, and gastrointestinal abnormalities) as well as in patients suffering from systemic infections (Olivier, 1987).

Comparing the conventional (Cv) to the computerized (Cp) ECG method, the second one had shown a higher accuracy, because of its ability to detect readings of 1 millisecond (ms), while in the Cv method, readings can only be made from 5ms in paper speed of 100mm/sec (Schiwen et al., 1996). Also, Cp ECG has some other advantages like the possibility of been used in intensive care units with reliable reproducibility of its measures which enables management of larger volumes of ECGs (Tilley, 1992; Wolf et al., 2000).

The aim of the present study was to analyze the differences in the recorders between conventional and computerized methods (screen monitor and printed recorded data).

Thirty healthy adult cats were housed in appropriate cages, fed a dry pellet diet twice a day, and received water *ad libitum*. The animals were allocated into two groups according to gender: group F, n=16 females ranging from 2.74 to 4.53kg and group M, n=14 males ranging from 3.57 to 6.10kg. All animals were submitted to conventional (Cv) and computerized (Cp) electrocardiography. In the Cv method, a monochannel (ECG6 – ECAFIX) electrocardiographic device, provided with thermal sensitive millimetrated paper was used Fig. 1. For the Cp electrocardiographic method (EGC-PC version 2.07 – TEB), an electronic circuit connected to a personal computer (Pentium, 1660MHz, 32MB) provided with specific software, able to calculate and analyze electrocardiographic data, was used. Recorded tracings were show on the computer screen Fig.1B. After performing the computerized method, ECG tracings of each subject were printed in order to analyze the recorded data, which was named as computerized printed method (CpP) (Fig.1C). The paper used for printing was endowed with millimetrated spaces for the recording of waves, intervals, and segments defined by the electronic program, by means of a jet printer connected to the computerized ECG.

The animals were positioned on right lateral recumbency, on an appropriate table, with limbs perpendicularly positioned to the trunk. Electrodes were attached to forelimbs and hindlimbs. Speed used for all recordings was 50mm/s, with calibration of voltage of 1 centimeter for each millivolt (1mV=1cm). Both registrations were obtained with a regular sequence, first the Cv than Cp method.

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Figure 1. Cat. A: conventional ECG tracing recorded on thermal sensitive paper. B: computerized ECG tracing recorded on the screen monitor. C: computerized ECG tracing printed on paper. A, B, and C recorded in the lead II, at 50mm/s and calibrated to 1 millivolt which corresponds to 1cm.

The ECGs were recorded in the bipolar lead II (L II) and the evaluated parameters were: heart rate, cardiac rhythm, duration (milliseconds-ms) and amplitude (millivolts-mV) of the P wave, duration (ms) of the PR, QT interval and QRS complex, amplitude (mV) of the R wave, polarity characteristics of the T wave, presence or absence of uneven ST segment, and values (in degrees) of the mean electrical axis (MEA). The electrocardiographic measurements were analyzed in accordance of descriptions made by Tilley (1992).

Data recorded by Cv and Cp ECG were analyzed using paired *t* test in order to interpret possible effects capable to change the means of each variable regarding electrocardiographic methods. Values of $P<0.05$ were considered significant.

All animals in this study showed a normal cardiac sinus rhythm and absence of wandering pacemaker. Table 1 shows the mean values of Cv and Cp ECG. No differences were found in heart rate such as R wave amplitude between groups. The P wave duration and amplitude, QRS duration, and the PR and QT intervals were greater ($P<0.05$) in both groups by the Cp ECG. The MEA values were not different between groups ($P>0.05$).

Table 1. Means (±SEM) of conventional and computerized electrocardiography values in cats, according to gender

Group	ECG	HR (bpm)	P Wave (ms)	P Wave (mV)	PR Interval (ms)
Female	Cn	183.75±32.84	29±7.15*	0.097±0.02*	75±8.16
(n=16)	Cp	185.75±27.19	40.87±3.24	0.12±0.03	75.62±13.02
Male	Cv	177.14±28.13	31±8.10*	0.14±0.18	69.71±13.96
(n=14)	Cp	172.36±25.35	41.71±4.03	0.11±0.02	75.86±8.83
Group	ECG	QRS Complex (ms)	R Wave (mV)	QT Interval (ms)	MEA (degrees)
Female	Cv	32.5±7.28*	0.27±0.18	136.25±19.62*	64.31±52.49
(n=16)	Cp	43.75±6.64	0.23±0.10	155.25±10.74	68±46.25
Male	Cv	33.57±7.45*	0.24±0.14	134.29±17.85*	55.14±41.25
(n=16)	Cp	41.93±4.71	0.29±0.19	155.64±17.08	44.92±59.09

HR: heart rate; MEA: mean electrical axis; bpm: beats per minutes; ms: milliseconds; mV: millivolts; Cv: convencional; Cp: computerized. *Different between methods in the same group (paired *t* test, $P<0.05$).

The mean values of the Cv and CpP methods are showed in Table 2. Heart rate presented similar values between groups and methods (P<0.05). However, the P wave duration was greater (P<0.05) in Group F by the CpP method compared to Cv. Group M presented greater P wave amplitude in the Cv ECG compared to CpP. No differences were found in PR duration, QRS, and QT intervals, as well as the MEA.

Table 2. Means (±SEM) of conventional and computerized P (printed recorded data) electrocardiographic values in cats, according to gender

Group	ECG	HR (bpm)	P Wave (ms)	P Wave (mV)	R Interval (ms)
Female	Cv	183.75±32.84	29±7.15*	0.097±0.02	75±8.16
(n=16)	CpP	185±25.82	37.62±4.53	0.11±0.02	77.5±17.70
Male	Cv	177.14±28.13	31±8.10NS	0.14±0.18*	69.71±13.96
(n=14)	CpP	172.86±24.31	36.43±6.17	0.10±0.02	72.43±8.56
Group	ECG	QRS Complex(ms)	RWave(mV)	QTInterval(ms)	MEA(degrees)
Female	Cv	32.5±7.28	0.27±0.18	136.25±19.62	64.31±52.49
(n=16)	CpP	37.37±7.15	0.23±0.11	146.50±14.65	65.12±47.40
Male	Cv	33.57±7.45	0.24±0.14	134.29±17.85	55.14±41.25
(n=14)	CpP	37.71±4.08	0.29±0.21	148.57±20.70	43.78±58.44

HR: heart rate; MEA: mean electrical axis; bpm: beats per minutes; ms: milliseconds; mV: millivolts; Cv: conventional; CpP: computerized P. *Different between methods in the same group (Paired *t* test - P<0.05).

Table 3 shows the mean values of Cp and CpP ECG for both groups (M and F). No differences were observed in the heart rate, P and R waves amplitudes, and PR and QT intervals. Both groups presented P wave and QRS complex duration greater (P<0.05) by Cp method. The MEA did not differ between groups.

Table 3. Means (±SEM) of computerized and computerized P (printed recorded data) electrocardiographic values in cats, according to gender

Group	ECG	HR (bpm)	P Wave (ms)	P Wave (mV)	PR Interval (ms)
Female	Cp.	185.75±27.19	40.87±3.24*	0.12±0.03	75.62±13.02
(n=16)	CpP	185±25.82	37.62±4.53	0.11±0.02	77.5±17.70
Male	Cp.	172.36±25.35	41.71±4.0*	0.11±0.02	75.86±8.83
(n=16)	CpP	172.86±24.31	36.43±6.17	0.10±0.02	72.43±8.56
Group	ECG	QRS Complex (ms)	R Wave (mV)	QT Interval (ms)	MEA (degrees)
Female	Cp	43.75±6.64*	0.23±0.10	155.25±10.74	68±46.25
(n=16)	CpP	37.37±7.15	0.23±0.11	146.50±14.65	65.12±47.40
Male	Cp	41.93±4.71*	0.29±0.19	155.64±17.08	44.92±59.09
(n=16)	CpP	37.71±4.08	0.29±0.21	148.57±20.70	43.78±58.44

HR: heart rate; MEA: mean electrical axis; bpm: beats per minutes; ms: milliseconds; mV: millivolts; Cp: computerized; CpP: computerized P. *Different between methods in the same group (paired *t* test - P<0.05).

Considering the T wave polarity, similar values of positive and biphasic waves for Group F were observed in all methods. Negative waves were not observed in Group F. Controversially, a great percentage of positive waves compared to the biphasic waves were observed in Group F. Group M presented similar values for positive and biphasic waves in Cp and CpP methods. A great percentage of positive waves were observed in this group (Table 4).

Conventional ECG is a non invasive and feasible diagnostic method commonly used in veterinary medicine to access alterations in the cardiac rhythm, as well as baseline values of intervals, segments, amplitudes, and wave durations (Hoffman and Cranefield, 1964; Tilley, 1992). However, there is a requirement for more studies to obtain references values from the computerized ECG method in cats. The comparison of results from the three different methods (Cv, Cp, Cp P), highlighted that the P wave duration (ms) and QRS complex (ms), in both groups (F and M), featured significant increased values for the Cp and CpP methods with regard to Cv method (Tilley, 1992). Results in dogs were reported in a previous study, when the Cv, Cp, and CpP methods were compared (Wolf et al., 2000).

Table 4. Percentage of occurrence of the T wave in accordance to its polarity in cats submitted to conventional, computerized (monitor screen), and computerized P (printed recorded data) ECGs, according to gender

Group	Convencional ECG			Computerized ECG			Computerized P ECG		
	Polarity of the T wave			Polarity of the T wave			Polarity of the T wave		
	Pos	Neg	Biph	Pos	Neg	Biph	Pos	Neg	Biph
Female (n=16)	87.50	0	12.50	87.50	0	12.50	87.50	0	12.50
Male (n=14)	71.44	14.28	14.28	85.72	0	14.28	85.72	0	14.28

Pos: positive; Neg: negative; Biph: biphasic.

Other variables significantly changed when comparing the three different ECG methods, notably the P wave amplitude (mV), duration of the QT interval, and polarity of the T wave, nevertheless these results did not exceed the values preconized for the Cv method, which was also seen in another study with dogs (Wolf et al., 2000).

In the meantime, significant differences were not evidenced in some variables, such as duration of the PR interval (ms), R wave amplitude (mV), unlevelling of the ST segment, and MEA, in contrast with another study that reported these differences in dogs (Wolf et al., 2000).

Notwithstanding, the cardiac rhythm did not vary between the various ECG methods used in this study, been characterized as 100% sinus rhythm, in accordance with other authors, which verified rhythm constancy, independently of the method used, with the exception of respiratory sinus arrhythmia in all groups of dogs (Wolf et al., 2000). Such difference may be explained due to the higher activity of the sympathetic autonomous component present in the feline species when comparing with the canine, which more often shows enhanced of the parasympathetic tonus (Tilley, 1992; Kittleson, 1998).

The differences between the Cv and Cp methods seen in this study may be attributed to the higher accuracy of the computerized measurement because, according to Shiwen et al. (1996), this method is able to detect readings of 1ms, whereas the Cv method, the reading can only be made from 5ms, with paper speed of 100mm/sec. Moreover, it was noticed that the Cp ECG method allows monitoring for longer period, which ultimately makes it a value alternative in intensive care units and it confers the capacity of managing and storing larges volumes of electrocardiograms in a shorter period. In addition, it enables the concomitant observation of several leads, beyond an easier and faster method to measure waves and intervals (Tilley, 1992; Nunes, 2002). Furthermore, depending of the operational system, the informatized method shows reproducibility of its measurements, improves the control of quality, and allows comparisons between electrocardiographic tracings obtained in different periods.

In conclusion, this study ensures that there are differences among the three ECG methods herein evaluated, notably the computerized method, which showed mean values of duration of the P wave and QRS complex above the reference values preconized for the conventional method. Considering these differences, special attention should be given during the computerized electrocardiographic interpretation in both clinically healthy cats and those suffering from any cardiac disease.

Keywords: feline, electrocardiogram

RESUMO

Foram analisados e comparados, os registros eletrocardiográficos (ECG) obtidos pelos métodos convencional (Cv), computadorizado (Cp) e pela leitura direta do registro computadorizado impresso (CpP) de 30 gatos adultos sem raça definida, clinicamente normais e distribuídos em dois grupos: grupo F (n=16 fêmeas) e grupo M (n=14 machos). Para a análise estatística, utilizou-se o teste t. Não foi observada diferença entre os grupos. Entre os métodos, foram observadas diferenças quanto à duração em milissegundos da onda P e do complexo QRS, especialmente em relação ao método computadorizado.

Palavras-chave: felino, eletrocardiograma

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