Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883**
Sch. Acad. J. Biosci., 2013; 1(4):115-118

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com **DOI:** 10.36347/sajb.2013.v01i04.004

Research Article

Information condition of dog's skin at different pathologies

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Abstract: We investigated the information state of the skin of dogs with benign and malignant tumors. It was revealed that in all studied types of tumors information system of the skin becomes simpler, and as a result, increases its reliability and ordering, and the system is aimed at growth. It was found that the changes of information parameters are more pronounced in malignant pathologies than in benign tumors.
Keywords: Entropy, biosystem, skin, tumor, adaptation

INTRODUCTION

Changes in pre- and postnatal development of mammals in normal and pathological conditions are increasingly considered as a phenomenon caused by the dynamics of adaptation and regeneration capabilities of living systems at different hierarchical levels [2, 10]. To assess the ability of adaptation and regeneration proposed to use Shannon entropy and its derivatives of tissue parameters. Information state of the tissue is an indicator of adaptive capacity of biosystem [1, 3].

Several authors do not exclude the existence of a direct link between change of information state of system and the development of pathological processes in the period of appreciable senile changes. It is shown that in case of damage and adaptation responses in biological systems occurs a redistribution of energy-flow accompanying the process of restructuring the tissue. Small number of publications examine the information condition of organs and tissues [4-9,11].

From the above, it seems actual to study the information status of the skin in dogs at normal and at benign and malignant skin tumors.

MATERIALS AND METHODS

Was examined histologic specimens of a dog skin, with various pathological processes:

- normal (n = 54);
- at papilloma (n = 68);
- at fibropapilloma (n = 66);
- at angiopapilloma (n = 54);
- at squamous cell carcinoma (n = 54);
- at basal cell carcinoma (n = 61);

The diagnosis is based on data of postmortem and histologic examination. To determine the information status at focal lesions of the skin, pieces of tissue were taken from the least altered areas on the border with macroscopically distinct lesions. In case of visual homogeneity of organ material was taken from any part of it. Based on the concept of information in a tissue system, like the displaying of the diversity of morphology and function of the process for assessing the information status of organs and tissues have been proposed and tested the such indicators - information morphological capacity (H_{max}), information morphological entropy (H), information morphological organization (S), the relative morphological entropy (h) and redundancy (R) [1]. In this case, the baseline characteristics, which were used to calculate these parameters can vary widely (the linear dimensions of the structures, their number, etc.). In our study was defined the volume of the nuclei of skin cells.

Information morphological capacity H_{max}, which means the maximum structural diversity, calculated by formula [1]:

$$H_{max} = \log_2 n$$

where n - number of classes.

Next, we made the calculation of the real structural diversity H. Real structural diversity is the parameter that clearly illustrates the degree of determinism of morphofunctional system in time and space [1].The calculation was made using the formula:

$$H = -\Sigma P_i \log_2 P_i,$$

where ΣP_i is the sum of probabilities of stay of the measured parameter of cells in a one of existing classes; $\log_2 P_i$ - logarithm of the probability of staying in one of the possible classes. In this case, the value of P_i is defined as the classical probability [1].

Knowing the maximum and actual structural diversity, we can calculate the organization of the system (S), the difference between the maximum

possible and the real structural diversity (implemented structural diversity). This parameter, in our opinion, displays the state of the system adaptability to date. To determine the value of this parameter is used the formula [1]:

$$S=H_{max}-H.$$

It is necessary to consider that when $H = H_{max}$, the system is deterministic, but such relation to the vast majority of permissible is possible only in theory. Then we determined the coefficient of relative entropy of the system, or (the coefficient of compression of information) h by [1]:

$$h=H/H_{max}.$$

High levels of relative morphological entropy provide evidence of the disorder of the system and significantly reducing of its structural integrity [1].

The coefficient on the relative organization of the system (redundancy factor) R is given by [1]:

$$R=(S/H_{max})\times 100\%$$

With these data, the researcher have the opportunity to calculate the equivocation of the system (the value of reliability) *e* [1]

$$e=(H_p-H_n)/H_{max}$$

where H_n - real structural diversity in normal, H_p - real structural diversity in pathology.

Values are expressed as mean (± SD). The statistical analysis was performed using one-way analysis of variance (ANOVA). The statistical difference determined using repeated measures analysis of variance or paired Student t-tests. A p value of < 0.05 was considered statistically significant.

RESULTS

Skin of healthy dogs was characterized by the following parameters. H_{max} was 3.0±0.003 bit, rate of H is equal to 2.35±0.011 bits, respectively, S was 0.640±0.0014 bit, h - 0.7558±0.0044 bit (Fig.1), R equaled 21.62±0.85% (Fig.2).

Skin at papilloma characterized by decrease of H in comparison with the norm to 1.982±0.019 bits, the value of S was much higher than normal, making 1.016±0.019 bits, h on the contrary, decreased to 0.6661±0.005 but, R was significantly increased to 33.80±0.69%. *e* ratio was -0.4165±0.0065.

At fibropapilloma the value of H also decreased to 1.950±0.027 bits, S was 1.025±0.027 bits, h was decreased to 0.6505±0.0032 bit, and R is increased to 34.99±1.27%. The value of *e* was -0.442 ± 0.027.

At angiopapilloma informational parameters of skin similarly differ from the norm. So, H value was 1.95±0.019 bits, S was equal to 1.025±0.019 bits, h reached 0.6500±0.006 bits, R reached 35.91 ± 1.9%, and *e* was -0.4495 ± 0.007.

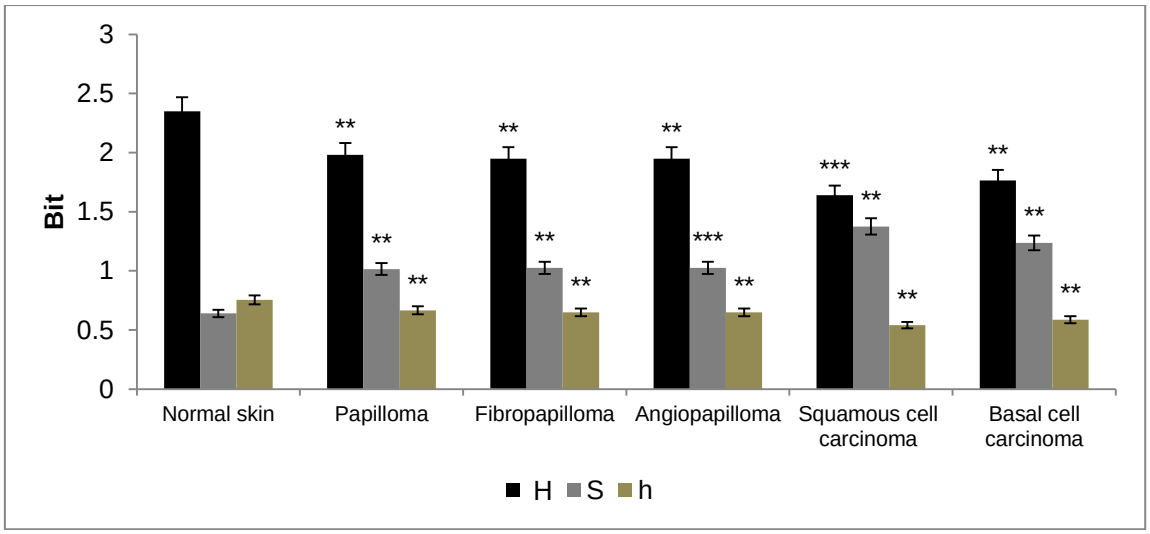

Fig. 1: Magnitude of the H, S and h in normal skin of dogs, and in examined pathologies. Statistical significance was assessed using Student t-test. * indicates P<0.001, ** indicates P<0.01, * indicates p<0.05.**

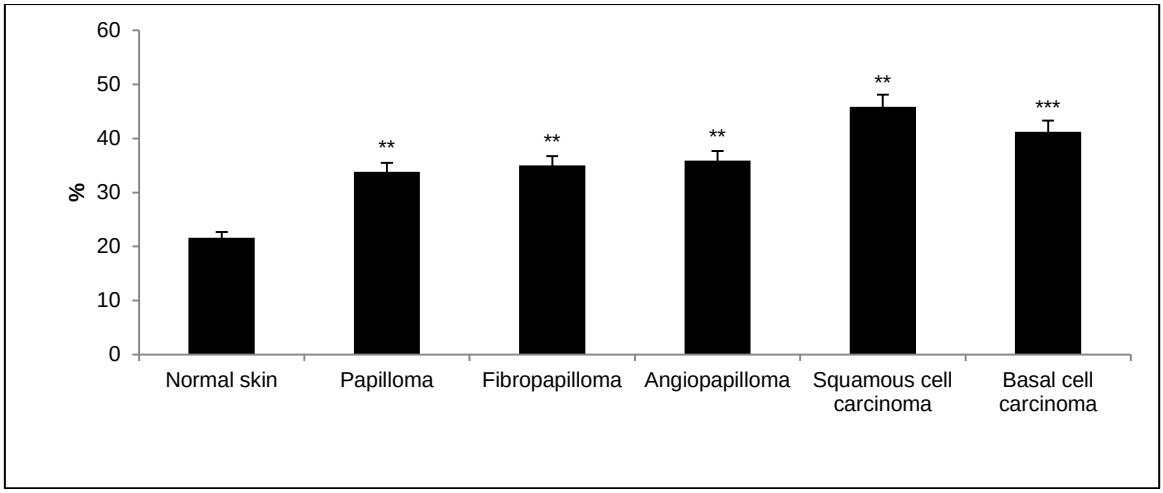

Fig. 2: Value of the R index in normal skin of dogs, and in examined pathologies. Statistical significance was assessed using Student t-test. * indicates P<0.001, ** indicates P<0.01, * indicates p<0.05.**

For dog skin at squamous cell carcinoma we found the H equal 1.624±0.015 bits, S was 1.3755±0.015 bits, h - 0.5415±0.007 bits, R equaled 45.85±1.27%, and *e* is equal to -0.773 ± 0.0153.

At basal cell carcinoma informational parameters of dog's skin similarly differ from the norm. So, H value was 1.7652±0.019 bits, S was equal to 1.2375±0.019 bits, h reached 0.5874±0.009 bits, R reached 41.25 ± 1.1%, and *e* was -0.6385 ± 0.004.

DISCUSSION AND CONCLUSION

At oncological diseases of the skin of dogs take place a decrease of both total and relative entropy of the system against the decrease of its structural diversity and increase of the rate of redundancy. The information system of the skin at tumors is simplifying, and as a result, there is an increase of its reliability, ordering, and the system aims to increase that may be the consequence of the compensatory-adaptive reactions in the body, and in the case of innidiation of malignant tumors. Changes of the information parameters are more pronounced in malignant pathologies than in benign tumors. Thus, the information state of skin papillomas in dogs indicates a higher level of adaptation and regeneration opportunities authority than in malignant tumors.

ACKNOWLEDGMENTS

This work was supported by Moscow regional state university.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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