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The Effect of Ferulic Acid and D`Arsonwal's High Frequency Currents Activity over the Number of Exanthema among Adult Women

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ABSTRACT

Acne vulgaris is one of the most often diagnosed dermatological diseases. With some people, it can appear after a period of puberty, however with the others; it can emerge in their young age and last continuously in their adulthood. Current research has shown that acne among mature patients occurs usually after the age of 25.

The purpose of the following work it to evaluate the treatment procedures based on Ferulic acid application and d`Arsonwal's high frequency currents in the context of reduction of exanthema in inflammatory and non-inflammatory stage among patients above the age of 25 with mild and moderate type of acne.

60 women took part in the research and they were randomly divided into two groups. Ferulic acid, manually applied on faces, was used on probands from the first group. On the other hand, the probands from the second group were treated with d`Arsonwal's currents, by using contact method in the area of skin on the face.

The research conducted, proved positive effect on skin face of both Ferulic acid and d`Arsonwal's high frequency currents. As a result of application of one or the other series of treatments, the number of exanthema both inflammatory and non-inflammatory was significantly reduced.

Combined treatment of acne vulgaris may be supported with success by procedures working externally on skin, such as emission of d`Arsonwal's currents and Ferulic acid application.

Keywords

Acne vulgaris, D`Arsonwal's currents, Ferulic acid, Skin.

Introduction

Acne vulgaris is a chronic and recurring seborrhoeic disease. The exanthema of different character: microcomedones, blackheads, whiteheads, papules, pustules and inflammatory nodules cover most of all face area (forehead, chin, nose, cheeks), chest and back. In severe stages, it can lead to lasting and often enough extremely disfiguring scars. Their visible location is usually an additional emotional burden for the people inflicted with this disease and it definitely lowers their quality of life.

Acne vulgaris was initially identified with puberty. Now, it is known, also because of Loughlin's personal research published in 1964, that the illness can emerge also in the adulthood. At that moment, because of the occurrence time of the disease, two types can be distinguished:

- Puberty continuation – persistent acne,
- Symptoms, whose beginning is noticed around the age of 25- late onset acne [1].

In a subject literature, information can also be found about some researchers that distinguish reoccurring acne among adult women.

It is described, as disappearing after puberty, to reactivate in the period of adulthood [2].

The typical skin changes connected with acne vulgaris are first of all, blackheads or whiteheads, more seldom papules and pustules [3]. This fact is also confirmed in research of H.C.Williams, who also underlines the inflammatory character of papules and pustules and non-inflammatory type of above mentioned comedones [4].

It is assumed that pathogenesis of acne among adult women covers most of all, excessive sebum production, disorder of follicular xeroderma and comedo formation in hair follicles and colonization of the follicle by Propionibacterium acnes and inflammatory stage [5]. What is more, the research also proved a significant role of other factors such as: genetic predisposition, hormonal changes, long-lasting stress, and diet with high glycemic index, comedogenic cosmetics and smoking cigarettes [6].

The example of research over genetic predispositions oriented towards acne vulgaris is among all research done by Dumont-Wallon. The author of research had analysed a treatment group of 79 women above the age of 25, where the average age of probands was 31.8. The above mentioned research proved the appearance of Acne vulgaris among first line relatives of 59 % of women taking part in the research [7].

The researchers pay attention in a different degree to the effect of hormones over the development of acne changes. Even 85% of women with diagnosed acne can experience more severe course of the illness in the days preceding menstruation. Stoll's study partly confirmed this phenomenon and showed increasing tendency of symptoms in a direct proportion to age. A definite increase of changes in premenstrual period was declared by 39% probands between 20-33 years old and in the age group above 33, it was 53%. [8]. In the subject literature, a suggestion is raised that excessive sebum observed among adult women may be treated as an indicator of disorders having hormonal or genetic background. However in the clinical practice, there has been observed a large number of adult patients with dry skin, that for now creates an open field research [6].

Numerous therapeutic schedules are used in the treatment of Acne vulgaris, that are published in the international literature. It is recommended to use cosmetic formulations of a moisturising character with them. It usually does not influence the efficiency of treatment process [7,9]. It is worth remembering however, to beware of comedogenic activity of some substances, that may worsen the state of the illness afflicted skin [9].

Among the factors that make the process of acne more severe are stimulating substances, especially tobacco. The increased number of acne changes was confirmed especially among women after the age of 25, who systematically smoked cigarettes [10].

Nowadays, many researchers also notice the occurrence of relationship between high glycemic index of food consumed and worsening the state of skin afflicted with acne vulgaris. The research papers, devoted to this topic, very often suggest keeping a diet based on products with low glycemic index during the therapy [11].

Everyday exposition to stress, may also be one of potential factors that can worsen the state of skin of patients with acne. Nervous tension may cause the activating of inflammatory skin stage and appearance of skin exanthema [7].

In the development of the discussed affliction, a very important part is played by Propionibacterium acnes. The resistance of discussed bacteria to earlier administered antibiotics (Tetracycline, Macrolide) was confirmed by Goulde at as far as 82% of studied adult women [12].

Ferulic acid

Ferulic acid is a naturally appearing plant product, that is formed by metabolising Phenylalanine and Tyrosine. It is very often encountered in fruit and vegetables (tomatoes, corn, rice bran and wheat grain). It is easily absorbed from the diet and its high concentration level remains longer in blood than vitamin C [13]. The research point out its anti-oxidative, anti-bacteria, antivirus, anti-inflammatory and anti-thrombosis activity [14, 15].

The discussed acid is called: the effective sweeper of free radicals. Because of its properties of stopping lipid peroxidation, in some countries it was even approved as a food additive [16]. The positive comments in the subject literature regarding the properties of Ferulic acid seem to suggest that applying it as a supportive substance of treatment of acne vulgaris may be the right move.

Human immune system usually works against free radicals and reactive oxygen species (ROS) appearance in hair-sebaceous units. The popular antioxidants, such as vitamin C protect against the oxidative impairment of proteins, but also the skin integrity. The excessive number of ROS lowers the level of antioxidative substances and can cause the worsening of the condition of skin afflicted by acne vulgaris [17]. C. Rota demonstrated the strengthening of effectiveness of Benzoyl peroxide through vitamin E in the process of acne vulgaris treatment [17]. P. Ozuguz also researched the levels of vitamin E in serum and he confirmed lower intensification of changes in the groups with severe stage of acne vulgaris [17]. Next, O.H. Mills used with patients treated with a mixture of salicylic acid and Benzoyl peroxide, additionally five per cent vitamin E suspended in sunflower seed oil. After eight weeks, significant decrease of inflammatory and non-inflammatory exanthema was concluded [17]. The quoted data show that the application of antioxidants limits oxidative stress in hair- sebaceous units. They can therefore play the supportive part in acne vulgaris treatment.

D`Arsonwal's currents

The human body is a perfect set of conductors. For many years, the scientists have been using this attribute and have been finding positive influence of exposition of organism to electricity.

D`Arsonwal's currents are qualified as high frequency currents, with wave length of 1000-600 m and frequency of 300 – 500 kHz. D'Arsonvalization can be used in seborrhoeic skin treatment with tendency towards acne vulgaris [18].

The apparatus producing currents has a glass bulb (an electrode attachment) filled with noble gas. After bringing it closer to patient's body, sparks appear, in a colour depending on the gas filling the bulb. Neon lights in blue, air in purple and xenon in red. The biological activity of D`Arsonwal's currents causes changes in muscular coat tension of blood vessels in skin and their impulsive expansion and in consequence faster metabolism locally in tissues. Both: produced heat and irritation of sensory neurons in skin is very weak [19].

The electrostatic discharges of high frequency currents that include D`Arsonwal's currents are connected with ozone production- one of the strongest antioxidants. Ozone possesses very high bactericidal, fungicidal and virucidal properties. It results from its high oxidoreductive potential, that destroys enzyme structures of microorganisms. What is crucial, is that this destructive property is also perpetuated in relation to anaerobic bacteria. Therefore, the procedures with the use of D`Arsonwal's currents are often used among others, in treatment with badly healing wounds, diabetic foot or different kinds of bacterial infections [20]. The application of D`Arsonwal's currents in the therapy of acne vulgaris seems to have a scientific foundation.

The Purpose of Work

The purpose of the following work it to evaluate the treatment procedures based on Ferulic acid application and d`Arsonwal's high frequency currents in the context of reduction of exanthema in inflammatory and non-inflammatory stage among patients above the age of 25 with mild and moderate type of acne.

Methods and Materials

People qualified to take part in research had to fulfil particular requirements, among others, connected with sex, age, health and the state or type of skin. Therefore, the inclusion criteria were: sex-woman, age-above 25 years old and right type of skin- oily with changes characteristic for acne acne vulgaris.

The exclusion criteria were: pregnancy, the period of breastfeeding, violation of continuity of epidermis, acute or chronic infections, acne rosacea, atopic skin or skin with seborrhoeic dermatitis, undergoing surgical procedures within the last 6 months and around face area, using retinoids up to six months back, oral intake of antibiotics within the last 3 months, and local anti-acne medications in a period shorter than 4 weeks. The disqualification also included people with metal implants or simulators.

Because of the initial verification, the research was conducted on 60 women, randomly divided into two research-treatment groups. Keeping the integrity of sex of researched probands was a purposeful procedure. Its intention was to eliminate diversity factor of the results acquired in consequence working of different hormonal composition.

The first group of probands, after skin cleansing, were applied Ferulic acid with manual method and it was left for 6 minutes. Second group probands were applied d`Arsonwal's high frequency currents by using contact method directly onto the skin with the use of a glass bulb in a shape of a mushroom, also for 6 minutes. In both groups the applications were done in series, for the time period of 5 weeks, where one treatment was done once in every 7 days. In the process of treatment and in between treatments, all women used delicate, non-irritant agents for face washing and moisturising creams.

Before and after the series of treatments, in each of the groups, the effectiveness of therapy was evaluated, based on the number of skin exanthema, with the distinction into inflammatory and non-inflammatory ones. Photographic documentation was also gathered.

All the probands voluntarily and in written form gave permission to participate in the discussed study. Each of the women was informed, as early as the preliminary stage, about the purpose, duration time and the way of realising the study. The information was given, regarding potential risk, inconvenience or dangers and anticipated advantages. What is more, the participants were instructed regarding their rights and obligations. Additional questions that might have appeared while treatment process, could be asked directly by the probands to the person conducting the treatment.

The study was conducted with the agreement of Independent Bioethics Commission for Research at Medical University of Gdańsk (decision number: NKBBN188/2014).

Statistical Methodology

All the calculations were conducted by using statistical software StatSoft. Inc. (2014). STATISTICA (data analysis software system), version 12.0. www.statsoft.com and Excel spreadsheet.

Quantitative variables were characterized by using Arithmetic mean, standard deviation, Median, minimum and maximum value (scope), and 95% CI (confidence interval). On the other hand, qualitative variables were represented by using numerousness and proportion value (percentage).

In order to control if quantitative variable was a result of population with normal distribution, W. Shapiro-Wilk test was used. However, to control the hypothesis regarding equal variants, Leven (Brown-Forsythe) test was applied.

The gravity of differences between two groups (the model of unrelated variables) was tested by using the significance of differences test: student's t-test, (or in case of lack of homogeneity of variants -Welch test) or Mann-Whitney U test (in case of non-compliance of conditions of applying student's t-test or variables measured on ordinal scale).

The significance of differences between more than two groups was checked by using F test (ANOVA) or Kruskal-Wallis test (in case of non-compliance of conditions of applying ANOVA). In case of receiving significant statistic differences between the groups, post hoc analysis was applied (for F test – Tukey test, for Kruskal-Wallis- Dunn test).

In case of two variables interrelated model, student's t-test was applied or Wilcoxon signed-rank test (in case of non-compliance the conditions of applying student's t-test or for variables measurements on ordinal scale). The significance of differences between more than two variables interrelated model was checked by using variants analysis with repeated measurements or Friedman test (in case of non-compliance of conditions of applying the variants analysis with repeated measurements or for two variables measured on ordinal scale).

Tests of independence, A chi-squared test, were used for qualitative variables (adequately with the use of correction according to Yates for the numerousness of cells below 10, checking Cochran's conditions and precise Fisher test).

In order to find connection, force and direction between variables, correlation analysis was used, by calculating Pearson or/and Spearman correlation coefficient. In all calculations the level of gravity was acknowledged at p=0.05.

Results

Age

In the proband group that was applied Ferulic acid, the average age is 30,8 (4,8) range 24-42 years), and in the group with D`Arsonwal's currents applied, the average age is 30,3 (4,9) (range 23-42 years). No significant statistic differences regarding the age of probands in the compared groups were stated (p=0,7303). The detailed data was shown in Table 1.

		Ferulic Acid (N=30)	D`Arsonwal (N=30)	Together (N=60)	p-value
Age	avg. (SD)	30,8 (4,8)	30,3 (4,9)	30,6 (4,8)	[1]0,7303
	Range	24,0-42,0	23,0-42,0	23,0-42,0	
	Median	30,0	30,0	30,0	
	95% CI	[29,0;32,6]	[28,5;32,2]	[29,3;31,8]	

Table 1: Characteristics of researched groups regarding age. [1]t-Student (0,35).

Inflammatory exanthema

The average number of inflammatory exanthema before the first treatment regarding the group with ferulic acid application is 3,8 (4,3) (range 0-13) and in the group with D`Arsonwal's currents application is 7,0 (5,1) (range 0-22). In the D`Arsonwal's currents group, the number of exanthema before first treatment was significantly higher, in comparison to the Ferulic acid group (p=0,0099).

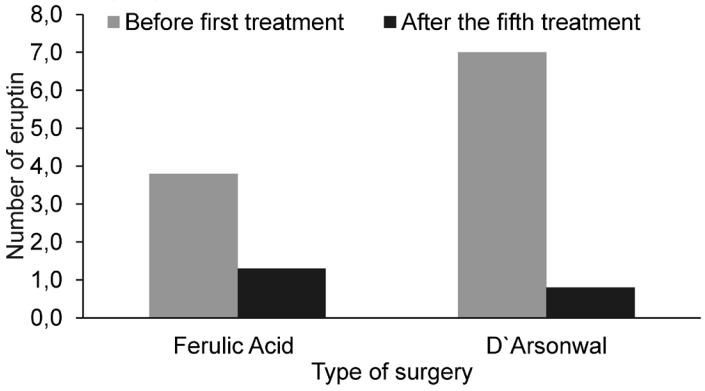
Tha average number of exanthema after the fifth treatment in the Ferulic acid group equals 1,3 (2,1) (range 0-6), and in the D`Arsonwal's currents group equals 0,8 (1,5) (range 0-6).No significant statistical changes in the number of inflammatory exanthema was noticed between the groups after the fifth treatment (p=0,6204).

With the probands in the Ferulic acid group, the number of inflammatory exanthema after the fifth treatment was significantly lowered (p=0,0002). In the D`Arsonwal's currents group, the number of inflammatory exanthema after the fifth treatment was also significantly lowered (p=0,0001).

The detailed data was shown in: Table 2 and Figure 1 (The average number of inflammatory exanthema in the tested groups before the first treatment and after the fifth treatment).

		Ferulic Acid (N=30)	D`Arsonwal (N=30)	Together (N=60)	p-value
Before 1 treatment	avg. (SD)	3,8 (4,3)	7,0 (5,1)	5,4 (4,9)	[1]0,0099
	Range	0,0-13,0	0,0-22,0	0,0-22,0	
	Median	2,5	7,0	5,0	
	95%CI	[2,2;5,4]	[5,1;8,9]	[4,1;6,7]	
After 5 treatment	avg. (SD)	1,3 (2,1)	0,8 (1,5)	1,0 (1,9)	
	Range	0,0-6,0	0,0-6,0	0,0-6,0	
	Median	0,0	0,0	0,0	[2]0,6204
	95%CI	[0,5;2,1]	[0,2;1,3]	[0,6;1,5]	
	Wartość p	[3]0,0002	[4]0,0001		

Table 2: The characteristics of researched groups in the context of number of inflammatory exanthema before the first treatment and after the fifth treatment.
[1]U Mann-Whitney (-2,58); [2]U Mann-Whitney (0,50); [3]Wilcoxon (3,77); [4]t-Student (7,59).



Non-inflammatory exanthema

The average number of non-infammatory exanthema before the first treatment in the Ferulic acid group is 12,4 (8,5) (range 0-37), In the D`Arsonwal's currents group, it is 11,3 (7,0) (range 2-25).

No significant statistical changes in the number of non-inflammatory exanthema was noticed between groups before the first treatment (p=0,6414).

The average number of exanthema after the fifth treatment in the

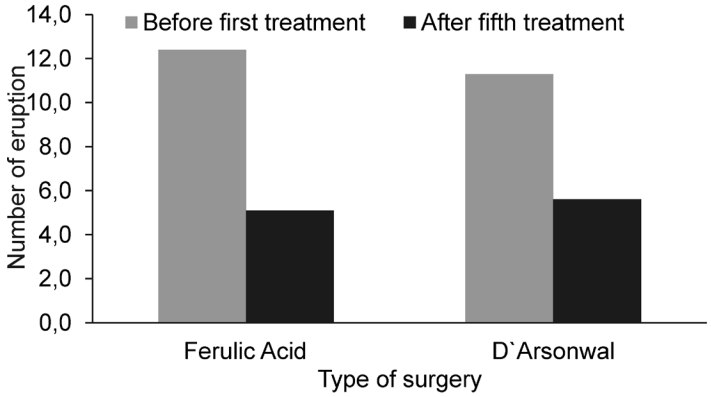
Ferulic acid group is 5,1 (6,1) (range 0-26) and in the D`Arsonwal's currents group, it is 5,6 (4,1) (range 0-16). No significant statistical changes in the number of non-inflammatory exanthema was noticed between the groups after the fifth treatment (p=0,1809).

With the probands in the Ferulic acid group, the number of non-inflammatory exanthema after the fifth treatment was significantly lowered (p=0,0001). In the D`Arsonwal's currents group, the number of non-inflammatory exanthema after the fifth treatment was also significantly lowered (p=0,0001).

The detailed data was shown in: Table 3 and Figure 2 (The average number of noninflammatory exanthema in the tested groups before the first treatment and after the fifth treatment).

		Ferulic acid (N=30)	D`Arsonwal (N=30)	Together (N=60)	p-value
Before 1 treatment	avg. (SD)	12,4 (8,5)	11,3 (7,0)	11,8 (7,7)	
	Range	0,0-37,0	2,0-25,0	0,0-37,0	
	Median	12,0	10,0	11,0	[1]0,6414
	95%CI	[9,2;15,5]	[8,7;13,9]	[9,8;13,8]	
After 5 treatment	avg. (SD)	5,1 (6,1)	5,6 (4,1)	5,3 (5,2)	
	Range	0,0-26,0	0,0-16,0	0,0-26,0	
	Median	3,0	4,0	3,5	[2]0,1809
	95%CI	[2,8;7,3]	[4,1;7,1]	[4,0;6,7]	
	p-value	[3]0,0001	[4]0,0001		

Table 3: The characteristics of researched groups in the context of number of non- inflammatory exanthema before the first treatment and after the fifth treatment.
[1]U Mann-Whitney (0,47); [2]U Mann-Whitney (-1,34); [3]t-Student (6,87); [4]t-Student (6,29).



Discussion

In the researched group, the average age of patients was determined at 30.6. That number corresponds with the results achieved by Szepietowski and Dreno, who, in their study, define the exanthema that appear after the age of 25 as adult acne [21,22]. Also Poli, when comparing the clinical characteristics of acne among adult women in France and Africa, accepts the age limit at 25 years old [23]. The average age of probands in the researched groups that was determined at 30.6 years old is therefore in accordance with the age ranges that were proposed by the researchers.

The study of Saij that were performed both in vitro and in vivo, with the use of Spectrophotometry, demonstrate the activity of Ferulic acid as a protective barrier against UV radiation [24]. That fact is confirmed in the Monti and associates study. The scientists proved that gel formulations that in their content include Ferulic acid, in comparison with the texture of oil in water, provide better sunscreen protection in the upper layers of skin, about 15 micrometers deep [25].

UV radiation absorption by Ferulic acid on skin stops the production of reactive forms of oxigen aka free radicals. At the same time, because of acid function, the capability of skin to defensive reactions is increased. It is worth noticing, that one of the characteristic phenomenon of acne vulgaris process is the appearance of bigger number of free radicals. The huge cumulation of reactive forms of oxygen can lead to damaging the cell structures, therefore to oxidative stress. G. Sarici, while researching a group of patients with acne diagnosis and a controlled group, demonstrated the role of oxidative damage of tissues in the appearance of acne. While conducting research analysis, the level of catalase (CAT), superoxide dysmutase (SOD), xantine oxidase (XO), nitric oxide (NO) and malondialdehyde (MDA) in venous blood was measured by using Spectrophotometric method. In the group of probands with acne, the levels of MDA, XO and NO were proved to be higher when compared with the controlled group, at the same time, pointing out oxidative damage of tissues as a reason of acne [26].

Because of effective fighting against harmful free radicals and suppressing oxidative reaction that appears after radiation, Ferulic acid may play an important function of an antioxidant in preserving the physiological integrity of cells exposed to air effect and UV radiation. What is crucial, adding the discussed acid to substances used externally, allows keeping its protective function [27].

The formulations with Ferulic acid provide unusually broad range of affecting possibilities because of its properties. It is visible, among all, in Cassano and Lin research. While conducting the study, gel with vitamin E and C supported by ferulic acid was placed on the skin of rabbits and it achieved much better results in protection against vitamin photodegradation than gel that did not include the discussed acid [28, 29]. The added value, during application of formulations containing ferulic acid, is the possibility of application no matter the season of the year or the degree of insolation. It is possible, because the discussed acid is a natural sunscreen fiter that practically does not cause any irritation. Thanks to that fact, therapeutic processes can be extended and the operation of other active substances can be strengthened [30].

Personal research conducted, that is the basis of this article, has demonstrated statistically important reduction of inflammatory exanthema and also and most importantly non-inflammatory afters the application of formulation with Ferulic acid. One can therefore venture a statement that introduction of the discussed acid in formulations used in acne vulgaris therapy is justified. The effectiveness of Ferulic acid makes it in every case, an attractive

and safe healing alternative.

D'Arsonowal currents belong to a group of high frequency currents, as they have frequency of 300–500 Hz. Their effect generates electric field in human tissues that corresponds with the frequency of these currents. It leads to, as a result of ionic friction, the production of relatively low quantity of heat in tissues. In the near vicinity of condenser electrodes that emit currents, ozone is produced [18]. The study regarding the effectiveness of d'Arsonowal currents was begun many years ago by Roucayrol [31].

The ozone can be potentially dangerous for human beings, just because it significantly increases the risk of damaging skin cells. F. Afaq, on the basis of the research conducted, suggested among others, that the contact with ozone can bring toxicologically undesired effect. The negative influence, however, in large degree depends on the concentration of discussed gas, exposition time and the way of contact [32].

Valacchi, Fortino and Bocci, while conducting their research regarding ozone, in a certain extent confirmed F. Afag's observation concerning the subject of negative effect of the discussed gas on human organism. The emission of a too huge amount of ozone can in fact be an undesired factor influencing human health. Among others, the harmful effect of excessive exposition to gas on respiratory system and immunological system was demonstrated and its influence over appearance of strong oxidative stress. Still, in controlled dosage, the discussed gas becomes a perfect antiseptic resource, that supports healing processes of skin infections [33].

Since the beginning, the attention of the members of the scientific community was first of all focused exactly on bactericidal possibilities of produced, while conducting treatment with the use of high frequency currents, ozone.

M. Gloor did a study on a group of 16 probands, applying ozone therapy with the measurement of thin layer chromatography. The acquired result did not demonstrate the lowering of the number of free fatty acids, therefore the ozone did not cause bactericidal effect on the skin layer [34]. Nevertheless, since second world war, in preservative dentistry, ozone generators are commonly used. They are used as a support, in both safe and precise manner, the treatment of badly healing wounds within the oral cavity. M. Nagayoshi with associates, decided therefore to analyse the effect of ozonated water on dis-activation of bacteria directly influencing periodontum illnesses. The research confirmed bactericidal properties of ozone and specially susceptible to it are anaerobic bacteria [35].

As one of the main reasons of acne vulgaris, the subject literature often mentions excessive colonisation of anaerobic bacteria Propionibacterium acnes. The scientists: Lynch and Swift confirmed, with their work, the elimination of bacteria by using ozone in a gas form. This fact seems to be highly useful in the context of feasibility of application of the discussed gas on the skin form in this exact state [36].

Białoszewski, while analysing in vitro strains of bacteria Staphylococcus aureus and Pseudomonas aeruginosa demonstrated higher effectiveness of ozonated water than the mixture of ozone with oxygen [37]. However Halbauer, while analysing the influence of ozone over the infection of dental canals, used ozone in the gas state. In his studies, he confirmed a significant decrease of number of Streptococcus mitis and Propionibacterium acnes identified earlier in collected samples [38].

Personal research that was discussed earlier, shows a statistically significant change in the number of exanthema- mainly inflammatory but also non-inflammatory after the application a series of treatments with the use of high frequency currents. Such a fact confirms the concept of using of d'Arsonowal currents as a method of combating anaerobic bacteria, involved in pathogenesis of acne vulgaris.

Even though, the probands were assigned to particular groups randomly, it turned out that, in the d'Arsonowal currents group, there were more patients with inflammatory exanthema. The comparison of the number of that kind of exanthema on every stage of study between groups, did not demonstrate statistically essential differences. The greatest reduction of inflammatory exanthema was observed just after the fifth and final treatment. It especially regarded people that were applied with d'Arsonowal currents that produced ozone. A higher effectiveness in the reduction of non-inflammatory exanthema was by contrast achieved after a series of treatments with the use of formulation enriched with Ferulic acid.

Summary

The research over the influence of Ferulic acid and d'Arsonowal currents over the number of inflammatory and non-inflammatory exanthema among adult women with diagnosed acne vulgaris, proved the decrease in the number of exanthema and improvement of probands' skin condition. The results gained, demonstrate that both methods applied on the surface of the skin may be used interchangeably in a mild stage of acne and they can support pharmacological treatment with more severe stages of acne. Because of possibility of lowering oxidative stress by using Ferulic acid, and at the same time anti-inflammatory properties of d'Arsonowal currents, it seems reasonable to apply both methods while performing single treatment. The application of Ferulic acid does not stand in counter-indication for emission of d'Arsonowal currents on the surface of the skin. It is sensible to expand the research with another group of probands that will undergo both methods at the same time. It is therefore possible in this case to demonstrate even higher effectiveness over the decrease of exanthema of both provenance in the process of Acne vulgaris.

Compliance with Ethical Standards

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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