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Antinociceptive effects of color polarized light in animal with formalin test

Our recent results show the efficacy of pain suppression by exposure of antinociceptive acupuncture points (APs) to white polarized (P) light. But it is known that white light contains electromagnetic waves of different length (colors) and, possibly, not all of them produce a similar effect. There are no comparative data about analgesic effects of the different colors of P light now. The purpose of this study was to clear up a question if analgesic effects of low-intensity P light depend on the color of light/wavelength. Formalin-induced pain behavior (licking of the painful area) was tested in control mice and mice exposed to one of the color of P light (red, orange, yellow, green, blue, violet) on the painful area or AP E-36. Exposure of the painful area or AP E-36 to color P light evoked a statistically significant decrease of the licking time in mice to 31.5-64.1% and 36.1-54.4% respectively. The red light was the most effective for pain behavior depression, analgesia averaged 64.1% and 54.4% accordingly. The analgesic effects of red light in compare to three "cold" colors (blue, green, and violet) and white light was more pronounced in case of its application on the painful area than on AP E-36. In conclusion, the intensity of analgesic effects of P lights strongly depends on its color (wavelength). Key words: color polarized light, formalin test, analgesia, acupuncture.

INTRODUCTION

White light includes all colors of the visible spectrum and ranges in wavelength from about 400 nanometers (nm) to about 780 nm. Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. For many centuries white and color light has been used for medical purposes (phototherapy). It is known that in the Middle Ages some mental diseases were cured by means of the color stained glass. Now light of blue lamps is used to cure jaundice, seasonal mental disorders, blood pressure decrease, insomnia, pain and pre-surgical treatment [3, 11, 13, 20, 27, 46]. During last years laser light draws a particular attention of many physicians. Laser produces a coherent polarized (P) light of only one frequency (one color) which travels in almost parallel lines with very little spreading. Low-intensity, soft, laser irradiation has been successfully used to provide analgesia in people and animals [19, 30, 32]. It has

been shown that low-intensity red laser light effectively suppresses acute and chronic pain [37, 43].

Now incoherent P light widely used for pain therapy. Incoherent P light is a spectrum of electromagnetic waves in an optical range, which have different frequencies that do not coincide in phase and, consequently, are not potentiates. One of the instruments emitting low-intensity incoherent P light is Bioptron device (Switzerland).

Our recent experimental data showed the notable pain suppression by exposure of antinociceptive acupuncture points (APs) to low-intensity white P light produced by Bioptron [28]. Thus, application of white P light to analgesic APs of mice, which had previously received a formalin injection (formalin test), reduced the pain behavioral response (licking of painful area) approximately by two times, and raised the pain threshold of acute pain [28].

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It is known that white light contains electromagnetic waves of different length and, possibly, not all from them cause the identical analgesic effect. The aim of the work was to ascertain if the analgesic effect depends on the wavelength (color) of P light. It was extremely important to find the color possessing the strongest pain-suppressing effect. The research provides for a quantitative assessment of pain intensity before and after application of light of Bioptron device equipped with different color filters.

METHODS

Experiments were carried out on outbred, adult male, albino mice weighing 27 g to 33 g. The animals were maintained in a vivarium with a controlled temperature (20 ± 1 °C) and 12 h dark-light cycle (lights on at 08:00). Animals were keeping in cages with thick sawdust bedding and had free access to water and food. All behavioral experiments were performed between 10:00 and 12:00. The mice were individually housed in plastic cages (36 cm x 24 cm x 5 cm) and brought to the test room three days before testing (for adaptation). Animals had a free access to water and food and were exposed to a standard 12:12 hour on/off light cycle. Each mouse was used in one experiment only. After experiment the mice received a lethal dose of urethane (intraperitoneally). All experiments were performed in accordance with the ethical standards of a responsible committee, the Helsinki Declaration and IASP's guidelines for pain research in animals [51].

The painful area was induced by injection of 5 % formalin solution (dissolved in 0.9 % solution of NaCl) in dorsal surface of left hind foot. Injections were performed subcutaneously (s.c.) with 26-gauge microsyringe in the volume of 10 μ l on every 10 g of mass. The *formalin test* was introduced as a model of tonic pain in 1977 [12], and has since been used extensively in rats and mice.

At once after an injection of formalin the mouse was exposed (during 10 minutes) to P light. On this period mouse was placed into the small plastic cages with a hole for the left hind limb. The cage was fixed to a tripod with a special clamp, and the researcher carefully restrained the left hind limb during light exposure. The control group received imitation of light application. They were sitting 10 min in the same plastic cages but without P light exposure. The cages in which the mice were restrained for treatment were clear. The room was bright as usually. A Bioptron Compact (Bioptron AG, Switzerland) was used as a light source. The power density of this device is 40 mW/cm²; light energy per minute is 2.4 J/cm² (<http://www.bioptron.com>). White light passed through a polarizing system of Bioptron device contained electromagnetic waves of an optical range from 480 nm to 3400 nm. No ultraviolet light was presented. It was not pulsing light. Light polarization up to 95% occurred while reflecting the light flow at Bruster angle. A five-layer pile, consisting of plane-parallel glass has been used as a deflector. Six color filters permitted us to receive of one of six color lights: red, orange, yellow, blue, green and violet. Without color filters we had the white light. Each color was tested on two groups of mice: in one group the light was directed to AP E-36 (zusanli) on the left extremity (Fig. 1), in the other it was applied directly

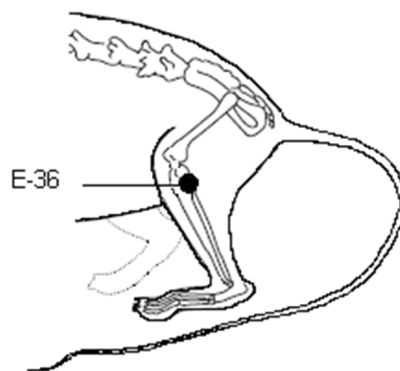


Fig. 1. Localization of the acupuncture point (AP) E-36 on the left hind limb of mice

to the painful area. The opaque nozzle created a beam 5-mm in diameter. The light filter was held 5 cm from the surface of the skin. It is well known that AP E-36 (stomach meridian) is one of the most effective points in Chinese medicine for the treatment of pain. At animals this AP is located on the lateral tibial prominence, 1/5 of the distance from the knee to the ankle. This way of a finding of the point corresponds to the human measurement system, in which the distance from the knee to the ankle is said to be 16 cun (zusanli, at 3 cun, is thus about 1/5 the distance). The E-36 point is in the middle of the cranial tibial muscle belly [8, 10, 14, 29, 39]. It innervated through a common tibial nerve from the LIV – LV segments of the spinal cord [47] the same segments innervate the back of foot in humans and rodents [6, 48].

Hundred and sixty mice were divided into fifteen groups: fourteen experimental (each involving 10 animals) exposed to one of the color of P light after formalin injection, one control (n = 20) received formalin injection and imitation of P light exposure.

After finishing the P light session (experimental animals) or imitation of light application (control animals), the mouse was returned in the cage, and the behavioral response (BR) to pain - licking of the injected foot - was observed for 60 min. Special computer program has been created to supervise over the behavior of animals. Pressing of a corresponding key of the computer keyboard marked the beginning of licking of the staggering paw. Pressing of other key marked the moment of the ending of a licking cycle. A computer program allowed calculating the duration of licking for any chosen interval of time was used. In this article the data on duration of painful reaction (licking of the source of pain) in consecutive 10 min and for all period of supervision as a whole (60-min) are resulted. Plots of the duration for pain BR, at 10-min interval, and for the 60-min observation period, were constructed (after finishing the experiment).

Skin temperature measurements were performed in two groups of mice (each involving 5 animals) which were treated in a manner identical to that described above but without formalin injections. In each animal, AP E-36 was exposed to P light (for 10 min). For the first group it was a red light, for the second – green light. Skin surface temperature was monitored by a precision electronic thermometer, and a shift of $\pm 0.1^{\circ}\text{C}$ used as a maximum limit for temperature variation during a single experiment. The sensor (microthermoresistor MT-54 “M” in glass insulation with the tip of 0.7 mm) was placed on the skin surface at the site of light exposure. Skin temperature was measured every 60 s: 3 times before P light application, 10 times during light exposure and 4 times after the source of P light switching off.

The duration (in sec) of pain BRs was measured and exposed as a mean \pm SEM. Comparisons between the groups were carried out by using one-way analysis of variance (ANOVA), followed by a Student's *t* - test. Statistically significant differences are expressed as P values less than 0.05.

RESULTS

Formalin-induced nociceptive response.

Subcutaneous formalin injection induces 2 distinct periods of high licking activity: an early phase lasting the first 5-10 min, and a late phase lasting more then 60 min after the injection. Injections of 0.9% solution of NaCl instead of formalin solution did not evoke similar effect [28]. It is well known that the early phase of formalin-evoked response to be due to a direct effect on nociceptors, while the late phase is due to inflammatory response [22, 38, 42, 45]. Because the first 10 minutes after formalin injection all our animals were restricted in the small plastic cages (the time of P light session or imitation of it) we have dealings only with the second phase of formalin evoked pain response.

Time course for the response to injection of formalin is shown in Fig. 2 and 3. The mean value of total time of licking the injected hind

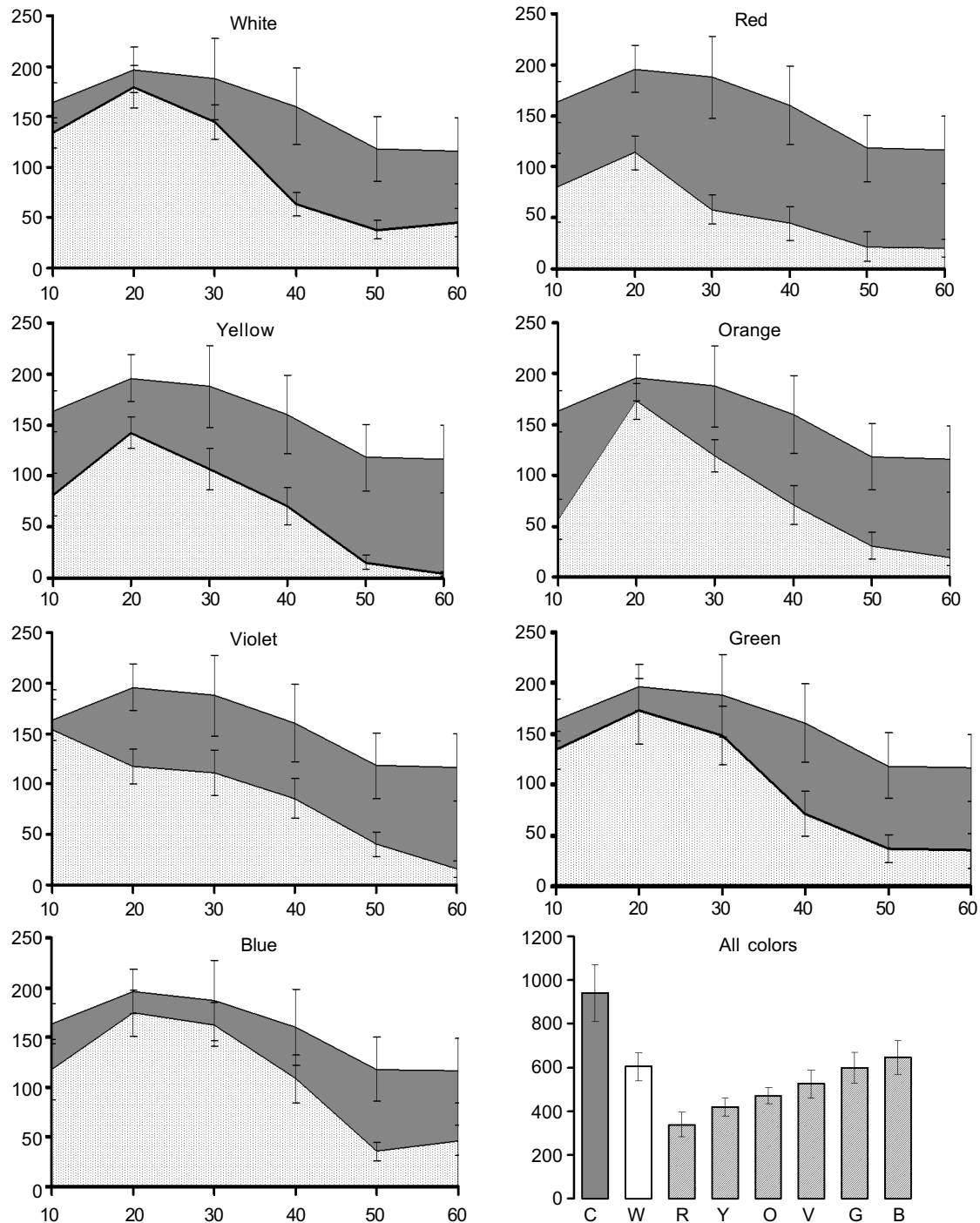


Fig. 2. Dependence of the pain behavioral response on exposure of painful area to polarized light with different colors: white, red, yellow, orange, violet, green and blue. Abscissa - time of observation (min), axis of ordinates - duration of licking the painful area (s). Mean (\pm SEM) duration (s) of licking the painful area in sequential 10 min observation periods or during 60 min of observation (diagram - "All colors"). Difference between mean value of time licking in control and experimental animals was marked by grey. On the diagram "All colors": control group (received injection of formalin solution in the hind limb and imitation of light exposure) was marked as C; seven experimental groups (were injection of formalin solution followed by color polarized light exposure of the painful area) were marked as W (white), R (red), Y (yellow), O (orange), V (violet), G (green), B (blue)

paw during 60 min observation period in mice which were not subjected to P light treatment (control group, n = 20) was 942.1 ± 130.9 s (Table 1).

Effect of color P light on formalin-induced nociceptive response.

We studied as application of light of Bioptron

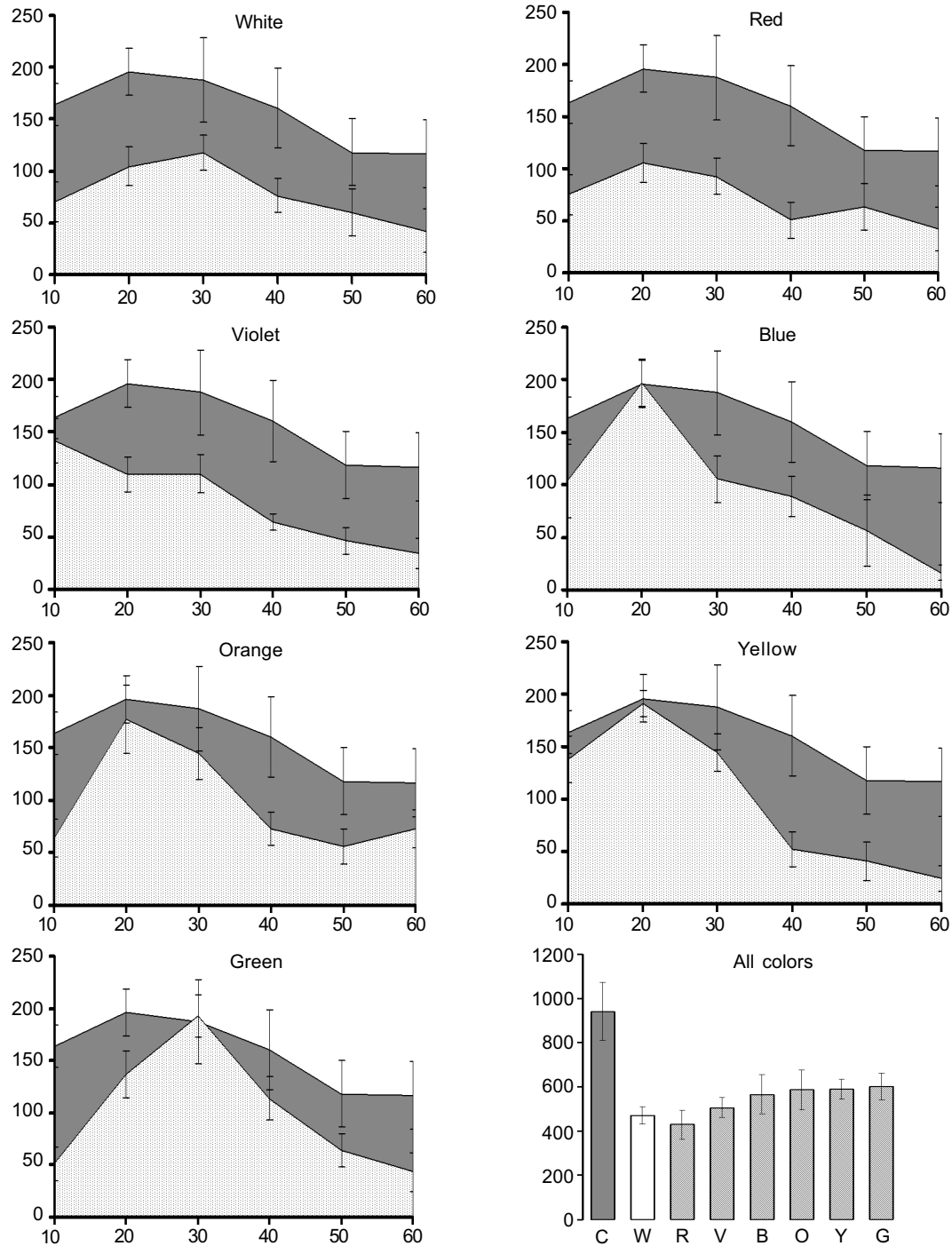


Fig. 3. Dependence of the behavioral response to pain on exposure of acupuncture point E-36 to polarized light with different colors: white, red, violet, blue, orange, yellow, green. The same designations, as on fig. 2. Difference will consist, that light has been directed on the acupuncture point E-36

device equipped with different color filters on the center of a pain or on the TA E-36 influences the painful BR caused by formalin. Fig. 2 shows the time course of formalin-induced nociceptive BR before and after the exposure of painful area to P light of different colors. Application of color P light to the painful area decreased this BR. The pain intensity score in sequential 10-min observation periods in all experimental groups was lower than in the control group (without exposure to light). Table 1 contains the mean values of duration of the painful area licking for the whole period of observation (60 min) in different groups. One-way ANOVA revealed significant differences in mean foot licking time among these groups ($F_{7, 81} = 20.14$, $P < 0.001$). The licking time in seven experimental groups of mice received application of one color of P light to the painful area was ranged from 338.2 ± 57.4 s to 604.7 ± 63.5 s against 942.1 ± 130.9 s in the control ($P < 0.001$, $P < 0.01$, $P < 0.05$). In comparison with the control group (accepted for 100 %) in the mice exposed to color P light on the painful area, the duration of licking was from $35.9 \pm 6.1\%$ to $63.6 \pm 7.5\%$. Statistically reliable decrease

of licking time was found after application of red (64.1%), yellow (55.4%), orange (50%), violet (44.3%), green (36.4%) and white (35.8%) light. Note, that the most effective was the red light and no significant difference between the group exposed to blue light and the control group was found (Fig. 4).

Our previous studies have shown that AP E-36 was the most effective AP to relieve pain under white P light application [28]. In the present study the AP E-36 was used to differentiate the effects of color P lights. Figure 3 shows the time course of the formalin-induced BR in mice exposed to different colors of P light compared with the control group (without of P light exposure). Pain responses in those groups where color P light was used were apparently weaker than in control group. The total mean value of duration of licking in the animals exposed to different color P light ranged from 429.8 ± 65.8 s to 601.8 ± 60.2 s, against 942 ± 130.9 s in the control group (Table 1). One-way ANOVA revealed statistically significant differences in the mean licking time ($F_{7, 81} = 19.03$, $P < 0.001$) among groups. In all seven groups exposed to color P light, the total licking time of the painful area,

Table 1. Duration (s) of formalin evoked pain response in control group of mice and mice received 10 min exposure of painful area or AP E-36 to color P light (white, red, orange, yellow, green, blue, violet)

Groups of mice	Painful area	AP E-36
Control (without light)	942.1±130.9 100%	942.1±130.9 100%
White light	604.7±63.5* 64.2±6.7%	471.3±38.0*** 50±4%
Red light	338.2±57.4*** 35.9±6.1%	429.8±65.8** 45.6±7%
Orange light	470.0±37.4** 49.9±4.0%	587.0±89.6* 62.3±9.5%
Yellow light	420.6±41.2** 44.6±4.4%	591.4±44.7* 62.8±4.7%
Green light	599.2±70.9* 63.6±7.5%	601.8±60.2* 63.9±6.4%
Blue light	645.176.5 68.5±8.1%	566.9±88.6* 60.2±9.4%
Violet light	524.6±64.8** 55.7 ±6.9%	505.8±44.8** 53.7±4.8%

Significant difference from the control: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

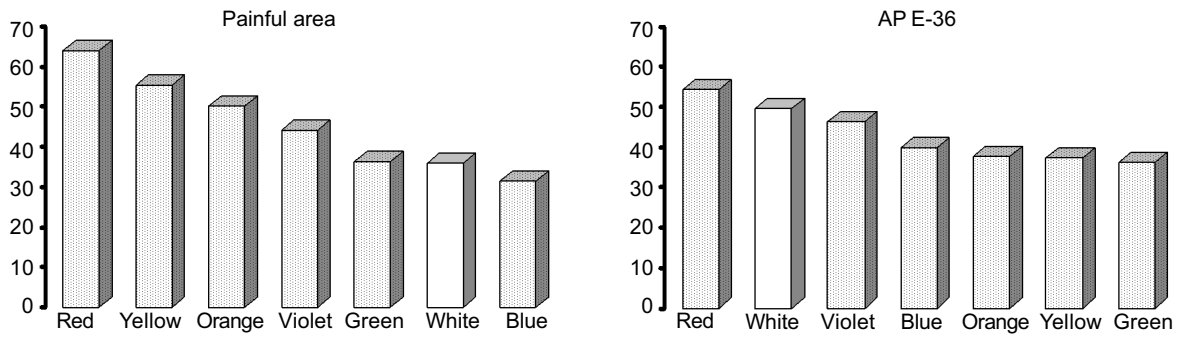


Fig. 4. Analgesia (in %) evoked by the exposure of painful area or acupuncture point (AP) E-36 to polarized light with different colors

during 60 min period of observation was reliably different from that in the control group ($P < 0.001$, $P < 0.01$, $P < 0.05$). In compare to the control group of mice (accepted for 100 %) in the mice exposed to P light on AP E-36 the duration of formalin-induced BR ranged from $45.6 \pm 7\%$ to $63.9 \pm 6.4\%$. The most effective decrease of licking time was found after red light exposure. Analgesia made up 54.4% (red light), 50% (white) 46.3% (violet), 39.8% (blue), 37.7% (orange), 37.2% (yellow), and 36.1% (green) respectively (Fig. 4).

Thus, our findings show, that red light evokes the greatest analgesia in both cases:

after application to the painful area or to the AP E-36. The light of this color decreased the time of licking of the injected paw by 2.8 and 2 times compared with the control. Are there statistical differences between effects of red light and light of other colors? Comparison of the mean value of duration of pain BRs in the group of mice exposed to red P light with the groups treated with another types of color lights are shown in Table 2 and Fig. 5. Received data show that the effect of treatment of the painful area by red light was increasingly greater than by other color. One-way ANOVA revealed statistically significant differences in the mean

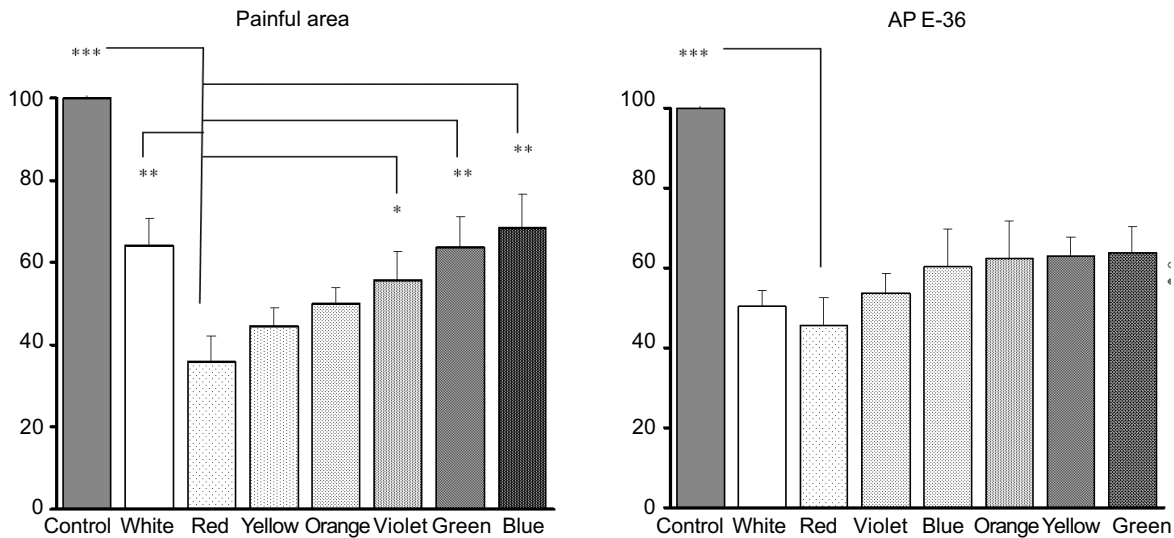


Fig. 5. Comparison of the pain response in the mice exposed to red and another colors of polarized light. Mean (\pm SEM) values of licking time (in % of the control value) for at 60 min period of observation after exposures of painful area or acupuncture point (AP) E-36 to different colors of polarized light. Significant difference from the red light group. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 2. Comparison of formalin evoked pain response duration in the group of mice exposed to red polarized light with the other experimental groups. Mean (\pm SEM) duration (s) of licking the painful area fore 60 min of observation after 10 min exposure of painful area or AP E-36 to P light with different color

Groups of mice	Painful area		AP E-36	
	Licking, s/60 min	Student's <i>t</i> - criterion	Licking, s/60 min	Student's <i>t</i> - criterion
Red light	338.2 \pm 57.4		429.8 \pm 65.8	
Orange light	470.0 \pm 37.4	1.92	587.0 \pm 89.6	1.41
Yellow light	420.6 \pm 41.2	1.17	591.4 \pm 44.7	2.03
Green light	599.2 \pm 70.9**	2.86	601.8 \pm 60.2	1.93
Blue light	645.1 \pm 76.5**	3.21	566.9 \pm 88.6	1.24
Violet light	524.6 \pm 64.2*	2.16	549.7 \pm 42.7	1.53

* $P < 0.05$; ** $P < 0.01$ compared with red light group (otherwise not significant)

value of licking time between experimental groups where P light was applied to the painful area ($F_{5, 54} = 3.62$, $P < 0.01$). When the total pain response was analyzed by Student's *t* test for each pair of data points, the difference reached statistical significance between groups exposed to red and three "cold" colors: blue ($P < 0.01$, $t = 3.31$), green ($P < 0.01$, $t = 2.86$), violet ($P < 0.05$, $t = 2.16$), as well as between the groups treated with red and white light ($P < 0.01$, $t = 3.11$). The effect of "warm" colors (orange and yellow) did not differ from the red light ($P > 0.05$, $t = 1.92$ and 1.17). The present study demonstrates that all colors of P light applied to painful area produce statistically significant suppression of formalin-induced pain response and analgesia depends on the color (wavelength) of P light. In contrast, as shown by one-way ANOVA, no statistically significant differences were found between the duration of pain responses in the groups treated with different colors of P light to AP E-36 ($F_{5, 54} = 0.95$, $P > 0.05$). In this series of experiments all colors depressed the painful response as compared with the group without light applications, but the effects from different colors were similar.

Effect of color P light on the skin temperature.

In order to estimate the effects of skin warming on the tested reactions during P light application the special experiments have been carried out. The superficial cutaneous tem-

perature of the AP E-36 was measured before, during and after red or green P light exposure (Fig. 6). These types of P light had the most higher and low influence on the pain BR, respectively.

Baseline skin surface temperature ranged from 35.17 ± 0.29 °C up to 35.43 ± 0.49 °C and the mean value was 35.3 °C. The exposure of the AP to P light resulted in rise of a skin temperature and it was increased with the exposure. Exposure (10-min) of TA E-36 to red P light evoke increasing of the skin temperature up to 37.4 ± 0.26 °C. The similar treatment with the green light increased the temperature to 36.95 ± 0.51 °C. After the termination of a P light session the skin temperature was slowly reduced to control value. The

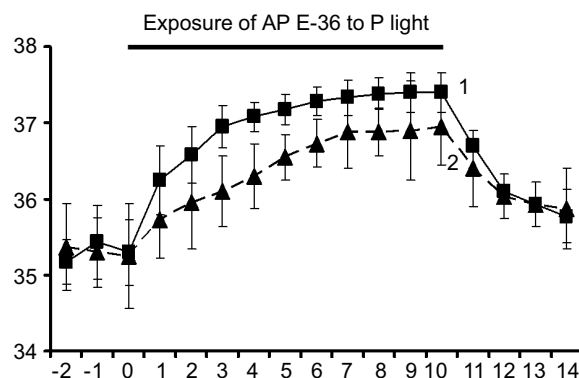


Fig. 6. Changes of the skin temperature in the area of the acupuncture point (AP) E-36 during application of red and green polarized (P) light. Ordinate - mean (\pm SEM) temperature (°C) before P light application, during 10-min exposure of the AP to red (1) or green (2) P light and during 4 min period after the ending of a light session

results demonstrate that 10-min exposure of mouse skin to red or green P light can cause a rise of cutaneous temperature only on 2.1 and 1.65 °C accordingly.

DISCUSSION

The main findings of this study were that exposure of painful area and AP E-36 to low-intensity P light was followed by remarkable depression of formalin-induced BR and the level of their depression depends on the color of light/wavelength. Such analgesic effects appeared due to exposure to the light but not due to movement restriction, because all mice (experimental and control) received equal movement restriction.

Analgesic effects of color P light.

Our results show that the applications of color P light to painful area or AP E-36 produced a similar effects in formalin-treated mice, both of them reduced licking of the staggering extremity. All tested colors evoked statistical significant analgesic effects in either event when P light was applied to AP E-36 and to painful area. After 10 min of color P light exposure analgesia was 31.5 - 64.1% and 36.1 - 54.4% respectively. Analgesia after 10-min exposure of painful area or AP E-36 to color P light produced by Bioptron device was almost equal to that obtained with the sedative method of classical acupuncture, which requires prolonged exposure to needle [18].

Our results are consistent with the data obtained from studying low-intensive laser (monochromatic coherent polarized light) effects on pain in humans and animals. However, P light of Bioptron differs from a laser radiation by its polychromatic and noncoherence. It was shown that exposure of APs to infrared laser energy in patients with pain syndrome increased their pain thresholds considerably [15, 34]. The effect of laser on formalin-induced inflammatory pain is well known [49].

AP E-36 is one of the most effective pain treatment points in traditional Chinese medi-

cine. The injection of apitoxin into AP E-36 of rats suffering from chronic arthritis evoked antinociceptive and anti-inflammatory effect [26]. In our previous study [28] it was shown that AP E-36 is the most effective point to relieve pain localized on the back of the foot of the mouse hind limb. As it follows from the present work, exposure of AP E-36 to color P light effectively suppresses the late phase of formalin-induced pain response.

Dependence of P light effects on the wavelength (color).

Received data show at first that the antinociceptive effect depends substantially on the color of P light/wavelength. The red light was the most effective to relieve pain localized on the back of the foot of mouse hind limb. The analgesic effects of red light were 64.1% (painful area) and 54.4% (AP E-36). The degree of suppression of the painful BR after application of other types of color light was weaker. Exposure of the painful area to yellow, orange, violet, green or blue P light evoke analgesia up to 55.4%, 50.1%, 44.3%, 36.4% and 31.5% respectively. Exposure of the AP E-36 to violet, blue, orange, yellow or green P light decrease the pain BR up to 46.3%, 39.8%, 37.7%, 37.2% and 36.1% respectively.

As time and power of P light in all experiments were identical, it comes out that analgesic effect depends on the color of P light in other words on the wavelength. It is known that optical properties of a skin influence depth of penetration of light [23]. The skin reflects the short-wavelength light (blue and green) but absorbs the long-wavelength light (orange and red).

The ability of different colors of light to penetrate the tissue is not equal. The depths of penetration of the red and near infrared wavelengths are greatest because they are not blocked by blood or water as much as other wavelengths. In contrast, the light whose wavelengths are shorter than 630 nm (yellow, green and blue) are blocked by the hemoglobin of blood and do not penetrate into the tissue very deeply. Different scattering and absorption prop-

erties of different wavelengths of light allow it to influence different depths of tissue [4].

The analgesia is not caused by thermal effect of polarized light.

As light is partially converted into thermal energy and thus produces a heat, we speculate that heat as well as light can contribute to the antinociceptive effects. Corresponding references show that skin heating up to 43°C is necessary to evoke effect classified as thermopuncture [9].

Our experiments have shown that after 10-min exposure of the AP E-36 to color P light (2.4 J/cm²) the skin temperature grew from 35.3°C (before light exposure) up to 37.4°C (red light) or to 36.95°C (green light). Thus temperature rises of 2.1 and 1.65°C, respectively. Results obtained in our study coincide with data received by other investigators in experiments on mice [9]. Exposure of albino mouse skin (right hind limb, zone of 1.5 cm²) to red laser (630 nm) at fluence rates between 100 and 200 mW/cm² course an s.c. temperature grew by 3-4°C respectively. Light dose of 300 and 400 mW/cm² induces temperature rise in s.c. tissue up to 7 and 10°C respectively [9]. There are evidences that power density of light higher than 150 mW/cm² may give artifacts due to effects of hyperthermia [36, 41]. It is necessary to emphasize that power density of Biopton device is much weaker (40 mW/cm²). These findings suggest that the analgesic effects of color P light on formalin-evoked pain response does not might be due to warming.

What are the mechanisms of the analgesic effect?

There are evidences that the low-power laser irradiation suppresses the excitation of the unmyelinated C-fibers in the afferent sensory pathway [33]. But it is known that such behaviors as paw licking involve supraspinal mechanisms [16]. Thus, the pain may be suppressed not only on the periphery but also on the level of brainstem structures. Corresponding references show that signals caused by stimulation of APs are carried in the periph-

eral sensory nerves to the spinal cord. At this level they may activate spinal pain inhibition gates. Spinal signals are also transmitted to specific sites in the thalamus, hypothalamus and midbrain, via the ascending tracts (spinothalamic tracts, ventro-lateral funiculi). These signals stimulate the own antinociceptive systems of the brain [44]. Acupuncture stimuli act as a central nervous system input that can activate the descending antinociceptive pathway to release endogenous opioids that inhibit transmission along the ascending nociceptive pain pathway [17]. There are evidences that antinociceptive effect of low intensity laser on APs [5, 25, 31, 40, 50] is produced via the opioidergic systems. Moreover, the exposure of APs to low-intensity laser light is accompanied with increasing of ATP and serotonin release that followed by reduction of the inflammatory process [7].

Except for classical neuronal pathways, effects of P light quite probably are mediated through specific power channels - meridians. Russian researchers at the Institute for Clinical and Experimental Medicine have shown that light (non-polarized light) applied to the human skin penetrate the body between 2 and 30 mm, depending on the color frequency. The researchers also found that only certain areas of the body were able to transfer light beneath the surface, and these areas corresponded to APs. Furthermore, the light was conducted within the body along the acupuncture meridians. It appears that the meridians are a light transferal system within the body somewhat like optical fiber [35].

The additional experimental study is necessary to compare the effects of P light versus non-polarized light. To quote one of the most recognized researcher in laser therapy, Tina Karu: "An analysis of published clinical results from the point of view of various types of radiation sources does not lead to the conclusion that lasers have a higher therapeutic potential than light emitting diodes. But in certain clinical cases the therapeutic effect of coherent light is believed to be higher" [24]. We have received preliminary

experimental data testifying that analgesic effects evoked by P and none-P light are different (at an equal exposition and power).

Experience of P light of device Bioptron application for treatment of painful syndromes at people has shown positive results [1, 2].

In conclusion, the present study shows the objective proofs of efficiency of application of color P light for reduction of pain. Color light therapy may be used as an effective noninvasive method to treat pain and red light is the best wavelength selection to induce analgesia in clinical applications.

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АНТИНОЦИЦЕПТИВНІ ЕФЕКТИ КОЛЬОРОВОГО ПОЛЯРИЗОВАНОГО СВІТЛА У ТВАРИН НА МОДЕЛІ ФОРМАЛІНОВОГО ТЕСТУ

Наші експериментальні результати показали ефективність пригнічення болю дією на протибольові точки акупунктури (ТА) низькоінтенсивним білим поляризованим світлом. Відомо, що біле світло містить електромагнітні хвилі різної довжини (різного кольору) і, можливо, не всі з них викликають однаковий протибольовий ефект. Нині немає порівняльних даних про знеболювальну дію світлових хвиль з різною довжиною хвилі. Метою нашої роботи було перевірити, чи залежить ступінь анальгезії від кольору, тобто від хвильового діапазону поляризованого світла. Біль викликали підшкірною ін'єкцією 1%-го розчину формаліну (25 мкл) у дорсальну поверхню стопи лівої кінцівки. Викликана формаліном больова поведінка (вилузування хворої лапки) була тестована у мишей контрольної групи і семи експериментальних груп, де миші зразу ж після ін'єкції формаліну піддавалися 10-хвилинному сеансу кольоротерапії: один з кольорів поляризованого світла (червоний, оранжевий, жовтий, зелений, синій, фіолетовий) був спрямований на осередок болю або на ТА Е-36. Кольорове поляризоване світло статистично достовірно ослаблювало біль. Тривалість больової реакції скорочувалася на 31,5–64,1% і 36,1–54,4 % відповідно. Найбільш виражену анальгетичну дію виявляло червоне світло. Різниця між знеболювальними ефектами червоного і трьох “холодних” кольорів (синій, зелений і фіолетовий), а також між червоним і білим світлом була більш виражена при дії на осередок болю. Зроблено висновок про те, що низькоінтенсивне кольорове поляризоване світло має анальгетичний вплив і ступінь анальгезії залежить від довжини хвилі (кольору).

Ключові слова: кольорове поляризоване світло, формаліновий тест, анальгезія, акупунктура.

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АНТИНОЦИЦЕПТИВНЫЕ ЭФФЕКТЫ ЦВЕТНОГО ПОЛЯРИЗОВАННОГО СВЕТА У ЖИВОТНЫХ НА МОДЕЛИ ФОРМАЛИНОВОГО ТЕСТА

Наші експериментальні результати показали ефективність подання болю путем воздействия на протибольові точки акупунктури (ТА) низькоінтенсивним білим поляризованим світлом. Известно, что белый свет содержит электромагнитные волны различной длины (разного цвета) и, возможно, не все из них вызывают одинаковый противобольной эффект. В настоящее время нет сравнительных данных о болеутоляющем действии световых волн с разной длиной волны. Целью настоящей работы было проверить, зависит ли степень анальгезии от цвета, то есть от волнового диапазона поляризованного света. Боль вызывали подкожной инъекцией 5%-го раствора формалина (25 мкл) в дорсальную поверхность стопы левой конечности. Вызванное формалином больное поведение (вылизывание больной лапки) было тестировано у мышей контрольной группы и семи экспериментальных групп, где мыши сразу после инъекции формалина получали 10-минутный сеанс цветотерапии: один из цветов поляризованного света (красный, оранжевый, желтый, зеленый, синий, фиолетовый) был направлен на очаг боли или на ТА Е-36. Цветной поляризованный свет статистически достоверно ослаблял боль. Длительность болевой реакции сокращалась на 31,5–64,1 и 36,1–54,4 % соответственно. Наиболее выраженное анальгетическое действие оказывал красный свет. Различия между болеутоляющими эффектами красного и трех “холодных” цветов (синий, зеленый, и фиолетовый) а также между красным и белым светом были более выражены в случае воздействия на очаг боли. Сделан вывод о том, что низькоінтенсивний цветной поляризований свет обладает анальгетическим действием и степень анальгезии зависит от длины волны (цвета).

Ключевые слова: цветной поляризованный свет, формалиновый тест, анальгезия, акупунктура.

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