Primerjava termičnih in hemodinamskih odzivov v koži in mišicah na ogrevanje z električnim in magnetnim poljem

Karmen Glažar, dipl. fiziot.; asist. dr. **Nina Bogerd**, dipl. fiziot.; asist. **Tina Grapar Žargi**, MSc, dipl. fiziot.; doc. dr. **Alan Kacin**, dipl. fiziot.

Zdravstvena fakulteta, Univerza v Ljubljani, Ljubljana, Slovenija

Korespondenca/Correspondence: Alan Kacin; e-pošta: alan.kacin@zf.uni-lj.si

Uvod: Raziskave kažejo, da elektromagnetna diatermija povzroči povišanje temperature površinskih in globokih tkiv, kadar je povprečna intenziteta dovedene energije zadostna (1, 2). Dvig temperature sproži različne fiziološke odgovore v tkivih (3). Kolikšni so dejanski toplotni učinki različnih oblik diatermije na kožo in spodaj ležeče mišice, še ni podrobno raziskano. Namen raziskave je bil primerjati termične in hemodinamske odzive v koži in mišicah na ogrevanje z električnim (EP) in magnetnim (MP) poljem. **Metode:** V raziskavi je sodelovalo 11 zdravih prostovoljcev (6 moških in 5 žensk). Vsak preiskovanec je bil na volarnem predelu podlakti izpostavljen 20-minutnemu ogrevanju z EP ali MP z najmanj 48-urnim razmikom. Terapija je bila aplicirana na levem zgornjem udu, medtem ko je desni ud služil kot kontrola. Intenziteta dovedene energije je bila določena z zgornjo mejo toplotne tolerance preiskovanca. Merili smo kožno in timpanično temperaturo, frekvenco srčnega utripa in kinetiko oksigeniranega in deoksigeniranega hemoglobina v mišici z infrardečo spektroskopijo. Preiskovanci so pred in med ogrevanjem ter med ohlajanjem ocenili občutenje in ugodje toplote na ogrevanem udu. **Rezultati:** Med 20-minutnim ogrevanjem z EP je temperatura kože narasla za 8,0 ± 1,3 °C in z MP za 8,1 ± 1,3 °C. Povečalo se je občutenje toplote, in sicer za 3 ± 1 pri ogrevanju z EP in za 2 ± 1 pri ogrevanju z MP. Prav tako se je spremenilo temperaturno ugodje pri ogrevanju z EP za 1 ± 1, pri ogrevanju z MP pa ni prišlo do značilnih sprememb. Minutna poraba kisika je narasla za 0,02 ± 0,02 $ml \cdot min^{-1} \cdot 100g^{-1}$ pri ogrevanju z EP in za 0,06 ± 0,04 $ml \cdot min^{-1} \cdot 100g^{-1}$ pri ogrevanju z MP. Prav tako se je med ogrevanjem z EP povečal minutni pretok krvi za 0,27 ± 0,25 $ml \cdot min^{-1} \cdot 100ml^{-1}$ in pri ogrevanju z MP za 0,72 ± 0,61 $ml \cdot min^{-1} \cdot 100ml^{-1}$. Vse navedene razlike so bile statistično značilne ($p < 0,05$). **Zaključki:** Pri enakem povišanju temperature kože ima ogrevanje z MP nekaj prednosti pred ogrevanjem z EP, in sicer je dvig temperature kože bolj postopen in zato za preiskovance bolj ugoden, poleg tega povzroči za ~ 42 % večji porast krvnega pretoka in porabe kisika v mišičnem tkivu. V primeru ciljane obravnave mišičnega tkiva je torej primernejša oblika diatermije z MP.

Ključne besede: radiofrekvenčna elektromagnetna diatermija, termični učinki, hemodinamski odzivi, mišična kinetika kisika.

Comparison of thermal and hemodynamic responses in the skin and muscles to heating with electric and magnetic field

Background: It has been demonstrated in humans that electromagnetic diathermy of sufficient energy output causes temperature elevation of surface and deep tissues (1, 2). The increase in tissue temperature triggers various physiological responses (3). However, little is known about the differences in responses elicited by various techniques of diathermy application. Purpose: To compare thermal and hemodynamic responses in the skin and muscles of the forearm to diathermy applied with predominant electric (EF) or magnetic field (MF). **Methods:** Eleven healthy volunteers participated (6 men and 5 women) in the study. They received one 20-minute diathermy session with EF and another one with MF, applied to the volar aspect of the forearm. The minimum interval between the two sessions was 48 hours. The energy output in each session was determined by the volunteer's pain tolerance. Measurements of skin and tympanic temperature, heart rate and muscle oxyhemoglobin and deoxyhemoglobin kinetics by near infrared spectroscopy (NIRS) were performed. Subjective heat perception and comfort at the experimental arm were also evaluated. **Results:** The skin temperature increased by 8.0 ± 1.3°C and 8.1 ± 1.3°C during the 20-minute application of diathermy with EF and MF, respectively. The thermal perception increased by 3 ± 1 during EF and 2 ± 1 during MF application. The thermal comfort changed by 1 ± 1 point during EF application, while no significant changes were noted during MF application. Minute muscle oxygen consumption increased by 0.02 ± 0.02 $ml \cdot min^{-1} \cdot 100g^{-1}$ during EF and 0.06 ± 0.04 $ml \cdot min^{-1} \cdot 100g^{-1}$ during MF application. Likewise, minute muscle blood flow increased by 0.27 ± 0.25 $ml \cdot min^{-1} \cdot 100ml^{-1}$ during EF and 0.72 ± 0.61 $ml \cdot min^{-1} \cdot 100ml^{-1}$ during MF application. All reported differences were statistically significant ($P < 0.05$). **Conclusions:** Despite an almost identical increase in skin temperature, the application of diathermy with magnetic field was perceived more comfortable by the subjects. This can be largely attributed to a slower rate of heat accumulation in the skin. Furthermore, the increase in both minute muscle blood flow and oxygen consumption was ~ 42 % higher compared to the diathermy with EF. Therefore, when muscle is the target tissue for therapy, a diathermy with magnetic field is a technique of choice.

Keywords: radio-frequent electromagnetic diathermy, thermal effects, hemodynamic responses, muscle oxygen kinetics.

Literatura/References:

1. Draper DO, Knight K, Fujiwara T, Castel JC (1999). Temperature change in human muscle during and after pulsed short-wave diathermy. J Orthop Sports Phys Ther 29 (1): 13–21.
2. Garrett CL, Draper DO, Knight KL (2000). Heat distribution in the lower leg from pulsed short-wave diathermy and ultrasound treatments. J Athl Train 35 (1): 50–5.
3. Cameron MH (2009). Diathermy. In: Physical agents in rehabilitation: from research to practice. 3th ed. St. Louis: Saunders Elsevier, 385–404.