# THERMAL IMAGING OF HANDS DURING SIMPLE GYMNASTICS ELEMENTS ON THE WOODEN BAR WITH AND WITHOUT USE OF MAGNESIUM CARBONATE

**Igor Pušnik[1] and Ivan Čuk[2]**

[1]Faculty of electrical engineering, University of Ljubljana, Slovenia
[2]Faculty of Sport, University of Ljubljana, Slovenia

*Research article*

***Abstract***

*The article describes investigation of effectiveness of magnesium carbonate in simple gymnastics. Students at the faculty of sports performed a simple element (one leg circle forward) while temperature of the bar and palms was measured with a thermal imager. In the first attempt they were using magnesium carbonate while in the second attempt they performed the element without magnesium carbonate. It was notable that with use of magnesium palm temperature rose, while during performance without magnesium the palm temperature was practically constant. Palm friction blisters are then expected to be less frequent when magnesium is not used, as the palm temperature does not rise (important effect of friction is warming of the bar surface and skin). As subjects did not report any grip problems, we could say that for easy elements without many repetitions not using of magnesium can be safe.*

***Keywords****: blisters, palm, safety.*

## INTRODUCTION

Magnesium in gymnastics terminology stands for magnesium carbonate ($MgCO_3$) and by Goetze & Uhr (1994, p.43) it is virgin white dust, which can be also produced in blocks. Gymnasts rub their hands with magnesium to make firm and secure grip with apparatus. Namely, magnesium neutralizes fat and sweat. It is not known the exact date when gymnasts started to use it in their training and competition. It is worth to mention that it was not used in parallel with development of gymnastics apparatuses. However, more precise inspection of old photos (Karacsony, 2002, p.14, p.21) show evidence that gymnasts used some white dust before WWI on rings and definitely before WW2 on a high bar. It is also worth to mention that probably gymnasts in the past used powder, which had similar effect as magnesium carbonate.

Nowadays gymnasts use magnesium on all apparatuses, not just to prevent their hands from blisters, but mostly to increase torsion with apparatus. They put magnesium on their feet as well e.g. beam, floor (Langsley, 1996, p.57) and their body parts (e.g. when bending for triple salto on floor, they put magnesium on their hands and calves, where they will have to grip legs).

While on one side grip is better the air because of magnesium dust is worse and dust on a certain floor can make it slippery. For primary and secondary school gymnasiums where in classes are many children it is also hard to control use of magnesium only for gymnastic purpose. Probably most have seen white hand sign on teammate trousers or dress, especially if they are of dark color. Another aspect is economic (school or club have to buy magnesium) as one block of magnesium is not cheap while it can easily be spent in one day.

In primary school curriculum (Ministry of Education, 2011) for physical education there is also gymnastics content. Teachers fulfill only 30 % to 40 % of the curriculum content (Bučar, 2003; Turšič, 2007). One reason why they do not fulfill the whole content from gymnastics is risk of an injury.

On up to shoulders height bar felge (Figure 1) from stand with one leg swing to support is compulsory while one leg circle forward is optional (Figure 2). Risk of injury during felge is rather small, probably a blister is the most serious injury while doing it and even that happens only after several repetitions.

Figure 1. *Felge from stand with one leg swing to support (Čuk et. al. 2006, p.33).*

Figure 2. *One leg circle forward (Čuk et. al. 2006, p.45).*

By Wikipedia (2013) a blister is a small pocket of fluid (with or without blood) within the upper layers of the skin, typically caused by forceful rubbing (friction). Friction blisters, caused by rubbing against the skin, can be prevented by reducing the friction to a level where blisters will not form. This can be accomplished in a variety of ways: taping a protective layer of padding or a friction-reducing interface between the affected area, gloves should be worn when using tools sports equipment, a lubricant, typically talcum powder can be used to reduce friction between skin and apparel in the short term. People put talcum powder inside gloves or shoes for this purpose, although this type of lubricant will increase the friction in the long term, as it absorbs moisture. Increased friction makes blisters more likely. Blisters are treated like wounds. To prevent hands from blisters proper hand care is advised (proper hydration and tenderness of skin). Blister is quite common in everyday life (e.g. feet) and sport (feet, hands).

From a practical point of view it is not a question whether magnesium is important for high performance male gymnasts or not. Logic says it is important, everybody use it, either for real need or just placebo. Perhaps we can notice on asymmetric bars that some elite gymnasts are not using magnesium. There is difference between wooden bars (used on asymmetric bars) and steel bars (high bar) in terms of friction, hygroscopic property and porosity (FIG, 2011). Therefore we were interested how palm temperature is changing, while performing elements on a wooden bar.

While impact on hands during felge is small, we choose for our experiment one leg circle forward where higher forces on grip are expected. The aim of our research was to determine temperature change of palms while performing one leg circle forward without and with use of magnesium carbonate. It seemed that thermal imaging could be a useful tool to conduct the mentioned research.

Thermography or thermal imaging is well used in medicine (Ring 2012, Ring & Ammer 2012) and many researches were done in defining injuries (Sands et. al. 1993, Hildebrandt et. al. 2010, Skala Kavanagh et. al. 2011, Sands et. al. 2011), however we could not find any research regarding skin palm temperature change while performing gymnastics. Otherwise thermal imaging could be performed in various sports (horse riding, rowing, climbing, cycling, weightlifting, etc.) in order to measure temperature remotely and in a non-contact way. In such a way it is possible to measure temperature differences rather than absolute temperatures because thermal imaging has quite a few practical limitations (Miklavec et. al. 2011, Grgić & Pušnik 2011). The most important limitations are small targets, various and changing emissivity values of targets, reduced transmittance of atmosphere at larger distances due to water vapor or other gases.

## METHODS

Seven adults (5 men and 2 women) physical education students, who were attending gymnastics class at the Faculty of Sports were participating in the experiment. Average age was 24,1 years ± 2,2 years, average height was 1,8 m ± 0,1 m, and average weight was 82,8 kg ± 12,3 kg. Temperature in gym hall was comfortable 21 °C.

One leg circle forward is a part of gymnastics curriculum at the Faculty of Sport. Participants were novices, therefore they tried one leg circles to perform one lesson earlier but none had more than 4 attempts. During their performance they were assisted by two assistants to safely conclude the task. They voluntarily participated in the experiment as we respected Helsinki declaration.

Four subjects performed the first three one leg circles without magnesium, then rested for 20 minutes and afterwards did three one leg circles with magnesium, while three subjects did it in the opposite order. After each one leg circle a subject stopped to show its right hand to the thermal imager to measure temperature, after approximately 15 seconds stop a subject continued with the next one leg circle.

For measurement of temperature we used the thermal imager Guide TP 8. The thermal imager has a resolution 384x288 pixels, operating wavelength 8-14 μm, minimum focus distance 50 cm and was calibrated with an expanded uncertainty of 0,6 °C. The maximum temperature of the right palm was measured. The imager was put on a stand at the distance of 2 meters. In the analysis of thermograms the emissivity of skin was set to 0,97 and the emissivity of wooden bar was set to 0,9. The thermal imager sometimes performed the self-calibration routine just when the measurement should have been taken. Such a routine disabled making a measurement for about 5 seconds. In this respect not all measurements were performed immediately after termination of the element. Nevertheless, results did not show a noticeable deviation due to this problem.

## RESULTS

First thermal images were analyzed and maximum values were extracted from the right hand (Figure 3). Before subjects performed one leg circle their average palm temperature was 33,23 °C (without magnesium) to 33,71 °C (with magnesium), pairwise t-test was not significant between temperatures (Table 1), so within the protocol we gave enough time for palms to cool down. Pearson correlations were without use of magnesium significant between one leg circle attempts, while with the use of magnesium were mostly not significant.

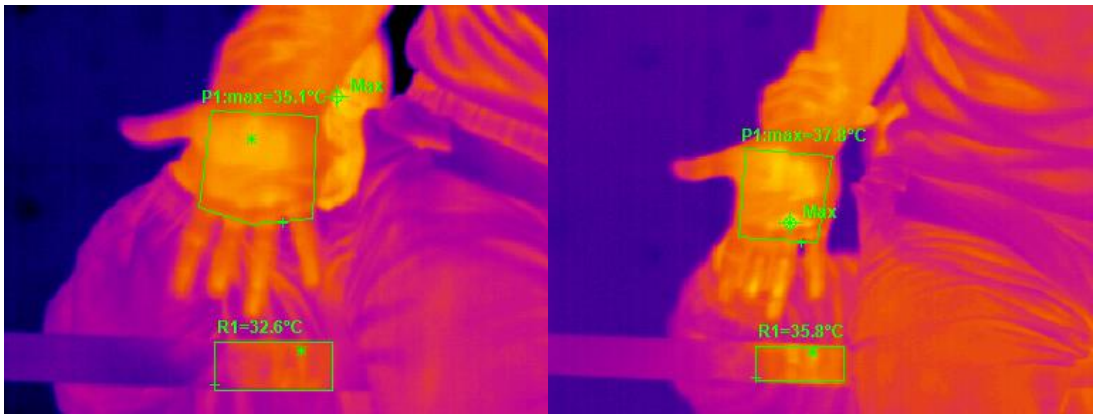


Figure 3. *Thermal image without magnesium and with magnesium.*

Table 1. *Descriptive statistics and Pairwise t-test.*

| | Temperature before one leg circle | Temperature after 1st one leg circle | Temperature after 2nd one leg circle | Temperature after 3rd one leg circle |
|---|---|---|---|---|
| **Without magnesium** | °C | °C | °C | °C |
| person | max. | Max. | Max. | Max. |
| 1 | 33,1 | 32,8 | 33,0 | 33,8 |
| 2 | 32,8 | 32,7 | 33,4 | 33,3 |
| 3 | 34,3 | 34,2 | 34,1 | 35,0 |
| 4 | 34,5 | 34,6 | 34,1 | 34,0 |
| 5 | 33,3 | 33,5 | 33,7 | 33,4 |
| 6 | 34,7 | 34,7 | 34,9 | 35,1 |
| 7 | 29,9 | 30,7 | 31,0 | 30,9 |
| xa | 33,23 | 33,31 | 33,46 | 33,64 |
| sd | 1,64 | 1,41 | 1,24 | 1,40 |
| p t-test previous/next | 0,54 | 0,35 | 0,34 | |
| p t-test 1st/last | | | | 0,07 |
| p t-test withouth/with | 0,34 | 0,00 | 0,00 | 0,00 |
| **With magnesium** | | | | |
| person | max. | max. | max. | max. |
| 1 | 35,3 | 34,8 | 35,5 | 35,5 |
| 2 | 33,2 | 34,8 | 35,6 | 35,3 |
| 3 | 33,6 | 35,7 | 36,6 | 35,8 |
| 4 | 33,8 | 34,4 | 34,3 | 34,8 |
| 5 | 34,2 | 34,7 | 35,5 | 34,7 |
| 6 | 34,1 | 35,6 | 37,2 | 37,8 |
| 7 | 31,8 | 32,8 | 32,4 | 33,1 |
| xa | 33,71 | 34,69 | 35,30 | 35,29 |
| sd | 1,07 | 0,96 | 1,57 | 1,41 |
| p t-test previous/next | 0,02 | 0,05 | 0,95 | |
| p t-test 1st/last | | | | 0,01 |

Table 2. *Pearson correlations (bolded r>0.67 significant at p<0.05).*

| **Without** | Before | After 1st | After 2nd | After 3rd | Height | Weight |
|---|---|---|---|---|---|---|
| Before | 1,00 | **0,99** | **0,97** | **0,96** | **0,70** | **0,72** |
| After 1st | | 1,00 | **0,97** | **0,92** | **0,68** | **0,72** |
| After 2nd | | | 1,00 | **0,94** | 0,60 | 0,58 |
| After 3rd | | | | 1,00 | 0,61 | **0,68** |
| Height | | | | | 1,00 | **0,68** |
| Weight | | | | | | 1,00 |
| **Correlation without/with** | 0,66 | **0,81** | **0,85** | **0,87** | | |

| **With** | Before | After 1st | After 2nd | After 3rd | Height | Weight |
|---|---|---|---|---|---|---|
| Before | 1,00 | 0,64 | 0,63 | 0,56 | **0,86** | 0,48 |
| After 1st | | 1,00 | **0,98** | **0,87** | 0,48 | 0,55 |
| After 2nd | | | 1,00 | **0,91** | 0,42 | 0,38 |
| After 3rd | | | | 1,00 | 0,40 | 0,27 |
| Height | | | | | 1,00 | 0,68 |
| Weight | | | | | | 1,00 |

## DISCUSSION

In general the palm temperature is lower than core body temperature (37 °C), which is normal because distal body parts have lower temperature (Medved, 1980) due to specific thermal regulation of a human body. Without magnesium use the palm temperature did not rise significantly from each one leg circle attempt, t-tests were not significant. Average palm temperature was changing, but after the third one leg circle average temperature was just slightly higher than before starting the first one leg circle and the change was also not significant. Just opposite was with the use of magnesium. Temperature change was significant between the first and after first one leg circle, also between the first and the second attempt, while from the second to the third attempt the palm temperature remained almost the same. Obviously the palms reach thermal equilibrium already after two attempts and temperature does not rise any more. Significant was also temperature change before the first one leg circle and after the third one, as the temperature rose for 1,5 °C. Despite the element is simple, it can be also generator of fear of unknown and therefore participant uses more hand force not to fall down, than it is really required. For maintaining temperature after the second to third repetition it can be already in more conscious control of hand grip strength. Pearson correlations between attempts were high and close to maximum, what means it has been almost linear upgrade of the palm temperature. Almost linear change is characteristic of both situations without and with magnesium (the difference is with use of magnesium for the correlations with before the first attempt and other variables as the first subject had warm palms before the first attempt of one leg circle). Body weight is in medium correlation with the palm temperature when not using magnesium, while when using magnesium it is even not significant. As the correlation is significant already before attempting any element and then is dropping, it is obviously not related to the one leg circle performance but to the body composition.

## CONCLUSION

Despite small subject sample, we gained first data how the palm temperature changed while performing gymnastics

elements on a wooden bar. We were testing how the palm temperature changed without or with use of magnesium during simple gymnastics element one leg circle forward. It was notable that with use of magnesium palm temperature rose, while during performance without magnesium the palm temperature was practically constant. Palm friction blisters are then expected to be less frequent when magnesium is not used, as the palm temperature does not rise (important effect of friction is warming of the bar surface and skin). As subjects did not report any grip problems, we could say that for easy elements without many repetitions not using of magnesium can be safe. Without using of magnesium in schools or clubs for simple elements, there can also be some small financial benefit.

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Corresponding author:

**Igor Pušnik**
Faculty of electrical engineering
Tržaška cesta 25,
1000 Ljubljana
E-mail:igor.pusnik@fe.uni-lj.si