VIA MEDICA

CASE REPORT

Przemysław Kasiak[1,2], Damian Parol[1], Marcin Baczyński[1], Tomasz Chomiuk[1], Artur Mamcarz[1], Daniel Śliż[1]

[1]3rd Department of Internal Medicine and Cardiology, Medical University of Warsaw, Poland
[2]Doctoral School, Medical University of Warsaw, Poland

Does starving mean being weak? Not at all! — a case report

Corresponding author:

Przemysław Kasiak
3rd Department of Internal Medicine and Cardiology, Medical University of Warsaw, Żwirki i Wigury 61 St., 02-091 Warsaw, Poland
Phone: +48 501-168-103
e-mail: przemyslaw.kasiak@wum.edu.pl

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ABSTRACT

Fasting is gaining the general popularity. Athletes also often fast to lose weight or due to cultural premises. The consequences of severe fasting on strength and sports performance are not well understood. Therefore, this paper presents a case of a 32-year-old male athlete who underwent a 7-day strict water fast merged with strenuous strength training. He applied Continuous Glucose Monitoring during the fast and the 7 days of a normal isocaloric diet. An athlete recorded training and measured the muscle's peak force. His fat mass decreased from 13.8 kg to 13.2 kg and his fat-free mass decreased from 63.9 kg to 61.2 kg. The lowest blood glucose of 58 mg/dL was noted at the end of 7th day. The athlete observed numerous smaller dips during the day and meaningful glucose spikes during workouts. The hypoglycaemia was clinically asymptomatic, and the athlete efficiently performed everyday activities. His training performance and peak force measurements increase slightly. Severe fasting did not provide any harmful symptoms. Body homeostasis was quickly rebuilt. Prolonged fasting does not necessarily limit exercise performance among strength athletes. Athletes could even make strength progress during periods of fasting.

Keywords: sports medicine, continuous glucose monitoring, strength athlete, physical training, fasting, hypoglycaemia, starvation

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Introduction

Fasting has been shown to provide health benefits, including weight loss probably due to caloric restriction [1]. However, the effects of prolonged or severe fasting on exercise performance and the general functioning of athletes are not well understood. The hypothesis is that heavy fasting could lead to a decrease in cognitive function and training results [2].

Team physicians and coaches often do not agree to prolonged fasting in athletes for whom it may be important for several reasons [3]. If the athlete decides to fast, it is most often supported by the individual's beliefs, without scientific background [4]. The premises the athlete would like to switch to starvation include ethical, religious, or cultural [2].

Previous studies about fasting by athletes mostly touched on the Ramadan Fast which is a kind of intermittent fast with a period of the day when eating is allowed [5]. Fasting during Ramadan or other types of intermittent fast diets does not necessarily limit exercise results [4, 6].

However, the sports consequences of complete fast by numerous days are unknown. In particular, it is unclear whether an athlete can build muscles or strength while fasting. Conducting such studies is problematic because the majority of athletes do not agree to undergo prolonged severe fasting. This is understandable and supported by previous research, which observed that up to 85.2% of athletes may be concerned about their sports performance when fasting [3].

Therefore, this study presents a unique and important case of an athlete who voluntarily underwent a 7-day strict starvation period and applied additional body monitoring.

Table 1. Training schedule during fast. Note: The personal coach supervised the training program

Day of fast	Training program
1st	1. Dumbbell overhead press: • 2 sets of 4 reps at 20 kg • 2 sets of 4 reps at 32.5 kg • 4 sets of 4 reps at 40 kg 2. Cable lateral raise: • 4 sets until RPE 7–8 3. Cable biceps curl: • 4 sets until RPE 7–8 4. Cable triceps extension: • 4 sets until RPE 7–8
2nd	1. Romanian deadlift: • 1 set of 8 reps at 20 kg 2. Muscle-up: • 1 set of 8 reps 3. Sumo deadlift: • 1 set of 4 reps at 70 kg with 10 sec hold on top • 1 set of 2 reps at 120 kg with 10 sec hold on top • 1 set of 1 rep at 160 kg with 10 sec hold on top • 1 set of 1 rep at 190 kg with 10 sec hold on top • 1 set of 1 rep at 210 kg with 10 sec hold on top • 1 set of 1 rep at 230 kg with 10 sec hold on top 4. Weighted pull-up: • 1 set of 4 reps at 20 kg • 1 set of 4 reps at 30 kg • 1 set of 4 reps at 40 kg • 1 set of 4 reps at 50 kg 5. Hip-thrust: • 1 set for 4 reps at 150 kg • 1 set for 4 reps at 250 kg • 1 set of 4 reps at 300 kg 6. Nordic Hamstring Curl with bodyweight • 1 set of 10 reps 7. Cable kickback: • 2 set until RPE 7–8 8. Calf raises: • 3 sets until RPE 7–8
3rd	1. Rest day
4th	1. Barbell Bench Press: • 1 set of 1 rep at 20 kg with 5 sec pause on touch • 1 set of 1 rep at 40 kg with 5 sec pause on touch • 1 set of 1 rep at 60 kg with 5 sec pause on touch • 1 set of 1 rep at 80 kg with 5 sec pause on touch • 1 set of 1 rep at 100 kg with 5 sec pause on touch • 1 set of 1 rep at 110 kg with 5 sec pause on touch • 1 set of 1 rep at 120 kg with 5 sec pause on touch
4th	2. Cable lateral raise: • 4 sets until RPE 7–8 3. Cable biceps curl: • 4 sets until RPE 7–8 4. Cable triceps extension: • 4 sets until RPE 7–8
5th	1. Back squats: • 1 set of 1 rep at 20 kg with 10 sec pause on bottom • 1 set of 1 rep at 70 kg with 10 sec pause on bottom • 1 set of 1 rep at 110 kg with 10 sec pause on bottom • 1 set of 1 rep at 140 kg with 10 sec pause on bottom • 1 set of 1 rep at 160 kg with 10 sec pause on bottom • 1 set of 1 rep at 170 kg with 10 sec pause on bottom 2. Muscle-up: • 1 set of 8 reps 3. Weighted pull-up: • 1 set of 4 reps at 10 kg • 1 set of 4 reps at 20 kg • 1 set of 4 reps at 30 kg • 1 set of 4 reps at 40 kg 4. Hip-thrust: • 1 set for 4 reps at 150 kg • 1 set for 4 reps at 250 kg • 1 set of 4 reps at 300 kg 5. Nordic Hamstring Curl with bodyweight • 1 set of 10 reps 6. Cable kickback: • 2 set until RPE 7–8 7. Calf raises: • 3 sets until RPE 7–8
6th	Rest day
7th	Dumbbell overhead press: • 2 sets of 4 reps at 20 kg • 2 sets of 4 reps at 32.5 kg • 4 sets of 4 reps at 40 kg Cable lateral raises: • 4 sets until RPE 7–8 Cable biceps curl: • 4 sets until RPE 7–8 Cable triceps curl: • 4 sets until RPE 7–8

RPEv — rating of perceived exertion

Case report

The present study reports this case according to Case Report Guidelines (CARE) [7]. A mandatory checklist has been attached in Supplementary Material 1.

A 32-year-old healthy male athlete was admitted to a physician and reported that voluntarily underwent a 7-day strict fast on his idea. According to the patient's medical records, the lack of chronic diseases and any kind of currently undergoing medical treatment was emphasized. Moreover, an athlete declined any previous surgeries. The male works as a personal coach (he did not work on night shifts). The same working pattern was utilized for the study period and before.

During the fast, he only drank water and trained in a gym (2 consecutive training days followed by 1 rest day). The training included 4 whole-body exercises for 70–80% of 1-rep max as presented in Table 1. He

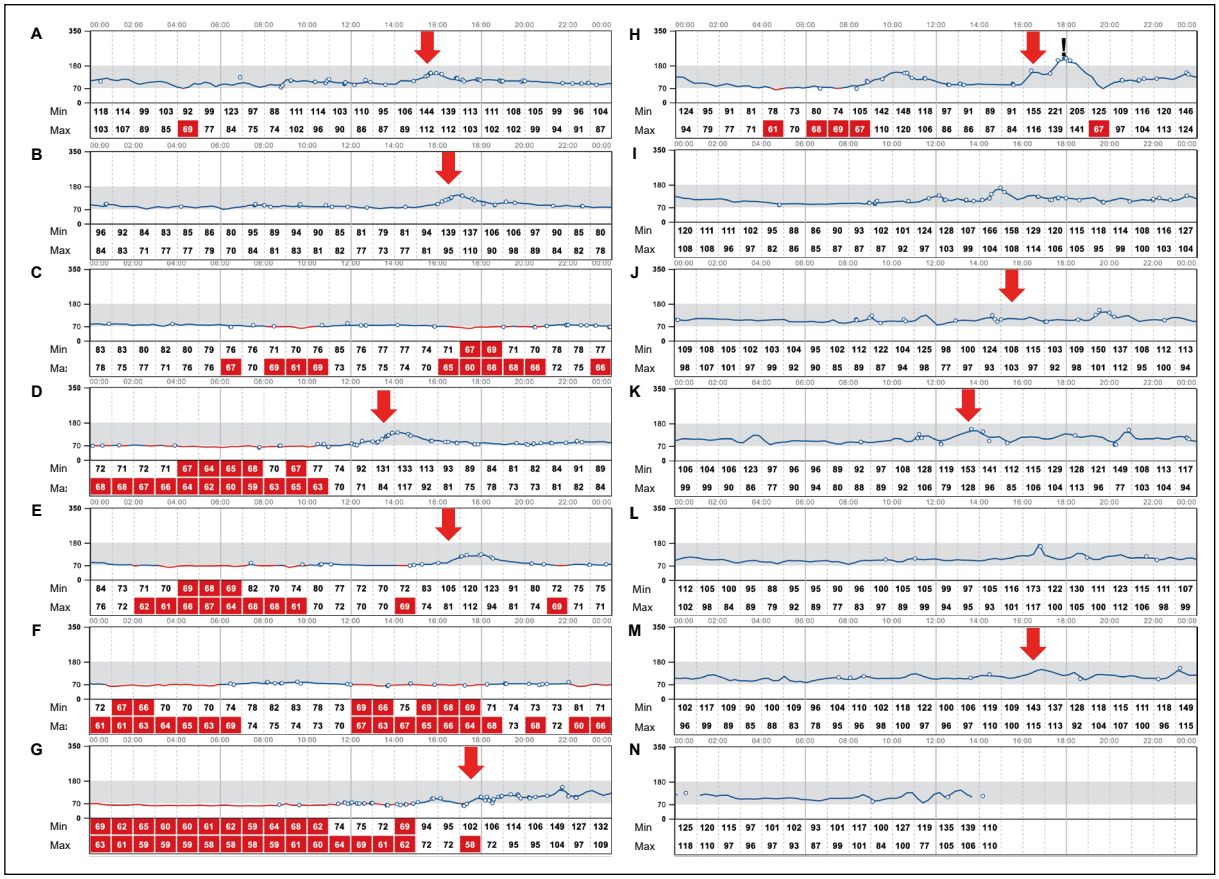

Figure 1. Continuous glucose monitoring curves**.** Max — maximal blood glucose level; Min — minimal blood glucose level. Note: Panel A represents the first day before fasting. Panels B-H represents the 7-day fasting. Panels I-N represent the period post-fasting when a patient returns to the previous diet and starts refeeding. All glucose records are presented in mg/dL. The red colour indicates episodes of blood glucose level < 70 mg/dL, however, all the episodes were asymptomatic and did not fall below the borderline of 54 mg/dL. Arrows indicate the time of workout on panels A, B, D, E, G, H, J, K, and M. All measurements were imported from the validated device FreeStyle Libre 2. The refeed started (i.e. the fasting was terminated) at 12:00 on panel H. During the first refeed day, an athlete observed the highest glucose spike between 17:00 and 18:00 with a blood glucose level of 221 mg/dL (marked with an "*")

applied Continuous Glucose Monitoring (CGM) to evaluate how his blood glucose level varied during a prolonged week-long fast paired with severe physical training. Additionally, he wears a CGM during a normal week with an energy-balanced diet to compare his well-being and functioning during the fast. CGM was introduced with the FreeStyle Libre 2 (Green Oaks, IL, USA) the day before the fast and kept for 6 days after the fast (in summary 14 days, see Fig. 1). Body composition was checked via Prodigy Primo X-ray densitometry (GE Healthcare, Chicago, IL, USA) before the fast began and after a week of refeeding.

The weight of the patient changed from 80.8 kg to 77.6 kg. Fat mass and fat-free mass decreased from 13.8 kg to 13.2 kg and from 63.9 kg to 61.2 kg, respectively. Slight glucose spikes were observed during wake-up and normal activities, while workouts provided severe glucose spikes, even during fast. As illustrated by the red colour on the GCM curves in Figure 1, the patient's blood glucose level < 70 mg/dL emerged frequently. However, those episodes were minimized by the body to keep homeostasis and were never observed during training. The longer the fasting was, the low blood glucose was more frequent and more severe. He noted the strongest dip at the end of the 7th day of the fast with a blood glucose level of 58 mg/dL (i.e. close to the borderline of hypoglycaemia in healthy non-diabetic individuals of < 54 mg/dL) [8]. The glucose spikes were observed during workout windows around noon or mid-afternoon (13:00–17:00).

Strength measurements were taken continuously during fasting and are presented in Figure 2. The athlete's peak force of the biceps brachii muscle during isometric contraction was measured by dynamometer

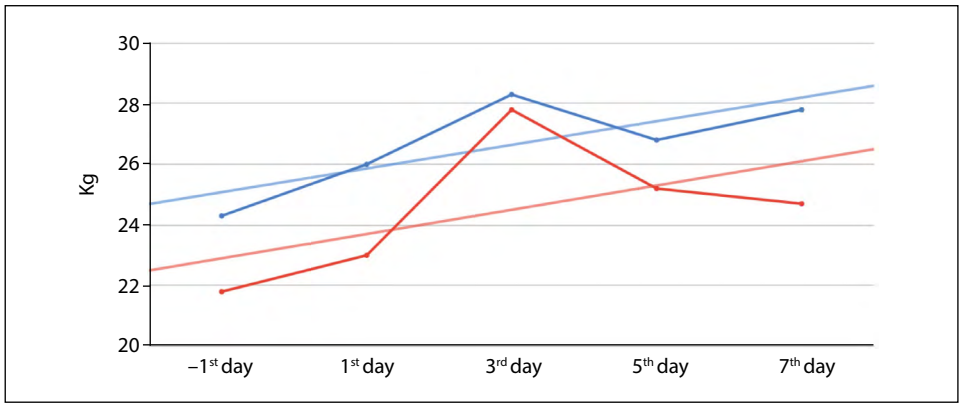

Figure 2. Peak force measurements of biceps brachii muscle during fasting. All peak force measurements are presented in kg. The measurements were taken during isometric contraction at 90° flexion utilizing a dynamometer. The red line with dots represents the right biceps brachii muscle. The blue line with dots represents the left biceps brachii muscle. The red continuous line represents a trend in changes of muscle force of the right biceps brachii muscle. The blue continuous line represents a trend in changes of muscle force of the left biceps brachii muscle. The measurements were taken the day before the fast and during the whole period of fasting

Tindeq Progressor 150 (BLIMS AS, Trondheim, Norway) at the 90° flexion. As shown in Figure 2, the strength slightly increases. The changes were not significant, but the most important finding is that the exercise performance did not deteriorate.

Despite severe fasting, on all days the patient reported a good overall state. Moreover, he continuously performed everyday activities, physical workouts, and his job. Assuming the described rare presentation, one can conclude that the patient did not observe any harmful symptoms and even noted some training progress. An athlete finished the week of severe fast in a good overall state. He did not require hospitalization. It is noteworthy that blood glucose never fell < 54 mg/dL and was therefore not clinically significant [8].

Discussion

We described the unusual circumstances in which the male athlete underwent prolonged strict fasting with everyday physical training and was then admitted to a physician with a full medical history. It is underlined that it has been his idea to test whether the fast would impact his exercises. Previous research was conflicting on whether there is a possibility to note progress during fasting and how the progress varies depending on individuals' fitness levels. Based on the presented data, rigorous fasting does not necessarily limit everyday functioning and physical performance.

It is worth noting that the decrease in body fat is slight (0.6 kg, i.e. about 4,500 kcal, which will equal the caloric demand from 1.5 to 2 days out of 7 days of fast). This would suggest that a major part of the energy deficit has been covered by the lean body mass. The present hypothesis is justified because the decrease in fat-free mass is 2.7 kg (which also includes muscles). So, it can be concluded here that the described methods do not seem to be an optimal way to lose weight. Although, in the view of body composition this decrease can also be falsely increased by the loss of glycogen [9]. The loss of lean body mass is also justified by the physiological bases as amino acids from proteins are a substrate for glucose production [10].

Blood glucose levels were only slightly affected without any symptoms [11]. It is underlined that the variability in blood glucose levels should be confirmed by the urinary or plasma glucose analysis on a wider sample. Additional biochemical tests or complete blood counts would enrich the learning value of such cases and are the area for further studies.

However, this Case Report guides the thoughts for future studies about the possibilities of building training progress or cutting weight with a rigorous diet. Despite the side effects of fasting, the present results are reassuring that returning to a normal diet quickly restores body homeostasis without prolonged negative health consequences [2, 11]. Elite athletes could even build strength on fasting, at least for periods lasting 7-days.

Conclusion

Severe fasting for 7 days did not limit sports performance. Periodic fasting for individual, important reasons

(ethical, social, or cultural) may be allowed for athletes under medical supervision. Such starvation periods should not harm sports or competition results and may be permitted under selected circumstances. Studies including more subjects and longer periods are necessary to confirm the degree to which it is possible to improve physical performance when fast.

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