

The influence of selected types of exercise in spa therapy for knee capacity in patients suffering from osteoarthritis

Wpływ wybranych rodzajów ćwiczeń w warunkach leczenia uzdrowiskowego na wydolność stawów kolanowych u pacjentów z chorobą zwyrodnieniową

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SUMMARY

Introduction: Gonarthrosis is a chronic process, inevitably progressive and irreversible. It develops gradually causing pain, reduced range of motion, decreased muscle mass and strength. Impairment of the knee leads to a reduction of physical activity and poor quality of the patient's life. The aim of the study was to compare the effectiveness of isokinetic training and active off-loading exercises with resistance dosed used in terms of spa treatment in patients with osteoarthritis of the knee.

Material and methods: The study included 36 patients participating in the 21-day spa therapy because of gonarthrosis. They were randomly assigned into two groups – with the isokinetic and isotonic training. The assessment of the efficiency and effectiveness of the therapy was based on evaluation of the range of motion, measurements of muscle forces moments in knee joint in isokinetic conditions and evaluation of pain using Laitinen scale.

Results: There was a statistically significant improvement in the knee capacity after treatment in both groups with regard to the range of flexion, selected isokinetic parameters and pain. There were no statistically significant differences between the compared groups both before and after the spa therapy.

Conclusions: It seems that both training methods give similar results. Due to the satisfactory therapeutic results obtained in the experiment, both methods can be a valuable element in the treatment of osteoarthritis of the knee.

Key words: gonarthrosis, isokinetic training, isotonic training, exercises

STRESZCZENIE

Wstęp: Choroba zwyrodnieniowa stawów kolanowych jest procesem przewlekłym, nieuchronnie postępującym i nieodwracalnym. Rozwija się stopniowo powodując ból, ograniczenie zakresu ruchu, zmniejszenie siły i masy mięśniowej, co prowadzi do ograniczenia aktywności ruchowej i pogorszenia jakości życia pacjenta. Celem pracy jest porównanie skuteczności treningu izokinetycznego i ćwiczeń czynnych z dawkowanym oporem stosowanych w warunkach leczenia uzdrowiskowego u pacjentów z chorobą zwyrodnieniową stawu kolanowego.

Materiał i metody: Badaniem objęto 36 pacjentów uczestniczących w 21-dniowym turnusie sanatoryjnym z powodu choroby zwyrodnieniowej stawów kolanowych, których losowo przydzielono do 2 grup – z treningiem izokinetycznym i izotonicznym. Ocenę efektywności i skuteczności zastosowanych terapii przeprowadzono na podstawie pomiaru zakresu ruchu, pomiaru siły mięśni w warunkach izokinetyki i oceny bólu skalą Laitinena.

Wyniki: Uzyskano istotną statystycznie poprawę wydolności stawów kolanowych po leczeniu w każdej z wyróżnionych grup ze względu na zakres ruchu zgięcia, wybrane parametry izokinetyczne oraz dolegliwości bólowe. Nie stwierdzono istotnych statystycznie różnic między porównywanymi grupami zarówno przed, jak i po zakończeniu turnusu sanatoryjnego.

Wnioski: Na podstawie przeprowadzonych badań wydaje się, że obie metody treningu dają podobne wyniki. Ze względu na zadowalające efekty terapeutyczne uzyskane w eksperymencie, obie metody mogą stanowić cenny element w leczeniu choroby zwyrodnieniowej stawów kolanowych.

Słowa kluczowe: gonartroza, trening izokinetyczny, trening izotoniczny, ćwiczenia

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INTRODUCTION

Population ageing and a change in lifestyle contribute to osteoarthritis in an increasing number of patients. The incidence of gonarthrosis increases with age and concerns 80% of the population over the age of 75. The aetiology of the disease is mixed and has not been fully explained. Without any doubt, large overloads connected with the support and locomotor function facilitate the development of gonarthrosis [1, 2].

Gonarthrosis is a chronic progressive process of degeneration of cartilage, subchondral layer, bone, and soft tissues surrounding the joint. It develops slowly with periods of exacerbation and remission of symptoms, leading to the destruction and disturbance of joint function and an imbalance between the strength of the tissues building the joint and the mechanical forces acting on it during movement. Pain and impaired knee function result in reduced mobility and physical activity, which decreases the quality of the patient's life [2, 3].

The main aim of gonarthrosis treatment is to halt its progression, reduce pain, and improve joint mobility and functional abilities. A comprehensive therapy, taking into consideration treatment and prevention, results in the best treatment outcomes. Due to the disease's character, physical therapy is an integral part of the conservative treatment. Appropriately selected kinesiotherapy, accompanied by physical therapy procedures, has a positive influence on the patients' status [1, 4, 5].

Spa treatment allows for the use of natural factors and more intensive rehabilitation. A variety of training forms offered (individual and in groups) undoubtedly improves joint function. The literature describes numerous exercise methods recommended in patients with gonarthrosis [4, 5, 6]. Seeking an optimal model for rehabilitation in this group of patients encourages studies on treatment efficiency.

The aim of the study was to compare the effectiveness of isokinetic training and active off-loading exercises with resistance dosed used in terms of spa treatment in patients with osteoarthritis of the knee.

MATERIAL AND METHODS

The study was conducted in 2013 at the 21. Military Spa and Rehabilitation Hospital in Busko-Zdrój. It involved a total of 36 patients with knee pain, including 25 women (69.4%) and 11 men (30.6%) aged between 29 and 83 years (mean age was 63.58 ± 10.34 years), diagnosed with osteoarthritis. The mean duration of pain was 10.58 ± 8.12 years. The shortest period reported was 1 year and the longest was 35 years.

During the 21 days of the spa treatment, all the patients underwent comprehensive physical therapy, including sulphide and hydrogen-sulphide baths, magnetic field therapy, laser therapy, and exercises in the pool.

The patients were randomly divided into two groups which differed in terms of the kinesiotherapy programme. 19 patients (52.8%) were assigned to isokinetic training preceded by a warm-up. The training was conducted with a PRIMA DOC machine for diagnostics and isokinetic exercise. 17 patients (47.2%) did isotonic training: active off-loading exercises with resistance dosed in UGUL. The parameters of the procedures and the method of conducting them were selected individually, according to the procedure methodology and indications. The isokinetic training was conducted in an open kinetic chain with the velocity of 320°/s, 220°/s, 120°/s in three series of 10 repetitions.

The study was approved by the Ethical Review Board in Łódź (Decision no. RNN/737/12/KB of 20 Nov 2012).

In order to assess the results, the patients were examined before and after the spa treatment in accordance with an established study protocol. The study included a measurement of the range of knee motion with a goniometer, pain assessment according to the Laitinen scale, and a measurement of selected parameters evaluated in isokinetic conditions: PEAK TORQUE (peak torque of flexors – Flx and extensors – Ext), ANGLE PT (joint angle at peak torque of flexors and extensors), MAX. POWER (maximum power of all repetitions for flexors and extensors), and TOTAL WORK (total work of flexors and extensors). The results were statistically analysed.

The calculations were performed with the use of STATISTICA PL 10 software. Quantitative variables were characterised with basic descriptive measures: mean and standard deviation (SD), minimum and maximum (min-max), median (Me), and interquartile range (IQR: Q25-Q75). In the case of qualitative variables, the number of observations (N) and the corresponding percentage (%) were given.

The normality of quantitative variables was tested by the Shapiro-Wilk test. In the case of quantitative variables, the results obtained before and after treatment were compared with Student's t test for dependent variables or Wilcoxon's signed rank test (depending on the distribution of variables). Quantitative variables in two independent groups were compared with Student's t test or the Mann-Whitney U test (depending on the normality of distribution). The method of repeated measures analysis of variance was used when necessary. The differences in qualitative variables were test-

ed with a chi-squared independence test. The results were deemed statistically significant at $p < 0.05$.

RESULTS

The two groups did not significantly differ in terms of gender, age, BMI, and the duration of symptoms (Tab. 1).

The majority of the patients had bilateral degenerative changes and thus the total number of knees studied was 68.

The range of knee motion before and after treatment was assessed with a goniometer. The results concerning flexion are summed up in Table 2.

There were no statistically significant differences between the groups with respect to the range of flexion before and after treatment ($p = 0.5606$ and $p = 0.3189$, respectively).

After treatment, a statistically significant increase in the range of flexion was found in both groups. It was slightly higher in the PRIMA DOC group (5.28%) than in the UGUL group (4.96%). Mean values in the PRIMA DOC group before and

after treatment were 109.8 ± 9.48 and 114.8 ± 7.75 , respectively ($p < 0.001$), while in the UGUL group they were 106.77 ± 11.29 before and 112.07 ± 9.11 after treatment ($p < 0.001$).

The range of extension in the PRIMA DOC group was normal in all patients both before and after treatment. In the UGUL group, an extension deficit was found in the case of only 2 joints. It was still present after treatment, but its value decreased. The results in the other patients were normal.

4 parameters were measured with the PRIMA DOC machine at the beginning and after the completion of the spa treatment: PEAK TORQUE, ANGLE PT, MAX. POWER and TOTAL WORK. The results obtained are presented in Tables 3-6.

There were no statistically significant differences between the groups with respect to the variables studied both before treatment and after its completion.

A comparison of the values before and after treatment revealed the following statistically significant differences:

1. in the group with isokinetic training (PRIMA DOC):
 - peak torque of extensors ($p = 0.0002$) and flexors ($p = 0.0032$) – values increased after treatment by 52.07% and 22.67%, respectively;
 - maximum power of all repetitions for extensors ($p = 0.0006$) and flexors ($p = 0.0076$) – values increased after treatment by 53.7% and 34.59%, respectively;
 - total work of extensors ($p = 0.0001$) and flexors ($p = 0.0090$) – values increased after treatment by 124.38% and 39.56%, respectively;
2. in the group with isotonic training (UGUL):
 - peak torque of extensors ($p = 0.0491$) and flexors ($p = 0.0001$) – values increased after treatment by 36.62% and 26.04%, respectively;
 - joint angle at peak torque of extensors ($p = 0.0086$) – values increased after treatment by 20.8%;
 - maximum power of all repetitions for extensors ($p = 0.0315$) and flexors ($p = 0.0011$) – values increased after treatment by 42.64% and 34.8%, respectively;
 - total work of extensors ($p = 0.0477$) and flexors ($p = 0.0092$) – values increased after treatment by 54.4% and 41.1%, respectively;

Pain was assessed with the Laitinen scale.

Table 1. Characteristics of study patients.

| Variable | | N (%) / descriptive measures | | p level |
|------------------|----------------|------------------------------|-------------------|---------|
| | | PRIMA DOC group | UGUL group | |
| Gender | F | 12 (63.2) | 13 (76.5) | 0.6148 |
| | M | 7 (36.8) | 4 (23.5) | |
| BMI | normal | 1 (5.3) | 5 (29.4) | 0.1118 |
| | overweight | 10 (52.6) | 8 (47.1) | |
| | obesity | 8 (42.1) | 4 (23.5) | |
| Age | Mean \pm SD | 66.63 \pm 7.60 | 60.18 \pm 12.05 | 0.0603 |
| | Min - Max | 57-83 | 29-83 | |
| | Me (Q25 - Q75) | 65 (61-69) | 61 (54-66) | |
| Symptom duration | Mean \pm SD | 8.58 \pm 4.48 | 12.82 \pm 10.11 | 0.2711 |
| | Min - Max | 2-24 | 1-35 | |
| | Me (Q25 - Q75) | 8 (5-10) | 12 (5-20) | |

Table 2. Comparison of range of flexion before and after treatment and between the groups.

| Group | Range of flexion | Mean | SD | Min | Max | Median | Q25 | Q75 | p level (before vs after treatment) |
|-----------------------------|------------------|--------------------------|-------|-----|-----|--------|-----|-----|-------------------------------------|
| PRIMA DOC | before treatment | 109.08 | 9.48 | 90 | 128 | 110 | 104 | 115 | 0.5606 |
| | after treatment | 114.84 | 7.75 | 97 | 129 | 116.5 | 112 | 120 | |
| UGUL | before treatment | 106.77 | 11.29 | 84 | 125 | 109.5 | 97 | 115 | 0.3189 |
| | after treatment | 112.07 | 9.11 | 96 | 127 | 114.5 | 102 | 120 | |
| p level - PRIMA DOC vs UGUL | | before treatment: 0.0000 | | | | | | | |
| | | after treatment: 0.0000 | | | | | | | |

Table 3. Comparison of peak torque before and after treatment and between the groups.

| Group | PEAK TORQUE | | Mean | SD | Min | Max | Median | Q25 | Q75 | p level (before vs after treatment) |
|-----------------------------|-------------|------------------|--------------------------|-------|-----|-----|--------|------|-----|---|
| PRIMA DOC | Ext | before treatment | 28.86 | 14.81 | 11 | 71 | 25.5 | 19 | 37 | 0.0002 |
| | | after treatment | 43.89 | 24.41 | 12 | 119 | 39 | 26.5 | 56 | |
| UGUL | | before treatment | 27.91 | 22.52 | 8 | 107 | 23.5 | 13 | 31 | 0.0491 |
| | | after treatment | 38.13 | 30.04 | 9 | 131 | 26 | 16 | 56 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.2211 | | | | | | | |
| | | | after treatment: 0.0945 | | | | | | | |
| PRIMA DOC | Flx | before treatment | 35.78 | 8.77 | 22 | 56 | 34 | 29 | 43 | 0.0032 |
| | | after treatment | 43.89 | 15.28 | 23 | 96 | 44 | 33 | 48 | |
| UGUL | | before treatment | 35.28 | 11.80 | 20 | 68 | 34 | 26 | 40 | 0.0001 |
| | | after treatment | 44.47 | 16.32 | 26 | 84 | 38 | 31 | 59 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.6224 | | | | | | | |
| | | | after treatment: 0.7443 | | | | | | | |

Table 4. Comparison of joint angle at peak torque before and after treatment and between the groups.

| Group | ANGLE PT | | Mean | SD | Min | Max | Median | Q25 | Q75 | p level (before vs after treatment) |
|-----------------------------|----------|------------------|--------------------------|-------|-----|-----|--------|------|------|---|
| PRIMA DOC | Ext | before treatment | 53.33 | 21.02 | 11 | 94 | 55 | 42 | 68.5 | 0.5159 |
| | | after treatment | 57.11 | 13.64 | 28 | 81 | 58 | 46.5 | 69 | |
| UGUL | | before treatment | 46.72 | 22.18 | 8 | 83 | 48 | 31 | 61 | 0.0086 |
| | | after treatment | 56.44 | 19.75 | 7 | 95 | 57 | 44.5 | 69.5 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.2010 | | | | | | | |
| | | | after treatment: 0.9804 | | | | | | | |
| PRIMA DOC | Flx | before treatment | 48.61 | 12.80 | 26 | 79 | 48 | 39.5 | 54.5 | 0.0897 |
| | | after treatment | 55.64 | 18.93 | 18 | 96 | 54 | 40 | 71.5 | |
| UGUL | | before treatment | 49.25 | 15.44 | 21 | 93 | 48 | 41 | 55.5 | 0.8986 |
| | | after treatment | 48.94 | 12.07 | 18 | 85 | 47.5 | 42 | 55 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 1.0000 | | | | | | | |
| | | | after treatment: 0.3045 | | | | | | | |

In the group with isokinetic training (PRIMA DOC) half of the patients scored at least 4 points before treatment and 0 points after treatment. The lowest score before treatment was 0 points and the highest was 10 points. After treatment, the lowest score was 0 points and the highest was 3 points. We found a statistically significant decrease in the number of points scored after treatment (p=0.0004).

In the UGUL group, half of the patients scored at least 4 points before treatment and 1 point after treatment. The lowest score before treatment was 0 points and the highest was 8 points. After treatment, the lowest score was 0 points and the highest was 4 points. We found a statistically significant decrease in the number of points scored after treatment (p=0.0007).

Table 5. Comparison of maximum power of all repetitions before and after treatment and between the groups.

| Group | MAX POWER | | Mean | SD | Min | Max | Median | Q25 | Q75 | p level (before vs after treatment) |
|-----------------------------|-----------|------------------|--------------------------|-------|-----|-----|--------|------|------|---|
| PRIMA DOC | Ext | before treatment | 41.64 | 28.45 | 2 | 114 | 40 | 21 | 54 | 0.0006 |
| | | after treatment | 64.00 | 40.97 | 1 | 191 | 58.5 | 34.5 | 86 | |
| UGUL | | before treatment | 39.72 | 38.78 | 3 | 172 | 31 | 11.5 | 54 | 0.0315 |
| | | after treatment | 56.66 | 49.28 | 10 | 206 | 34.5 | 18.5 | 86.5 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.3535 | | | | | | | |
| | | | after treatment: 0.1487 | | | | | | | |
| PRIMA DOC | Flx | before treatment | 44.97 | 20.00 | 10 | 114 | 40.5 | 33 | 56 | 0.0076 |
| | | after treatment | 60.53 | 29.80 | 14 | 158 | 57 | 41 | 69.5 | |
| UGUL | | before treatment | 46.06 | 25.28 | 9 | 107 | 45.5 | 26 | 60 | 0.0011 |
| | | after treatment | 62.09 | 30.05 | 20 | 136 | 50 | 41.5 | 84.5 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.9804 | | | | | | | |
| | | | after treatment: 0.9853 | | | | | | | |

Table 6. Comparison of total work of muscles before and after treatment and between the groups.

| Group | TOTAL WORK | | Mean | SD | Min | Max | Median | Q25 | Q75 | p level (before vs after treatment) |
|-----------------------------|------------|------------------|--------------------------|-------|-----|-----|--------|------|-------|---|
| PRIMA DOC | Ext | before treatment | 33.61 | 37.86 | 0 | 145 | 24 | 0 | 60 | 0.0001 |
| | | after treatment | 75.42 | 65.22 | 0 | 225 | 69.5 | 22.5 | 98 | |
| UGUL | | before treatment | 40.44 | 53.95 | 0 | 199 | 18.5 | 0 | 69 | 0.0477 |
| | | after treatment | 62.44 | 75.38 | 0 | 283 | 34 | 0 | 101.5 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.9393 | | | | | | | |
| | | | after treatment: 0.1432 | | | | | | | |
| PRIMA DOC | Flx | before treatment | 63.06 | 38.04 | 0 | 112 | 77 | 29 | 94.5 | 0.0090 |
| | | after treatment | 88.00 | 50.47 | 0 | 264 | 88 | 70.5 | 104 | |
| UGUL | | before treatment | 67.97 | 58.84 | 0 | 187 | 78.5 | 3 | 105.5 | 0.0092 |
| | | after treatment | 95.91 | 55.90 | 0 | 197 | 92 | 63 | 137 | |
| p level - PRIMA DOC vs UGUL | | | before treatment: 0.8294 | | | | | | | |
| | | | after treatment: 0.5718 | | | | | | | |

There were no statistically significant differences between the PRIMA DOC and UGUL groups both before ($p=0.2575$) and after treatment ($p=0.3969$) (Fig. 1).

DISCUSSION

An assessment of the effectiveness of various therapy methods in the treatment of gonarthrosis has been the subject of numerous reports [2, 3, 4, 5, 6].

The 21. Military Spa and Rehabilitation Hospital in Busko-Zdrój uses many types of exercise. The subject of this study was to compare the effectiveness of isokinetic training in the

PRIMA DOC machine with isotonic exercise using a system of weights and blocks.

Isokinetic exercises allow for increasing the muscle strength in specially adjusted conditions. They consist in dynamic muscle contractions with controlled and constant angular speed of movement. They are possible due to automatic adjustment of resistance to the strength of the muscle group tested along the whole movement range [7, 8, 9, 10]. The exercises require the use of the PRIMA DOC machine which guarantees individual adjustment of training parameters.

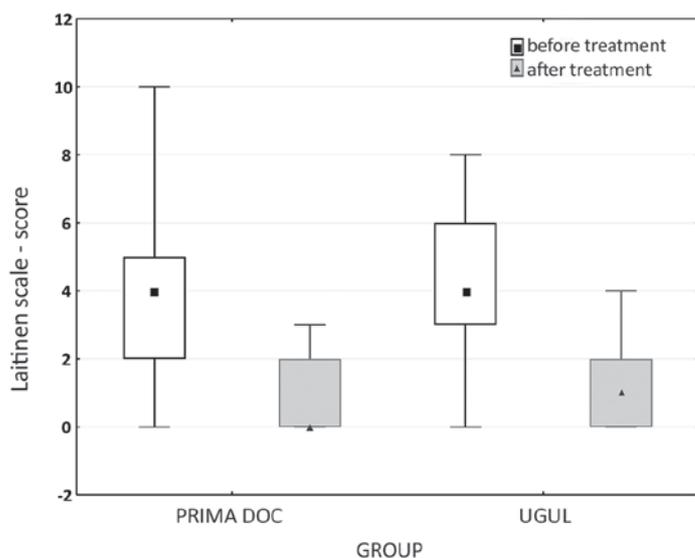


Figure 1. Assessment of health status according to Laitinen scale before and after treatment.

Off-loading exercise in a block and weight system with UGUL are the basis for osteoarthritis therapy. They allow for increasing the range of motion and improving muscle strength [6].

There are many methods assessing the effectiveness of these therapies [3, 10]. The assessment of muscle strength in isokinetic conditions is one of the objective methods. The scientific literature includes numerous papers concerning isokinetic studies of the knee [5, 6, 8, 10, 11, 12, 13, 14, 15].

Our study parameters improved in both groups of patients. There was a statistically significant increase in the values of the parameters measured in isokinetic conditions: PEAK TORQUE (peak torque of flexors and extensors), ANGLE PT (joint angle at peak torque of flexors and extensors), MAX. POWER (maximum power of all repetitions for flexors and extensors), and TOTAL WORK (total work of flexors and extensors). The increase in these parameters reflects an improvement in the dynamic properties of the muscle groups tested.

Based on studies evaluating the influence of isokinetic training on knee capacity in patients with gonarthrosis, Nitera-Kowalik et al. [5] found a statistically significant improvement in the maximum power during extension and an increase in the total muscle work and maximum power during flexion. More positive outcomes of isokinetic training described in many publications were connected with longer treatment [2, 3, 9].

Exercises conducted in both groups had a statistically significant influence on increasing the range of knee flexion.

An analysis of the results showed no statistically significant differences between the groups before and after the rehabilitation. Similar results observed in both groups may result from the fact the rehabilitation period was too short as it was limited by the length of the spa treatment. In a report comparing 8-week isokinetic and isometric training programmes, Rosa et al. point out the higher efficiency of isokinetic exercise [2].

There was a statistically significant decrease in pain measured with a modified Laitinen scale in both groups of patients. Without any doubt, this change was connected to the positive influence of physical therapy and exercise. The reduction in pain described in the paper contributed to limb function improvement and an increase in the patients' quality of life.

CONCLUSIONS

Numerous authors emphasize the advantages of isokinetic training in patients with gonarthrosis [2, 3, 4, 5, 12]. However, our study suggests that both training methods result in similar treatment outcomes. The sample is undoubtedly too small to draw firm conclusions and further studies are necessary.

Due to the satisfactory treatment outcomes obtained in the experiment, both methods may be valuable in the treatment of gonarthrosis.

Isokinetic examination of dynamic syndromes of the knee is a precise and objective method of assessing training results in patients with osteoarthritis, after injuries, and in sports [8, 9, 11, 14].

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- Wpływ metody Kinesiotaping na priopriorepcję stawu skokowego i równowagę dynamiczną kończyny dolnej.
- Metoda Kinesiotaping jako element rehabilitacji u dzieci z pastyką i wiotkością mięśni.
- Wpływ aplikacji Kinesio Tping na mięśnie antygravitacyjne oraz na równowagę ciała człowieka.
- Zastosowanie Kinesio Tapingu w leczeniu dolegliwości bólowych stopy.
- Zastosowanie aplikacji taśmy Kinesio Tex Gold w skoliozach.
- Wykorzystanie aplikacji Kinesiotaping u zwierząt.
- Ocena skuteczności metody Kinesiotaping wg Kenzo Kase w bolesnym obkurczeniu aktonu górnego mięśnia czworobocznego grzbietu.

Pakiety uczestnictwa: od 150 zł – 450 zł.

Od 100 zł – 390 zł dla absolwentów kursu Kinesiotaping.

VIP pakiet: cena + 150 zł do wybranego pakietu

Uroczysta kolacja na dachu Hotelu Victoria w towarzystwie dr. Kenzo Kase.

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