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ORIGINAL ARTICLE

EFFECTS OF RESISTANCE TRAINING WITH OR WITHOUT WHOLE BODY VIBRATION TRAINING ON PAIN AND FUNCTIONAL DISABILITY IN PATIENTS WITH KNEE OSTEOARTHRITIS

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ABSTRACT

Osteoarthritis (OA), commonly referred to as degenerative joint disease, wear and-tear arthritis. Primary OA or age-related arthritis is the most prevalent type of arthritis and a major factor in disability both in the United States and around the world. **Objective:** To determine the effects of resistance training with and without whole body vibration therapy on pain and functional disability in patients with knee osteoarthritis. **Methods:** A randomized controlled trial was conducted on 74 knee osteoarthritis (grade II, III) in which unilateral knee OA patients were included. Patients were divided into experimental and controlled group in which resistance training with whole body vibration and resistance training only was delivered respectively. Numeric pain rating scale (NPRS), Western Ontario and McMaster Universities osteoarthritis index (WOMAC), 6-minute walk test and timed up and go test (TUG) were used as outcome measures. **Results:** The mean age among resistance training group without whole body vibration (WBV) was 53.45±6.04 and age of resistance training with WBV was 54.81±5.36. Baseline pain level in resistance training group without WBV was 6.7±2.1 and 6.5 ± 1.7 for the resistance training group with WBV. After 8th weeks, pain in resistance training group without WBV and the group with WBV improved to 5.6±2.1 and 4.5 ± 1.6, respectively. The p value was less than 0.05 for both groups in terms of 6-minute walk test, TUG test, WOMAC score and NPRS scores. **Conclusion:** It is stated that, resistance training alone and in addition with whole body vibration therapy have projected positive effects on patients in terms of reducing pain and functional disability in patients with grade II and III Knee osteoarthritis patients. While, the combination of resistance training and whole-body vibration therapy showed evident differences than resistance training alone.

Keywords: Functional disability, Knee osteoarthritis, Pain, Resistance training, Whole body vibration therapy

INTRODUCTION

In osteoarthritis (OA) the cartilage within a joint begins to break down and the underlying bone begins to change. These changes usually develop slowly and get worse over time. This degenerative joint disease or age-related arthritis is the most prevalent type of arthritis and a major factor in disability both in the Pakistan and around the world[1,2-7]. The most frequent type of joint problem is osteoarthritis. The increasing population age and the epidemic of obesity are two factors that are

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expected to contribute to a rise in the number of persons who suffer from symptomatic knee OA[8]. Knee osteoarthritis (OA) affects all three compartments of the knee joint (lateral, medial, and patellofemoral joint). Often progresses very slowly over the course of ten to fifteen years and it became difficult to participate in day-to-day activities. The illness of the articular cartilage was traditionally thought to be "wear-and-tear" and attributed only to the effects of ageing, with inflammation being disregarded as a contributing factor[9].

Osteoarthritis of the knee is a devastating ailment that affects a significant number of elderly people all over the world[10]. People who have osteoarthritis of the knee experience discomfort and have difficulty carrying out routine daily tasks. The increased load that is passed over the medial compartment of the knee joint has been linked to the considerable occurrence of osteoarthritis (OA) in this area[11]. Even though a number of factors have been linked to the onset and advancement of osteoarthritis, especially OA of the medial compartment of the knee. However, the exact cause of knee osteoarthritis is still unknown. Recent research has focused on the biomechanical parameters associated with joint loading as a possible major factor in the cause of knee osteoarthritis (OA)[12].

Whole body vibration (WBV) exposure is a method of neuromuscular training that has become popular in recent years in the health industry, local gyms, and fitness and rehabilitation centres as an alternative or addition to traditional training and therapy. WBV improves muscle strength and power and makes muscles more flexible, etc. In the scientific literature, it has been reflected that muscle performance was better in those training programs that used WBV exposure than the other programs. During WBV, a vibrating platform sends low-frequency, low-amplitude mechanical stimuli to a person's body. The tonic vibration reflex says that the vibration stimulates the muscle spindles and sends nerve impulses to start muscle contractions[13,14].

Resistance training (RT) is good for the young skeleton in a number of ways. When more weight is put on the skeleton, the mineral content of the bones, changes. When the amount of bone in the body goes up, the strength of the bones also goes up. With more time of RT, the amount of bone in the body also goes up. Soccer players who only did 2 h of RT per week as compare to those who did 4 h or more of RT per week had much more bone growth. The soccer players who did 2 hours of RT per week had more bone growth than the soccer players in the control group. Resistance training is also linked to a higher bone strength index (BSI), which can be calculated by multiplying the cross-sectional moment of inertia by the bone mineral density of the cortical bone. Increased BSI has been seen in bones that are important for performance in certain sports. Researchers have found that the BSI of gymnasts has increased. Researchers have found that track and field athletes have higher BSI in the distal and proximal tibia, while water polo players have higher BSI in the distal radius. Studies have shown that a higher BSI is linked to a lower risk of breaking a bone[15].

Whole-body vibration and resistance exercise can help people with knee osteoarthritis get stronger and improve their quality of life. But there isn't enough evidence to compare whole-body vibration and resistance training for people with knee osteoarthritis. This study has also focused on strengthening the gluteus maximus and gluteus medius muscles, as well as the quadriceps and hamstrings.

MATERIALS AND METHODS

This randomized controlled trial was conducted at the Department of Physical Therapy, Government General Hospital Faisalabad. The study spanned over a duration of 9 months. The sample size was determined using the WOMAC pain scale[6] as an outcome measure, with a calculated sample size of 31 participants in each group. Accounting for a 20% dropout rate, the final sample size was set at 37 individuals in each group. Non probability purposive sampling technique was used to collect data from both genders, aged between 40 and 60 years, having knee osteoarthritis; grade II-III. According to Kellgren and Lawrence scale[7], facing persistent symptoms in unilateral knee such as pain and stiffness for a period of at least 3 months with no previous surgeries of any of the knee. Rest of the participants with secondary or inflammatory KOA and other pathologies like; ankle, hip or foot disorders, chronic back pain, fibromyalgia, neurological disorders like; Alzheimer's disease, Parkinson's disease, Motor neuron disorders, systemic illnesses like; diabetes mellitus, cardiac or respiratory insufficiency, tumors, history of trauma such as; meniscal injury, cruciate ligamentous injury, patellar fracture, dislocations, bursitis, patellar tendonitis, and inability to understand the procedure and unwillingness to participate were excluded from this study.

After screening for the eligibility criteria, the orthopedic physician of Government General Hospital referred the patients to the Physical Therapy Department. Patients fulfilling the eligibility criteria were asked to sign the consent forms before entering them to this single blinded study (assessor-blind). All the screened and willing participants were randomly allocated to two groups (Group A: experimental group / WBVT group + resistance exercises, Group B: comparative group / RT group) by lottery method.

Group A- Intervention: The treatment was started by routine physiotherapy comprised of TENS (setting was in a conventional mode, with a frequency of 80 Hz and a pulse duration of 50–100 µs. The intensity of TENS current was set to produce a strong tingling sensation and stretching exercises for whole body as a warm up, before starting the main treatment regime for 15 minutes. A vibration device was used for whole body vibration in which patient were asked to stand on the platform with 30^{o} flexed knees, holding the handles of machine with both hands and put weight equally on both legs. The vibrations were provided for 6 minutes with rest gap of 1 minute after every 1 minute. The frequency of vibration was 50-60Hz and the level was kept according to the patients' comfort. Resistance exercises include hamstring curl, hip extension, hip flexion, knee extension, knee flexion, and leg press with resistance band. Each exercise will be performed in 2 sets of 10 repetitions with 2 min of rest after every exercise set. The whole treatment session was started by 15 min warm up and end with 5 min cool down, delivered 3 times a week for 12 weeks yielding a total of 36 sessions within 3 months and duration of each session was of 35-45 min in Group A

Group B- Intervention: The group B got routine physiotherapy comprising of TENS (setting was in a conventional mode, with a frequency of 80 Hz and a pulse duration of 50–100 µs. The intensity of TENS current was set to produce a strong tingling sensation, but without pain.) and stretching exercises for whole body as a warm up, before starting the main treatment regime for at least 15 minutes. The main treatment of the Group B was resistance exercises with the help of resistance band whose color indicate the resistance level (yellow, red, green, blue, black or grey) including; hamstring curl, hip extension, hip flexion, knee extension, knee flexion, and leg press with resistance band. Each exercise was performed in 2 sets of 10 repetitions with 2 min of rest after every exercise set and end with 5 min cool down. The whole treatment session was delivered 3 times a week for 12 weeks yielding a total of 36 sessions within 3 months and duration of each session was of 35-45 min in Group B. The first two weeks of training was served as familiarization period to ensure that each exercise was performed by using correct technique.

Statistical Analysis

Data was assessed by assessor at baseline, at the end of 8th week and at the end of 12th week. Analysis was carried out on SPSS version 23. The data was assessed for normal distribution through Kolmogorov Smirnov and the data was normally distributed. Repeated measures ANOVA was applied to assess difference within group. Whereas, to analyze between group differences, independent sample t test was used. The p value of ≤ 0.05 was considered as significant.

RESULTS

The mean age of participants among resistance training group without WBV was 53.45±6.04 years and resistance training with WBV was 54.81±5.36 years. Table 1 showed overall WO-MAC score in both groups. Whereas, WOMAC pain score among resistance training group without WBV at baseline was 11.5±2.1, after 8th weeks was 8.9± 1.5 and after 12th weeks was 5.8 ±1.9. WOMAC function score at baseline was 27.7±10.4, after 8th weeks was 21.9 ±9.3 and after 12th week was 13.2±8.2. WOMAC stiffness at baseline was 5.1 ±1.2, at 8th weeks was 3.9 ±1.4 and after 12th weeks was 3± 1.5. Moreover, WOMAC score pain level among resistance tra-ining group with WBV at baseline was 11.5±1.7, after 8th weeks was 6.6± 1.6 and after 12th weeks was 3.9 ±1.8. At baseline WOMAC function was 32.2±9.7, after 8th weeks was 16.7 ±5.4 and after 12th weeks was 8.3±3.7. WOMAC stiffness at baseline was 5.4 ±1.1, at 8th weeks was 3.0 ±1.1 and after 12th weeks was 1.7± 1.1.

Furthermore, data normality was checked through Kolmogorov Smirnov test in which all the variables showed values above 0.05. Hence data was normally distributed, parametric tests were employed to analyze differences within and between group. According to independent sample t-test; there are no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values were greater than a significant value. However, the results revealed that there are differences in the numeric pain rating scale between the two groups. At the 8th week, time up and go test (TUG) and a six-minute walk were measured, and the p value was less than a significant value as depicted in Table 2.

Table 3 indicates within group differences analysis for WOMAC pain, stiffness and function at three different intervals. There are no differences in WOMAC subscales between the both groups at baselines because the p value was greater than significant value. There were statistically significant differences in both groups after 8 and 12 weeks of treatment.

There were no differences present at baseline as value was above significant value whereas at 8th and 12th week there was improvement in pain as the p value was less than 0.05 in both weeks. Whereas, the mean difference clearly describes that pain was reduced more in experimental group. There were no differences present at baseline as value was above significant value whereas at 8th and 12th week there was improvement in TUG test as the p value was less than 0.05 in both weeks. Whereas, the mean difference clearly describes that TUG test readings were improved more in experimental group, mainly from baseline to 12th week. There were no differences present at baseline as value was above significant value whereas at 8th and 12th week there was improvement in 6-minute walk test as the p value was less than 0.05 in both weeks. The mean difference clearly describes that 6-minute walk test readings were improved more in experimental group, mainly from baseline to 12th week, as presented in Table 4

Table 1. Descriptive statistics of baseline characteristics

Variable	Time	Resistance training without WBV	Resistance training with WBV
WOMAC	Baseline	6.7±2.1	6.5 ± 1.7
	8th Week	5.6±2.1	4.5 ± 1.6
	12th Week	3.0±2.0	1.8 ± 1.5
6 minutes-walk test	Baseline	449.5±33.5	457.1±26.9
	8th Week	460.2±30.4	475.2±23.9
	12th Week	465.2±27.3	501.3±19.2
TUG test	Baseline	13.0±2.9	12.0±2
	8th Week	11.9±2.9	9.9±1.7
	12th Week	11.0±2.8	8.8±1.8

Table 2. Independent sample t test for numeric pain rating scale, timed up and go test, and 6 minutes-walk test

Variable	Group	Mean	Std.	t	P
NPRS baseline	Resistance training without WBV	6.74	2.13	0.39	0.69
	Resistance training with WBV	6.55	1.75		
NPRS 8th week	Resistance training without WBV	5.58	2.13	2.21	0.03
	Resistance training with WBV	4.52	1.63		
NPRS 12th week	Resistance training without WBV	3.00	2.00	2.57	0.01
	Resistance training with WBV	1.84	1.53		
Time up and go baseline	Resistance training without WBV	12.95	2.93	1.53	0.13
	Resistance training with WBV	11.97	2.05		
Time up and go 8th week	Resistance training without WBV	11.87	2.92	3.23	0.00
	Resistance training with WBV	9.91	1.67		
Time up and go 12th week	Resistance training without WBV	10.99	2.76	3.65	0.00
	Resistance training with WBV	8.85	1.75		
Six-minute walk baseline	Resistance training without WBV	449.52	33.48	0.98	0.33
	Resistance training with WBV	457.10	26.92		
Six-minute walk 8th week	Resistance training without WBV	460.16	30.40	2.16	0.04
	Resistance training with WBV	475.16	23.86		
Six-minute walk 12th week	Resistance training without WBV	465.23	27.35	6.00	0.00
	Resistance training with WBV	501.26	19.22		

Table 3. Repeated measures ANOVA for WOMAC subscales

Variable	Group	Mean	Std.	P	F
WOMAC pain score baseline	Resistance training without WBV	11.5	2.1	1.00	0.00
	Resistance training with WBV	11.5	1.7		
WOMAC stiffness score baseline	Resistance training without WBV	5.4	1.2	0.82	0.05
	Resistance training with WBV	5.4	1.1		
WOMAC function score baseline	Resistance training without WBV	27.7	10.4	0.08	3.18
	Resistance training with WBV	32.2	9.7		
WOMAC pain score at 8th week	Resistance training without WBV	8.9	1.5	0.00	31.87
	Resistance training with WBV	6.6	1.6		
WOMAC pain score at 12th week	Resistance training without WBV	5.8	1.9	0.00	16.23
	Resistance training with WBV	3.9	1.8		
WOMAC function score at 8th week	Resistance training without WBV	21.9	9.3	0.01	7.16
	Resistance training with WBV	16.7	5.4		
WOMAC function score at 12th week	Resistance training without WBV	13.2	8.2	0.00	9.32
	Resistance training with WBV	8.3	3.7		
WOMAC stiffness score at 8th week	Resistance training without WBV	3.9	1.4	0.01	8.67
	Resistance training with WBV	3.0	1.1		
WOMAC stiffness score at 12th week	Resistance training without WBV	3.0	1.5	0.00	13.90
	Resistance training with WBV	1.7	1.1		

Table 4. Repeated measures ANOVA for numeric pain rating scale, timed up and go test, and 6 minutes-walk test

Variable	Group	Mean	Std.	P	F
Time up and go baseline	Resistance training without WBV	13.0	2.9	0.131	2.35
	Resistance training with WBV	12.0	2.0		
Time up and go 8th week	Resistance training without WBV	11.9	2.9	0.002	10.44
	Resistance training with WBV	9.9	1.7		
Time up and go 12th week	Resistance training without WBV	11.0	2.8	0.001	13.34
	Resistance training with WBV	8.8	1.8		
Six-minute walk baseline	Resistance training without WBV	449.5	33.5	0.330	0.97
	Resistance training with WBV	457.1	26.9		
Six-minute walk 8th week	Resistance training without WBV	460.2	30.4	0.035	4.67
	Resistance training with WBV	475.2	23.9		
Six-minute walk 12th week	Resistance training without WBV	465.2	27.3	0.000	36.02
	Resistance training with WBV	501.3	19.2		
Numeric pain rating scale baseline	Resistance training without WBV	6.74	2.13	0.697	0.15
	Resistance training with WBV	6.55	1.75		
Numeric Pain Rating Scale at 8th week	Resistance training without WBV	5.58	2.13	0.031	4.89
	Resistance training with WBV	4.52	1.63		
Numeric Pain Rating Scale at 12th week	Resistance training without WBV	3.00	2.00	0.013	6.59
	Resistance training with WBV	1.84	1.53		

DISCUSSION

In the present study the aim of our study was to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. The outcome measures we used in this study were Numeric Pain Rating Scale for pain, Western Ontario and McMaster Universities Osteoarthritis Index, TUG test, and 6 minutes' walk test for functional disability. We concluded in this study that there were no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values were greater than a significant value. However, the results revealed that there were differences in the Numeric Pain Rating Scale between the two groups. At the 8th week, time up and go and a six-minute walk were measured, and the p value was less than a significant value.

The study conducted by Lai *et al.* (2021) to determine the therapeutic effect on neuromuscular function by whole body vibration training among the patients of knee osteoarthritis. They randomly allocated their patients in to three groups. In the first group they performed (ST) strength training along with Whole body vibration, 2nd group was only given strength training without whole body vibration, whereas in the 3rd group in this participant were delivered with health education. The outcome measures that were for pain visual analogue scale, isokinetic muscle strength test, TUG test, 6-min walk test and proprioception were performed. Whereas the present study aimed to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. The outcome measures we used in this study were numeric pain rating scale for pain, Western Ontario and Mc-

Master Universities Osteoarthritis Index, TUG test, and 6 minutes' walk test for functional disability. They concluded in this study that there were no differences in the Numeric pain rating scale, Time up and go test, and six-minute walk test between the two groups at baseline because the p values > 0.05. There was no significant difference was found between the groups in the context of pain intensity, proprioception, Time up and go test and 6-min walk test. There was a significant effect was uncovered in-between groups for isokinetic muscle strength whole body vibration group as compared to health education showed improvement in isokinetic muscle strength. In the present study, we concluded there was no differences in the Numeric pain rating scale, Time up and go test, and six-minute walk test between the two groups at baseline because the p values were greater than a significant value. However, the results revealed that there were differences in the Numeric Pain Rating Scale between the two groups. At the 8th week, time up and go and a six-minute walk were measured, and the p value <0.05[16].

Another study evaluated the effects of whole-body vibration technique on the muscles of lower extremity in patients suffering from knee osteoarthritis. For this they enrolled 45 patients suffering from knee OA in to three groups one group received whole-body vibration 2nd group received two exercises in home and 3rd group performed exercise like whole-body vibration group on-off vibration system. They evaluate electromyography activity of lower limb muscles. Whereas the present study aimed to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. We concluded in this study that there were no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values > 0.05. The results revealed that there were significant differences found between the groups according to the EMG activity of vastus medialis in semi squat position (p=0.05), semitendinosus in semi squat position (p=0.05) and in plantar flexion position (p=0.02) and also soleus in plantar flexion position (p=0.00). So, they concluded in their study that the group which received the whole-body vibration training showed improvement in the muscles among the patients with knee OA especially muscles' progression rates in a four-week period[17].

In the present study, the aim of our study was to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. The outcome measures we used in this study were numeric pain rating Scale for pain, Western Ontario and McMaster Universities Osteoarthritis Index, TUG test, and 6 minutes' walk test for functional disability. We concluded in this study that there were no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values >0.05. However, the results revealed that there were differences in the numeric pain rating scale between the two groups. At the 8th week, time up and go and a six-minute walk were measured, and the p value was <0.05. Whereas the study conducted by Hamid Reza Bokaeian (2016) to explored the effects of whole-body vibration training on the hamstrings and quadriceps along with strength training in the patients of knee osteoarthritis. The outcomes measure they used in this study was visual analogue scale for pain, Western Ontario and McMaster University Osteoarthritis index for quality of life, 2-minute walk test, time up and go test, muscle peak torque, muscle power and 50-foot walk test for functional activity. For measuring the muscle performance of quadriceps and hamstrings they used (IBM) Isokinetic Biodex machine. The study found no significant difference between the experimental groups in term of pain, quality of life, TUGT and 50 FWT. The result of the study suggests that adding WBV training to strengthening training may provide better treatment effects for patients with Knee OA[18].

In another study conducted by Park *et al.* (2013), the effect of whole-body vibration and strength training among the patients of chronic OA in the context of reducing pain were explored. They evaluated pain intensity through numeric pain rating scale, Lysholm scoring scale (LSS) and Korean Western

Ontario McMaster score (KWOMAC). Quadriceps strength Biodex stability system was used for measuring dynamic balance whereas in the present study the aim of our study was to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. The outcome measures we used in this study were numeric pain rating scale for pain, Western Ontario and McMaster Universities Osteoarthritis Index, TUG test, and 6 minutes' walk test for functional disability. It was concluded in this study that there were no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values >0.05. However, the results revealed that there were differences in the numeric pain rating scale between the two groups. At the 8th week, time up and go and a six-minute walk were measured, and the p value < 0.05 likewise Park *et al.* (2013) concluded in their study that whole body vibration reduced pain intensity and there was improvement in the strength of quadriceps and dynamic balance performance as p-value <0.05[19].

Another study conducted to determine the effects of squat training in combination with whole body vibration among the patients of knee OA in the context of muscle strength and physical function. The outcome measures they used in their study were for pain VAS, for physical function (TUG), 6-min they walk distance test, and for strength isokinetic measurements were taken. Whereas the present study aimed to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. The outcome measures we used in this study were Numeric pain rating scale for pain, Western Ontario and McMaster Universities Osteoarthritis Index, TUG test, and 6 minutes' walk test for functional disability. We concluded in this study that there were no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values > 0.05. Lai *et al.* (2019) concluded in their study that after the 8th week of whole Body Vibration training in combination with squat training was more beneficial as p-value <0.05 in the context of improving the knee extensors strength when compared with Squat strength in patients with Knee osteoarthritis[20].

Another study conducted to determine the effectiveness of whole-body vibration training in combination with quadriceps strengthening exercise and alone on functioning and gait on patients suffering from knee OA. For this they enrolled 39 participants into two groups. Whereas in the present study the aim of our study was to evaluate the effects of resistance training with or without whole body vibration training on pain and functional disability in patients with knee osteoarthritis. The outcome measures we used in this study were numeric pain rating Scale for pain, Western Ontario and McMaster Universities Osteoarthritis Index, TUG test, and 6 minutes' walk test for functional disability. We concluded in this study that there were no differences in the numeric pain rating scale, time up and go test, and six-minute walk test between the two groups at baseline because the p values were greater than a significant value. However, the results revealed that there were differences in the numeric pain rating scale between the two groups. At the 8th week, time up and go and a six-minute walk were measured, and the p value > 0.05. Whereas their study revealed that over a 3 months period, whole body vibration training in combination with quadriceps strengthening exercises showed improvement as the p-value <0.05 in the context of physical function, pain and gait[21].

CONCLUSION

It is stated that, resistance training alone and in addition with whole body vibration therapy have projected positive effects on patients in terms of reducing pain and functional disability in patients with grade II and III Knee osteoarthritis patients. While, the combination of resistance training and whole-body vibration therapy showed evident difference than resistance training alone. Clinically, it is recommended to consider this as a rehabilitation management of knee osteoarthritis to enhance the overall health status to perform activities of daily living independently.

DECLARATION

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