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Different kinesio taping tensions present similar benefits for postural control, dynamic balance, agility and instability sensation in individuals with chronic ankle instability: randomized clinical trial

Diferentes tensões de kinesio taping apresentam benefícios semelhantes para controle postural, equilíbrio dinâmico, agilidade e sensação de instabilidade em indivíduos com instabilidade crônica do tornozelo: ensaio clínico randomizado

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Abstract – Ankle sprain is the most common injury in the lower limbs of physically active individuals, and one of its complications is chronic ankle instability (CAI), for which Kinesio Taping (KT) can be an alternative treatment. The aim of this study was to compare two treatment protocols with KT at different tensions on postural control, dynamic balance, agility and instability in individuals with chronic ankle instability. This is a randomized clinical trial in which postural control was evaluated through the force platform, agility by the side Hop Test, dynamic balance by the modified Star Excursion balance Test, and application of *the Cumberland Ankle Tool Instability* and *Foot and Ankle Outcome Score* to assess self-reported instability and functional instability. An initial assessment was conducted, followed by 5 weeks of intervention with weekly applications of KT, and one week after the completion of the intervention, a reassessment was performed. 21 participants were distributed to the group KT with tension (KTT: n=11) and the group KT without tension (KTWT: n=10). KT improves postural control (anteroposterior velocity: p=0.006 and mediolateral: p<0.001; anteroposterior frequency: p<0.001 and mediolateral: p=0.043 of the area of the center of pressure), dynamic balance (p< 0.001), agility (p=0.001) and feeling of instability in individuals with ICT (p=0.001) for both groups. Only one variable, sports category of the FAOS-FOOT questionnaire showed significant change (p=0.008). KT, with or without tension, is able to improve postural control, balanced balance, postural control, and feelings of instability in young adults with ICT.

Key words: Ankle; Postural balance; Clinical trials.

Resumo – *A entorse de tornozelo, uma lesão comum em indivíduos fisicamente ativos, frequentemente resulta em uma complicação chamada instabilidade crônica do tornozelo (ICT). A Kinesio Taping (KT) pode ser uma alternativa de tratamento para essa condição. O objetivo deste estudo foi comparar dois protocolos de tratamento com KT em diferentes tensões no controle postural, equilíbrio dinâmico, agilidade e instabilidade em indivíduos com instabilidade crônica do tornozelo. Trata-se de um ensaio clínico randomizado no qual o controle postural foi avaliado por meio da plataforma de força, a agilidade pelo side Hop Test, o equilíbrio dinâmico pelo Star Excursion balance Test modificado e para avaliar instabilidade funcional e autorrelatada aplicou-se o Foot and Ankle Outcome Score e o Cumberland Ankle Tool Instability. Foi realizada uma avaliação inicial, seguida de 5 semanas de intervenção com aplicações semanais de KT, e uma semana após o término da intervenção, foi realizada uma reavaliação. 21 participantes foram distribuídos para o grupo KT com tensão (KTT: n=11) e o grupo KT sem tensão (KTWT: n=10). KT melhora o controle postural (velocidade ântero-posterior: p=0,006 e médio-lateral: p<0,001; frequência anteroposterior: p<0,001 e médio-lateral: p=0,043 da área do centro de pressão), equilíbrio dinâmico (p<0,001), agilidade (p=0,001) e sensação de instabilidade em indivíduos com ICT (p=0,001) para ambos os grupos. Apenas uma variável, categoria esportiva, do questionário FAOS-FOOT apresentou alteração significativa (p=0,008). O KT, com ou sem tensão, é capaz de melhorar o controle postural, o equilíbrio equilibrado, o controle postural e a sensação de instabilidade em adultos jovens com ICT.*

Palavras-chave: *Tornozelo; Equilíbrio postural; Ensaios clínicos.*

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INTRODUCTION

An ankle sprain (AS) is one of the most common musculoskeletal injuries in the physically active population, affecting between 600 and 700 per 100,000 people per year in the general population[1-4]. When the symptoms of primary AS persist for 6 months or more, it is considered chronic ankle instability (CAI)[5,6]. CAI is a broad term used to classify the chronic symptoms of primary sprains, recurrent sprains, functional instability, and mechanical instability[7,8].

AS recurrence is common if a primary injury is not properly treated[9]. This recurrence can lead to compromised balance, reaction time, and muscle strength, potentially contributing to ankle instability[6,10,11]. After an injury, the proprioceptors are damaged, reducing the individual's ability to stabilize the joint against the mechanisms of injury[6,10,11]. Ankle mechanical instability is closely associated with neuromuscular deficits[6,10,11].

It is important to assess clinical condition parameters and functional tests after episodes of sprains, whether acute or chronic, as they can lead to a deterioration in dynamic postural control and self-reported function[2,12]. Tests such as the Side Hop Test (SHT), dynamic balance tests like the Modified Star Excursion Balance Test (SEBTm), and postural control assessments using a force platform are crucial to understand the consequences of CAI on individuals[12].

The literature suggests that CAI is associated with neuromuscular deficits resulting from damage to joint and cutaneous receptors[13-16]. Kinesio Taping (KT) is considered a valuable alternative for the prevention and treatment of musculoskeletal disorders[13-16]. It works by stimulating the central nervous system (CNS) and proprioception through the pressure applied by the tape on the skin[13-16]. The rationale behind the use of tape is that it enhances sensory input, allowing muscles to maintain proper tension during physical activity[13-16]. Additionally, it provides a sense of joint stability without requiring constant control from regions such as the cerebellum or premotor cortex, which are responsible for movement planning and adjustment[13-16].

Several authors have conducted studies on the effects of increasing tension in KT by enhancing the stimulation of cutaneous mechanoceptors and receptors, thereby increasing afferent signals and stimulating the CNS[17-20]. However, the specific details of how tape tensioning is performed are often poorly explained in these studies[18-23]. Furthermore, most of these studies only assess the immediate effects of KT application, within 24 to 72 hours after application or removal of the tape, leaving a gap in understanding the effects of long-term treatment protocols[18-23].

In view of these facts, we hypothesized that the protocol with tape tension would yield superior results compared to the protocol without tension in the evaluated outcomes. Therefore, the objective of this study was to compare two treatment protocols using KT with different levels of tension on postural control, dynamic balance, agility, and sensations of instability in individuals with CAI.

METHODS

This study was approved by the Human Research Ethics Committee of University Pitágoras Unopar under opinion number 3,059,113 and registered at ClinicalTrials.gov (NCT04568577).

Participants

Participants were young adults (aged 18-35 years) with chronic ankle instability (CAI), recruited through personal contact and social media outreach. The inclusion criteria were as follows: unilateral or bilateral CAI; experienced the first episode of ankle sprain at least a year ago, with the most recent sprain occurring within the last 3 months in the tested ankle; self-reported ankle instability; no surgical procedures on the tested lower limb in the last year; no history of lower limb fractures; ability to perform all required tests; absence of wounds or skin diseases in the ankle and foot region; no allergies to KT; not currently undergoing physiotherapeutic treatment. Participants who did not complete the study or withdrew their consent were excluded. The inclusion and exclusion criteria were based on the International Ankle Consortium of 2014.

Procedures

The following variables were evaluated: age, gender, weight, height, body mass index (BMI), dominance, level of physical activity, and history of lower limb injuries.

Two questionnaires recommended by the International Ankle Consortium[7] were used in two moments (baseline and post-intervention):

Cumberland Ankle Instability Tool (CAIT)[24]: Consisting of 30 questions, with a low score (≤24) indicating higher self-reported instability and ankle instability.

FAOS-FOOT (Foot and Ankle Outcome Score)[25]: Consisting of 42 questions divided into five domains: pain, other symptoms, activities of daily living, sports and recreational activities, and quality of life related to the ankle and foot. Functional instability is defined as a score ≤75% of the total points in three of the five domains.

Participants were randomly assigned to either the KT group with tension (KTT) or the KT group without tension (KTWT) (Figure 1). Random allocation was achieved using a 6-block exchange randomization method with opaque envelopes for blinding. Participants were blinded to their assigned group to avoid bias.

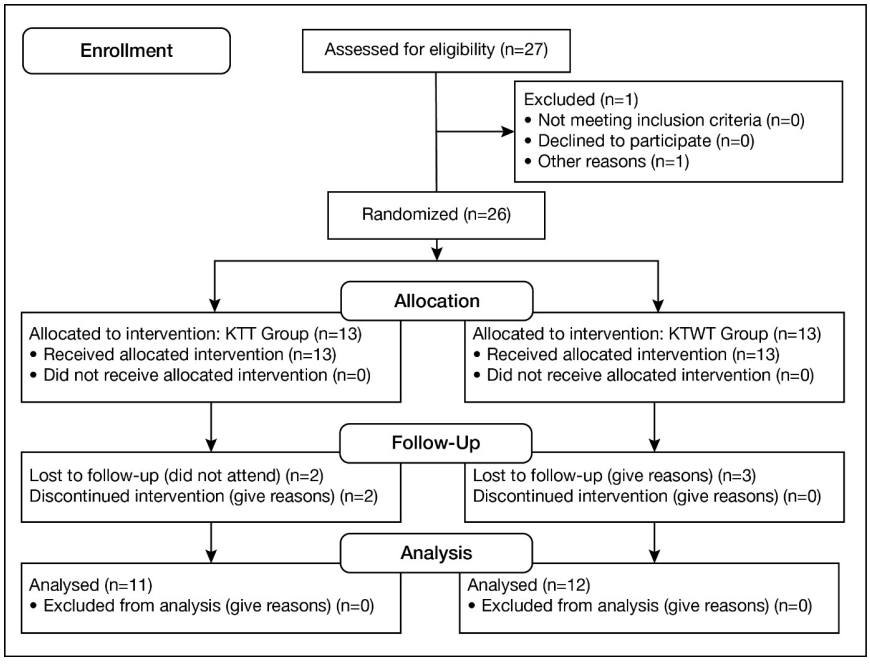

Figure 1. Trial Flow Diagram.

Functional tests were performed at baseline and post-intervention. The tests were sequenced from least physically demanding to most physically demanding to minimize the influence of fatigue[24-29]. The sequence of tests was as follows: postural control on a force platform, SEBTm, and Side Hop Test SHT[24-29].

The BIOMEC400 force platform from EMG System do Brasil-SP Ltda. was used to assess postural control, with a sampling frequency of 100Hz. The test was performed on the ankle reported by the participant as having instability. If bilateral instability was present, the test was conducted on the ankle with lower CAIT scores. During the test, participants stood barefoot on one leg at the center of the force platform. They maintained this position for 30 seconds, fixating their eyes on a target positioned on the wall, two meters away and at eye level. The upper limbs were relaxed by the sides, and the contralateral lower limb remained free, positioned at a 90° angle of knee flexion.

The postural control test was performed three times by the same evaluator, with a 30-second rest interval between each execution. The average of these evaluations was used for statistical calculations after the participant became familiar with the test. Variables analyzed included center of pressure area (A-COP), displacement velocities in the anteroposterior (Vel-AP) and mediolateral (Vel-ML) directions, and displacement frequencies in the anteroposterior (F-AP) and mediolateral (F-ML)[26].

The first functional test administered was the SEBTm. Participants stood on one leg and reached as far as possible in three directions: anterior, posteromedial, and posterolateral. The distances were marked on the ground with tapes, and actual measurements of the lower limb were used to calculate the range[27]. The second test, SHT, assessed agility, coordination, and the foot's interaction with the ground. Participants performed lateral jumps over a 30cm distance between marked points on the ground[28]. They were instructed to complete 10 jumps as quickly as possible, and the time taken to complete the jumps was recorded[28]. If there was any contact with the ground, failure to surpass the marking, or a drop, the test was repeated[28]. There was a 60-second rest interval between each set of three jumps[28]. Both the SEBTm and SHT were conducted at baseline and one week after completing the intervention protocol, and the same evaluator administered both tests.

The study utilized Therapy Tex® tape and the same KT application technique, following the protocol defined by Morini-Junior[29]. The only difference between the groups was the tension of the tape. Hair removal and skin cleansing were performed before the KT application. KT applications were performed weekly, with a seven-day interval, by the same experienced physiotherapist trained in the method[29]. Participants were instructed to keep the tape on for four days from the day of application.

Before applying the KT tape, the distances from point A to point B and from the calcaneal tendon to the front of the talus were measured. The tape size was determined accordingly[29]. The "technique for ankle stabilization" involved the application of an "I" tape from one malleolus to the other, passing through the hindfoot[29]. Another "I" tape was used to encompass the ankle joint, starting from the calcaneal tendon and crossing in front of the talus (Figure 2).

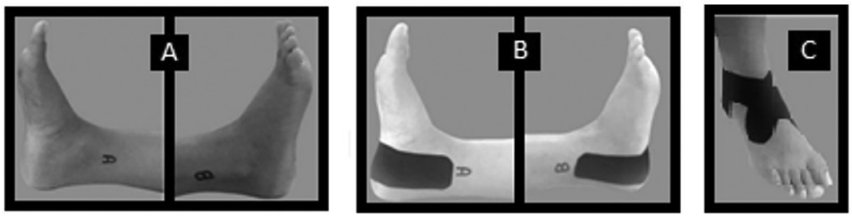

Figure 2. Kinesio Taping Method of application. **A.** Marking points A (medial malleolus) and B (lateral malleolus) are highlighted. **B:** application of the "I" tape without a fixed point from malleolus to malleolus by hindfoot. **C:** application of the "I" tape with no fixed point of the calcaneus tendon until it crosses the front of the talus

In the KTT group, with a progressive tension protocol, the first week involved the application of KT without tension and, from the second to the fifth week, the tension gradually increased by 5% during the four weekly applications. For this, the previously calculated tape size was multiplied by 20% and divided by 4 weeks. Consequently, the tape was cut to a smaller size according to the desired tension to reach the reference points mentioned in Figure 2- A, B and C. In the KTWT group, KT was always applied without tension during the entire intervention (from week 1 to week 5), and the reassessment took place in week 6.

Statistical analysis

Data normality was assessed using Shapiro-Wilk test. Normally distributed data were described using mean and standard deviation, while non-normally distributed data were described using median and interquartile range. Categorical data were described using absolute frequencies. Chi-square test compared the proportion of men and women between groups. Baseline data were compared using t-test for normally distributed data and Mann-Whitney test for non-normally distributed data. Two-way mixed ANOVA analyzed group differences, changes over time (baseline vs. post-intervention) within each group (time effect), and interaction effect (group membership influencing time effect). Bonferroni post hoc test was performed. Effect size (Cohen's d) assessed responsiveness, calculated as mean difference after intervention divided by standard deviation of baseline value. Effect size magnitude was classified as low (<0.50), moderate (≥0.50 to 0.79), or large (≥0.80). Statistical analysis used SPSS Statistics 22 program, with $p<0.05$ significance level. Power analysis conducted using GPower 3.1.9.2 program determined sample size for detecting at least moderate effect size (0.4) after intervention using Two-way mixed ANOVA. With p-value of 0.05, a sample of 21 individuals (11 in KTT group and 10 in KTWT group) achieved 93% power to detect significant interaction (group vs. time).

RESULTS

The characterization of the sample is shown in Table 1, shown below.

Table 1. Sample characterization: anthropometric data and profile of ankle sprains.

Anthropometric data	KTT (n=11)	KTWT (n=10)	*p*
Sex (M/F)	7/4	4/6	0.395
Age (years)	26 [23-29]	29 [25-31]	0.349
Weight (Kg)	73 [69-95]	68 [57-77]	0.251
Height (m)	1.75 [1.66-1.82]	1.65 [1.62-1.75]	0.099
BMI (Kg/m2)	23.83 [22.38-29.32]	23.82 [22.81-25.99]	0.918
Unstable ankle			0.543
Right, n (%)	4(19.1)	6(28.6)	
Left, n (%)	4(19.1)	2(9.5)	
Both, n (%)	3(14.2)	2(9.5)	
Tested ankle			1.000
Right, n (%)	6(28.6)	5(23.8)	
Left, n (%)	5(23.8)	5(23.8)	
1st sprain			0.635
<3 months, n (%)	2(9.5)	3(14.2)	
>3 months, n (%)	9(42.9)	7(33.3)	
Interruption activities			0.765
Without interruption, n (%)	1(4.8)	2(9.5)	
1 day, n (%)	1(4.8)	1(4.8)	
>1 day, n (%)	9(42.9)	7(33.3)	
Last sprain			0.311
<3 months, n (%)	1(4.8)	3(14.2)	
>3 months, n (%)	10(47.6)	7(33.3)	

Note: KTT: kinesio taping with tension; KTWT: Tension-free kinesio taping group; M/F: Male/female; BMI: Body mass index. Anthropometric data, except sex, are presented in median [interquartile range].

The results of the analysis of the variables of postural control tests, functional tests and questionnaires are presented in Table 2.

Table 2. Balance variables, functional tests and questionnaires, according to treatment assignment.

	KTT		*d*	KTWT		*d*	*p* Group	Time	Group x time
	Baseline	6th week		Baseline	6th week				
Postural Control									
A-COP	9.1[7.4-10.9]	9.5[7.2-11.8]	0.2	11.4[9.7-13.2]	9.7[7.5-12]	-0.54	0.318	0.237	0.060
Vel-AP	2.3[1.9-2.7]	2.1[1.6-2.5]	-0.5	2.9[2.5-3.3]	2.6[2.1-3]	-0.37	0.076	0.006	0,652
Vel-ML	2.7[2.3-3.1]	2.4[2-2.8]	-0.5	3.4[3-3.9]	3[2.6-3.4]	-0.57	0.017	<0.001*	0.505
F-AP	0.4[0.3-0.5]	0.3[0.2-0.4]	-1	0.5[0.4-0.6]	0.4[0.4-0.5]	-1	0.022	<0.001*	0,358
F-ML	0.7[0.6-0.7]	0.6[0.5-0.7]	-1	0.8[0.7-0.9]	0.7[0.7-0.8]	-0.5	0.012	0.043	0.976
Functional Tests									
SEBTm	90.7[84.1-97.3]	96.3[91-101.5]	0.51	97.3[90.7-103.9]	108.3[103-113.5]	1.23	0.018	<0.001*	0.166
SHT	15.1[10.2-20.1]	10.1[7.7-12.5]	-0.54	14[9.1-19]	10.3[7.9-12.7]	-0.74	0.848	0.001*	0.555
Questionnaires									
CAIT	15.7[11.6-19.8]	19.5[16.1-22.9]	0.55	17.1[13-21.2]	21.2[17.8-24.6]	0.73	0.516	0.001*	0.879
FAOS-FOOT									
Pain	86.9[80.6-93.2]	85.3[78.6-92]	-0.17	78.9[72.6-85.2]	88[81.3-94.8]	0.94	0.450	0.184	0.061
OS	72.1[62.1-82.2]	75.7[65.7-85.8]	0.25	71.8[61.8-81.8]	79.3[69.2-89.3]	0.47	0.803	0.032*	0.419
AVD's	93.7[86.3-101]	94.7[90.1-99.3]	0.10	93[85.6-100.4]	97.3[92.8-102]	0.33	0.780	0.243	0.467
Sport	75.6[63.3-87.8]	76.5[65.4-87.6]	0.06	64.5[52.3-76.7]	86.5[75.4-97.6]	1.01	0.944	0.004	0.008*
QV	66.3[53.2-79.3]	72.9[59.6-86.2]	0.42	61.9[48.9-74.9]	73.8[60.4-87.1]	0.51	0,832	0.019	0.475

Note: KTT: group kinesio taping with tension; KTWT: group kinesio taping without tension; EZ: Effect size; A-COP: Pressure center area; AP VEL: Anteroposterior speed; ML VEL: Mid-laterals speed; F AP: Anteroposterior frequency; F ML: Mid-lateral frequency; SHT: side hop test; SEBTm: Modified Star Excursion Balance Test; OS: Other symptoms; AVD's: Daily life activities; QOL: Quality of life. The data are presented as mean [95% confidence interval]; d Cohen value; P value, repeated two-way mixed ANOVA measurements. * Value of p<0.

Only one variable, the sports domain of the FAOS-FOOT questionnaire, showed a significant interaction (p=0.008). This variable also exhibited a significant difference in the time factor (p=0.004), indicating an increase in participants' capacity for sports and recreational activities, regardless of the group factor (p=0.994). The effect size of KT in KTWT was large (d=1.01), while it was low in KTT (d=0.06). Postural control variables (Vel-ML, F-AP, and F-ML) showed differences among the groups, following a similar trend to the means and confidence intervals. The effect size for F-AP and F-ML was large (d=-1). Except for A-COP, all postural control variables had statistically significant results in the post-intervention evaluation. SEBTm demonstrated differences among the groups (p=0.018) and improvement in performance from baseline to post-intervention evaluation (p<0.001). The effect size for KTWT was large (d=1.23), but no interaction was observed. SHT showed a significant improvement in the post-intervention evaluation (p=0.001) without differences between the groups (p=0.848), indicating similar performance improvement for both groups. KT had a positive effect on self-reported instability after the intervention (p=0.001) without distinguishing between the groups. Three out of the five functional instability variables of the FAOS-FOOT questionnaire also showed improvement: other symptoms rather than pain (p=0.032), sports and recreational activities (p=0.032), and quality of life (p=0.019). In summary, the present study did not identify significant interactions, and out of the 13 variables analyzed, only three did not show any difference between baseline and post-intervention levels.

DISCUSSION

The objective of this study was to compare two protocols of KT in young adults with CAI. The protocols differed in terms of applying tension or not applying tension to the tape. KT is considered a helpful tool in the treatment of musculoskeletal injuries[18,20,21,23] and, therefore, these protocols were explored as adjuncts to CAI treatment.

The literature presents conflicting results regarding the immediate and late (classified in 7 days) effects of KT application[18,22,30], as well as the tension used to apply the tape (ranging from 10% to 70%)[18,20,21,23]. For example, the study by Yin and Wang[30] applied four tapes with 50% tension each and found limited effects on postural control in individuals with CAI after a 4-week application protocol. The time of tape use may influence the proprioceptive effects, as suggested by Alguacil-Diego et al.[22], who found immediate effects within 7 days after application. This suggestion aligns with the present study, which demonstrated that weekly tape applications over 5 weeks improved postural control, agility, dynamic balance, and instability in young adults with CAI, with favorable effects observed for without tension applications in the tape.

The study observed a linear improvement in single hop test (SHT) performance in both groups after the intervention protocol, with a moderate effect magnitude for both tensioned KT (KTT) and tension free KT (KTWT). In other words, applying tension to the tape may have a similar effect to tension free application when assessing agility through the SHT. Additionally, there was a significant difference in dynamic balance after the treatment protocol (p<0.001) and between the groups (p=0.018). This suggests that applying voltage to the KT may be necessary.

The sensation of self-reported instability and functional instability caused by CAI is an important factor to consider[30]. Although instability is a subjective parameter, its evaluation is necessary as it impacts the daily life of individuals with CAI and is a diagnostic criterion. KT in this study demonstrated the ability to reduce the feeling of self-reported instability at the end of the treatment protocol, with moderate effects observed for both tension and without tension applications. KT provides a sense of joint security and stability, which is crucial for daily and sports activities, and offers important visual and sensory feedback[30].

The only variable that showed an interaction (p=0.008) effect in the study was the sports domain of FAOS-FOOT questionnaire. This highlights the importance of using KT to improve the feeling of instability associated with CAI and enhance functionality. Although the study had a relatively small sample size, the power analysis was calculated to mitigate this limitation. An effect size of ≤0.4 would be detected if there was an interaction.

However, it is important to consider the limitations of this study. The sample size was relatively small, and the follow-up period was short. Future research with larger sample sizes and long-term follow-up is needed to confirm these results and further explore the effects of KT in the treatment of CAI; although these findings provide promising evidence for the use of KT as an adjunctive therapeutic approach in the treatment of CAI. However, more research is needed to confirm and expand on these results, assessing the long-term effects of KT in the treatment of this chronic condition.

CONCLUSION

The application of KT proved effective to improve postural control, dynamic balance, agility and instability in individuals with chronic ankle instability, without any difference to tension placed on the tape. Thus, KT shows itself as an effective resource to be added to the treatment of chronic ankle instability.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee –Pitágoras Unopar and the protocol (no. 3.059.113) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: GFMO and RACA; Performed the experiments: GFMO; Analyzed the data: GFMO, MRS, FVCM, RACA; Contributed reagents/materials/analysis tools: GFMO, MRS, CSGM, FVCM, MRO and RACA; Wrote the paper: GFMO, MRS and RACA.

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