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KINESIO TAPING USE FOR THE PREVENTION AND TREATMENT OF SPORTS INJURIES IN ATHLETES

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ABSTRACT. Kinesio taping (KT) is a simple, cost-effective, affordable and safe rehabilitation method that is currently used for enabling natural healing, as it ensures local support and stability, and corrects joint position, helping athletes to quickly recover after minor or even major injuries, and to increase their athletic performance. KT helps weakened muscles, improves local blood and lymph flow, reduces pain, removes the abnormal tension accumulated at the muscle level, alleviates muscle fatigue associated to exercising and decreases the exercise-related disruption of dynamic balance. All these effects contribute to the post-injury recovery of athletes. KT is frequently used in the acute postoperative recovery after the reconstruction of the anterior cruciate ligament, in conjunction with the rehabilitation program, as it reduces edema and pain, and increases the range and force of movement. Another frequent use of KT is in patellar tendinopathy and in reducing the risk of injury as a result of balance impairment produced by muscle fatigue. The effect of KT on the range of joint motion remains unclear, and its use is still controversial, as there are many trials that do not show any beneficial effects thereof, especially in terms of effects on muscle strength and activity, and of tendon flexibility.

Keywords*: kinesio taping, rehabilitation, athletes, recovery, sport performance.*

REZUMAT. ***Utilizarea kinesio taping în prevenirea şi tratamentul leziunilor la sportivi.*** Kinesio tapingul (KT) este o metodă de reabilitare simplă, economică, accesibilă şi sigură, folosită curent pentru facilitarea vindecării naturale, realizând sprijinul şi stabilitatea locală, precum şi corectarea poziţiei articulare, ajutând sportivii să se recupereze rapid după leziuni minore sau chiar majore şi pentru creşterea performanţei sportive. KT ajută musculatura slăbită, îmbunătăţeşte fluxul sangvin şi limfatic local, reduce durerea, îndepărtează tensiunea anormală acumulată la nivel muscular, atenuează gradul oboselii musculare asociate exerciţiilor şi reduce perturbarea echilibrului dinamic asociată acestora. Prin

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toate aceste efecte, ajută la recuperarea post-leziune a sportivilor. KT se foloseşte frecvent în recuperarea acută postoperatorie după reconstrucţia ligamentului încrucişat anterior, asociat programului de refacere, deoarece reduce edemul şi durerea şi creşte gradul şi forţa de mişcare. O altă utilizare frecventă a KT este în tendinopatia patelară şi în diminuarea riscului de leziuni cauzate de deteriorarea capacităţii de echilibru, prin oboseală musculară. Efectul KT asupra gradului de mişcare articular rămâne neclar, iar utilizarea sa la sportivi rămâne controversată, deoarece există numeroase studii care nu evidenţiază nici un efect benefic al utilizării sale, mai ales în ceea ce priveşte efectele asupra forţei şi activităţii musculare, precum şi a flexibilităţii tendoanelor.

Cuvinte-cheie: *kinesio taping, reabilitare, sportivi, recuperare, performanţă sportivă*.

Introduction

The new taping technique, created by Kenzo Kase in the 1970s, i.e. kinesio taping, is a non-invasive therapy method that can enhance endurance and performance during training sessions and matches, as well as accelerate recovery after intense exercising (Bandyopadhyay & Mahapatra, 2012; Kase, Hashimoto & Tomoki, 2003; Gligor & Gligor, 2018).

This rehabilitation method is different from traditional taping techniques (Kase, Hashimoto & Tomoki, 2003; Banerjee, Briggs & Johnson, 2016) and it is used for enabling natural healing, ensuring support and stability, without limiting the range of motion (Kase, Wallis & Kase, 2003; Trobec & Persolja, 2017; Sarkar et al., 2018). The method was first used in sports medicine, and it is currently used on a large scale in other clinical specialties as well (orthopedics, traumatology, surgery of the motor system, neurology, oncology, pediatrics). In Europe, kinesio taping was first used in 1998. After Kenzo Kase, the taping technique developed by him has several functions, i.e.: it restores muscle function by supporting weakened muscles, reduces local congestion by improving blood and lymph flow, reduces pain by stimulating the nervous system, decreases pressure on the nociceptors, and repositions subluxated joints by removing abnormal muscle tension, helping to restore the function of the fascia and muscle; it also increases proprioception by stimulating the cutaneous mechanoreceptors (Kase, Hashimoto & Tomoki, 2003; Sarkar et al., 2018; Williams, Whatman, Hume & Sheerin, 2012). This method involves the application of a very thin, special, elastic, adhesive tape directly onto the skin (Sathya, Ramakrishnan, Phadke & Jena, 2016). The tape, called kinesiology tape (K-active tape) does not contain latex or any chemical or pharmacological substances, is sensitive to heat and may be worn up to 5 days.

It has variable length and width, and it may be applied using various techniques (for removing pain, for recovery, for correcting posture and increasing sport performance) (Banerjee, Briggs & Johnson, 2016; Gligor & Gligor, 2018). Moreover, it can be stretched up to 120 – 140% of its original length. (Kase, Wallis & Kase, 2003; Hosp, Folie, Csapo, Hasler & Nachbauer, 2017) After application, it tends to return to its initial length supplying constant thrust on the skin (Hosp, Folie, Csapo, Hasler & Nachbauer, 2017). The tape may cover full parts of the body (e.g. ankle, wrist, fingers etc.) and it may prevent, especially in gymnastics, ankle injury (resulting from overuse) or wrist injury. In addition, the tape helps the patient maintain the normal biomechanics of the area (Bandyopadhyay & Mahapatra, 2012).

The purpose of this research is to review literature data on the effects of applying kinesio taping for preventing and treating sports injuries in athletes.

Methods

In order to highlight the effects of kinesio taping on sports injuries we have identified a series of specialized studies using the following online databases: PubMed, NCBI, Research Gate, Semantic Scholar, EBSCOhost, Google search. The research was limited to full-text studies in English, published between 2007 and 2018, using the following key words: kinesiotaping, kinesio tape, kinesio tape effects, kinesio tape efficacy, rehabilitation of athletes. We have included in our study scientific research that had an available abstract, original data and were discussing the use of kinesio tape for preventing and treating sports injuries, as well as review studies on the same topic.

Results and Discussions

Following the primary analysis of the scientific data obtained we selected a total number of 34 studies that were relevant for this topic. Many studies investigated the effects of kinesio taping on pain, muscle strength and flexibility, on the range of motion and proprioception in patients or healthy individuals (Aktas & Baltaci, 2011; Halseth, McChesney & DeBeliso 2004; Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016), as well as the effects on balance, posture and neuromuscular system (Bandyopadhyay & Mahapatra, 2012).

Ozmen T. et al. have recently investigated the effects of applying kinesio taping on the quadriceps femoris muscle, in terms of muscle pain and flexibility (measured as range of knee flexion), and running speed in 19 female students during their recovery after squat exercises. They found an increased muscle

pain 48 hours after squat exercises, both in the presence and in the absence of KT application on the quadriceps femoris muscle (Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016)

A temporary muscle lesion may occur after difficult exercises (e.g. with eccentric contractions), accompanied by a decrease in muscle performance, which is associated with DOMS – "Delayed Onset Muscle Soreness" (Nguyen et al., 2009; Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016). DOMS is characterized by pain, stiffness and maximum intensity, 24-48 hours after difficult exercises, especially those with eccentric contractions, which go down within 96 hours (Cheung, Hume & Maxwell, 2003; Connolly, Sayers & McHugh, 2003). If DOMS does not alleviate, it can affect the athletes' performance during successive games or training sessions, through a reduction in the knee joint range of motion, and peak torque (Cheung, Hume & Maxwell, 2003). Shoger M. et al. (Shoger, Nishi, Merrick et al., 2000; Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016) noticed that KT does not reduce the pain associated to DOMS in the flexors of the radiocarpal joint.

Merino Marban R. et al. also showed that the application of KT on the athletes' calf, after a duathlon competition, did not reduce muscle pain right away, or 10-15 minutes after the competition (Merino-Marban et al., 2011; Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016). Other researchers (Thelen, Dauber & Stoneman, 2008; Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016) noticed that pain went down immediately after the application of KT or a few days after its application. Equally, Zajt-Kwiatkowska J. et al. noticed that after the application of KT in injured individuals, pain was reduced and the edema visibly resolved (Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007). Pain relief after the application of KT was also confirmed by Herbert R. (Herbert, 2001; Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007). After knee injury. Similar results were presented by Salish G.B. et al. (Salish, Brechtter, Farwell & Powers, 2002; Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007), and Yi C. et al. showed that knee joint stability increased after the application of KT. (Yi, Brunt, Kim & Fiolkowski, 2003; Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007).

For many athletes, fast running performance is a fundamental skill; as shown by the research carried out by Ozmen T. et al. the application of KT on the quadriceps femoris muscle did not have a favorable effect on the running capacity, at 2 days of recovery after squats. Concerning the flexibility of the quadriceps femoris muscle, Ozmen T. et al. noticed that muscle flexibility maintained 2 days after recovery, this being an important condition for preventing musculoskeletal injuries in athletes (Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016; Bahr & Holme, 2003; Witvrouw, Danneels, Asselman, D'Have & Cambier, 2003). In

exchange, Merino-Marban R. et al. did not find any effect of KT application on the flexibility of tendons in healthy students. (Merino-Marban et al., 2011; Ozmen, Aydogmus, Dogan, Acar, Zoroglu & Willems, 2016).

According to Fratocchi G. and Yoshida A., the use of KT can change muscle activity and increase muscle strength (Fratocchi et al., 2013; Yoshida & Kahanov, 2007; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015). In the case of football players, in order to obtain significant muscle strength and performance improvements, they must perform endurance exercises and trainings for improving speed and movement coordination and for maintaining balance and functionality (Cunha et al., 2013; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015). In general, the studies having assessed the effects of KT on muscle strength and activity in athletes are contradictory. Thus, Slupik A. et al. found an increase in the muscle activity of the vastus medialis in healthy young people, 24 hours after the application of the kinesio tape, an increase that persisted for 24 hours (Slupik, Dwornik, Bialoszewski & Zych, 2007; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015). Similarly, Huang C.Y. et al. found an increase in the activity of the triceps surae muscle during vertical jumps, after the application of the kinesio tape in healthy athletes (Huang, Hsieh, Lu & Su, 2011; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015). In exchange, Fu T.C. et al. concluded that the application of the kinesio tape on the quadriceps muscle in healthy athletes does not change the knee extension strength, and Nunes G.S. et al. noticed that the kinesio tape does not improve jumping performance or balance (Fu et al., 2008; Nunes, de Noronha, Cunha, Ruschel & Noé, 2013; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015).

Serra M.V.G.B. et al. researched the effect of KT on knee extension strength in 34 healthy, professional football players, who performed two maximum voluntary isometric contractions of the lower limbs before and 24 hours immediately after the application of the kinesio tape, and did not find any change (Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015). They concluded that KT does not influence the strength related results obtained right away and 24 hours after the application of KT. Also, Kim H. and Lee B. did not notice any significant differences in the isokinetic muscular function of horse racing jockeys immediately after the application of KT (Kim & Lee, 2013; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015). Unlike Serra M.V.G.B. et al., other researchers found an increased eccentric knee extension strength during isokinetic exercises in non-athlete women, after the application of KT onto the skin overlying the quadriceps (Vithoulka et al., 2010; Serra, Vieira, Brunt, Goethel, Gonçalves & Quemelo, 2015).

Both for sports, and for daily life activities, it is highly important to maintain balance, which is based on the continuous feedback from the visual, vestibular, somatosensory, and proprioceptive structures (Hosp, Folie, Csapo,

Hasler & Nachbauer, 2017). In the case of physical activity involving big muscle groups (e.g. jogging, cycling, walking) muscle fatigue occurs (Simoneau, Bégin & Teasdale, 2006; Hosp, Folie, Csapo, Hasler & Nachbauer, 2017; Tajik, Shokri & Ghanbari, 2016). Many researchers showed the harmful effects of muscle fatigue on the balance capacity, which is generated by the change of proprioceptive impulses (Simoneau, Bégin & Teasdale, 2006; Hosp, Folie, Csapo, Hasler & Nachbauer, 2017). The impairment of the balance capacity caused by the fatigue induced by eccentric physical exercises is alleviated by the application of KT on the knee joint, which reduces the risk of knee injuries during sports activities, the effect being obvious especially in those with low basic balance capacity (Hosp, Folie, Csapo, Hasler & Nachbauer, 2017). According to Kase K., KT improves proprioception by the increased stimulation of the mechanoreceptors located in the skin, muscles and joint capsules (Kase, Wallis & Kase, 2003).

Hosp S. et al. investigated the effect of KT on balance capacity after eccentric physical exercises in a group of healthy young men, and they found that the application of the kinesiology tape on the knee joint has gradually alleviated the fatigue related to exercising, and low balance capacity (Hosp, Folie, Csapo, Hasler & Nachbauer, 2017).

As reported by Zech A. et al., both general and localized fatigue have effects on postural, static and dynamic control (Zech, Steib, Hentschke, Eckhardt & Pfeifer, 2012; Tajik, Shokri & Ghanbari, 2016). Fatigue may change the condition of muscular activity and slow the related influx transmission, thus weakening postural control and generating the risk of sports injuries (Munn, Sullivan & Schneiders, 2010; Tajik, Shokri & Ghanbari, 2016).

Tajik A. et al. studied the effects of applying kinesio taping to the quadriceps muscle on the dynamic postural control, after fatigue induced to the quadriceps, in healthy, amateur (non-professional) athletes. They concluded that the application of KT may reduce the harmful effect of muscle fatigue on the dynamic balance of athletes, being useful for the improvement of balance after induced fatigue (Tajik, Shokri & Ghanbari, 2016). The effect of KT on the range of motion is unclear due to the limited number of studies on the different types of joints, and divergent outcomes. The positive effects of KT found in the study conducted by Thelen M.D. et al. suggested that KT may at least have a small, brief effect on the range of motion for certain joints, as it appears from literature (Thelen, Dauber & Stoneman, 2008; Williams, Whatman, Hume & Sheerin, 2012).

Alam S. et al. investigated the immediate effect of kinesio taping on the peak torque of the external rotator muscle of the shoulder on the range of motion in healthy individuals. The results of the study showed no differences with respect to muscle strength or range of internal/external rotation motion induced by KT, when compared to the result of placebo taping or lack of taping.

In general, KT did not cause any important difference in the peak torque of the external rotation of the shoulder and in the internal and external shoulder range of motion, in healthy individuals (Alam, Malhotra, Munjal & Chachra, 2015).

The injuries of the kinetic system need recovery, and sometimes even orthopedic surgery; and the recovery process has a variable duration (of weeks or even months) (Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007).

Despite the contradictory opinions on the advantages and disadvantages of athlete taping, it is still used, with certain precautions, for the benefit of athletes, in post-injury recovery and for sport performance, as this is a simple, cost-effective, affordable and safe treatment for pain and musculoskeletal dysfunctions. During professional and recreational sports activities, both motor stress and injuries may occur, especially at the level of joints and muscles. KT enhances the therapy applied in sports medicine and allows athletes to perform physical activities when they have minor injuries or to quickly recover in case of major injuries (Bandyopadhyay & Mahapatra, 2012) .

In such situations, if there is no ligament tear and incomplete loss of joint stability, KT can be used to reduce pain and post-traumatic edema, for 1 - 2 weeks. (Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007). In female basketball players, in about 48% of cases, ankle sprain occurs to the side, and the impairment of mechanoreceptors and loss of joint position sense lead to the installation of functional ankle instability. In athletes and basketball players, ankle taping is recommended for ankle instability, as it is considered to help tissue healing and repair (Kiliç, Yildiz, Tűrker, Ömer & Şensu, 2017).

This effect is based on the functions of the kinesio tape to support the ankle, regulate muscle functions, eliminate tissue fluids and subcutaneous hemorrhage, reduce pain and correct joint position (Kiliç, Yildiz, Tűrker, Ömer & Şensu, 2017). Kiliç B.B. et al. investigated the effects of kinesio taping on the sport performance of female professional basketball players, with a clinical diagnosis of chronic ankle instability. For this purpose, they assessed the effects of KT application on the ankle in terms of endurance and muscle strength, postural stability, proprioception and value of the high jump. These researchers concluded that the short-term KT application on the ankle was not efficient for the neuromotor healing, and it only supported the ankle; therefore, it had a positive effect only on maintaining the posture, by correcting the kinematics of the standing position.

However, the authors consider that, due to its therapeutic effects, KT may be used for preventing injuries in case of chronic ankle instability (Kiliç, Yildiz, Tűrker, Ömer & Şensu, 2017). In the past years, the use of kinesio taping has become extremely popular for reducing the severity and incidence of knee

injuries. In the case of athletes, the impairment of the balance capacity due to physical fatigue represents a high risk (almost 40%) of knee injury (Changela, Selvamani & Ramaprabhu, 2012; Hosp, Folie, Csapo, Hasler & Nachbauer, 2017). KT prevents the aggravation of balance impairment induced by eccentric exercises and, in this way, it helps reducing the risk of knee injuries associated to sports activities.

As stated by Agel J. et al., the injuries of the anterior cruciate ligament account for approximately half of the knee injuries in athletes (Agel, Arendt, & Bershadsky, 2005; Balki, Göktaş & Öztemur, 2016). The complete tear of this ligament requires its reconstruction, and the recovery program after ACL (anterior cruciate ligament) reconstruction should alleviate the consequent effects such as pain, edema, motor incapacity, as well as the reduction of the range of motion, proprioception and muscle strength at the level of the lower limbs (Hohmann, Tetsworth & Bryant, 2011; van Grinsven, van Cingel, Holla & van Loon, 2010; Balki, Göktaş & Öztemur, 2016). For this purpose, both medication and other treatment methods are used, such as cryotherapy, elastic bandage, pushing exercises for the ankle, patellar mobilization, continuous passive motion therapy, KT (Boguszewski, Tomaszewska, Adamczyk & Bialoszewski, 2013; Balki, Göktaş & Öztemur, 2016).

During recovery from the ACL reconstruction surgery, it is highly important to treat postoperative edema and pain, as the edema diminishes the strength of the quadriceps, and pain reduces joint motions, (Balki, Göktaş & Öztemur, 2016); this can also be achieved by using KT (Lim & Tay, 2015; Balki, Göktaş & Öztemur, 2016). The efficiency of KT as an adjuvant to recovery after ACL reconstruction was assessed by Boguszewski D. et al., who found that the application of KT from the 28th day reduced postoperative pain and edema (Boguszewski, Tomaszewska, Adamczyk & Bialoszewski, 2013; Balki, Göktaş & Öztemur, 2016).

Balki S. et al. investigated the effects of KT application in the acute postoperative recovery phase after ACL reconstruction, with the allograft or autograft of the tendon, in a group of 30 patients; they were randomly divided into two groups: one experimental group who received a KT treatment using lymphatic and muscle correction techniques, and one control group, where false KT was applied. Both interventions were applied twice, for a period of 10 days, starting with the 4th days after surgery.

All patients followed the same recovery program for 3 months. The results of the research showed a significant decrease in pain severity, 5 days after the KT treatment, as well as a reduced edema in the operated knee. An important factor determining the functional level after ACL reconstruction is the quadriceps strength; however, the KT treatment applied in the experimental group did not result into important increases of the quadriceps strength (Bryant, Kelly & Hohmann, 2008; Balki, Göktaş & Öztemur, 2016). After having

analyzed the effects of KT in the acute postoperative recovery phase after ACL reconstruction, the authors concluded that the application of KT, in combination with the postoperative recovery program, is efficient for treating pain, edema, for increasing the range of knee flexion and strength of the hamstring muscle (Balki, Göktaş & Öztemur, 2016).

Kinesio taping is also used in professional athletes who suffer from patellar tendinopathy, a musculoskeletal injury that is also common in active persons, aged between 30 and 55 years, with an increasing prevalence. (Massei, Sanzo & Przysucha, 2017) In order to avoid the risk of tendon tear or structural injuries of the joint, the early use of therapeutic taping, with KT or leukotape (LT), is required (Massei, Sanzo & Przysucha, 2017).

Massei M. et al. carried out a pilot study for the purpose of researching the possible positive effects of therapeutic taping as to knee pain, range of motion (ROM), power, balance and strength, in individuals with an active lifestyle who suffered from patellar tendinopathy. After the application of therapeutic taping, they noticed significant effects on knee pain, range of motion and muscle strength.

The application of therapeutic taping in persons suffering from patellar tendinopathy did not significantly reduce knee pain, its effects depending on the type of technique used, on the injury and type of population. The knee range of motion, in those suffering from patellar tendinopathy, is limited by pain, and the application of KT and LT did not result into any changes in the extension or flexion of the knee (Williams, Whatman, Hume & Sheerin, 2012; Massei, Sanzo & Przysucha, 2017). Nakajima M.A. and Baldridge C. examined the efficiency of KT on muscle power, measured by assessing the height of the vertical jump, and on the dynamic postural control, measured using the SEBT test – "Star Excursion Balance Test". The obtained results showed insignificant differences between the taping conditions in terms of height of the vertical jump and dynamic postural control as per the SEBT. Maintaining the dynamic balance is essential for the sporting performance and for carrying out day-to-day occupational and functional tasks. The athletes suffering from patellar tendinopathy may have difficulties in maintaining an adequate balance, as the structure and function of the patella, and strength of the quadriceps, in general, have been compromised. The authors of the pilot study concluded that certain aspects of the motor functioning, such as strength of the knee flexor and balance, improved after the application of KT (Nakajima & Baldridge, 2013; Knežević & Mirkov, 2011).

Ostiak W. et al. assessed the efficiency of KT in treating soft-tissue injuries in adolescent football players after playing football, and found that kinesio taping is an efficient and fast method for reducing pain in the case of soft-tissue injuries, which allows football players to return to their sports activity (Ostiak, Peretiatkowicz & Krystkowiak, 2012).

The wide use of KT in the early stages, but also in the chronic stages of injuries is underlined by Zajt-Kwiatkowska J.Z. et al.; the authors found that the application of KT is a good method for supplementing the usual physiotherapy treatment, as it reduces the level of pain and increases the patient's functional capacity (Zajt-Kwiatkovska, Rajkowka-Labon, Skrobot, Bakula & Szamotulska, 2007).

Conclusions

Although kinesio taping is a rehabilitation method that is frequently used in athletes for reducing pain, increasing muscle performance (strength and flexibility), thus reducing the severity and incidence of injuries, its use remains controversial. This is due to the contradictory effects shown in many specialized studies. However, due to the limited number of specialized studies available, further, more detailed and numerous studies are necessary, in order to clarify the effect of kinesio taping on preventing and treating sports injuries in athletes. A possible use of this method in athletes is as an adjuvant to the classic rehabilitation therapy.

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