



International Journal of Occupational Safety and Ergonomics

ISSN: 1080-3548 (Print) 2376-9130 (Online) Journal homepage: <http://www.tandfonline.com/loi/tose20>

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To cite this article: Vladimir Berezutsky (2018): Possibilities of kinesio taping to prevent injuries of professional dancers, International Journal of Occupational Safety and Ergonomics, DOI: [10.1080/10803548.2018.1433281](https://doi.org/10.1080/10803548.2018.1433281)

To link to this article: <https://doi.org/10.1080/10803548.2018.1433281>



Accepted author version posted online: 26 Jan 2018.
Published online: 27 Mar 2018.



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Possibilities of kinesio taping to prevent injuries of professional dancers

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A literature review of the application of kinesio taping in the prevention of professional dancers' injuries indicated frequent dance-related and overuse injuries and a lack of organized information about this issue. This study aimed to assess the impact of kinesio taping on the musculoskeletal system of dancers, based on scientific research data from 2015–2017. The analysis revealed that kinesio taping can effectively reduce muscle spasms, rebuild muscle strength of the injured extremity, improve static and dynamic balance and ease pain, due to its ability to improve proprioception of joints and regulate muscle tone. These effects reduce muscle imbalance and joint instability, thus increasing treatment efficacy and shortening the physical load limitation. Kinesio taping significantly reduces the risk of overuse syndromes and dance-related injuries during dance training and strenuous exercises of people with chronic musculoskeletal diseases. Therefore, kinesio taping has broad utility in primary and secondary prevention of dance-related injuries.

Keywords: kinesio taping; dance-related injury; overuse injuries

1. Introduction

Any type of dance, be it classical ballet, contemporary, sport or folk dance, implies systematic physical activity which may lead to dance-related injuries. The frequency of these injuries is very high. According to 10-year retrospective research there have been 574 injuries per 520 dancer-years, which means that every dancer gets injured at least once a year [1]. The real number of dance-related injuries is supposed to be higher, since more than 15% of all injured dancers had not reported their injury, and their reasons for not reporting injury varied. In addition, strenuous and recurrent pumping of the same muscles leads to so-called overuse injuries. Overuse injuries usually include patellofemoral pain syndrome, Achilles tendinopathy, medial tibial stress syndrome, patellar tendinopathy, piriformis syndrome, plantar fasciitis, mechanical lower back pain (LBP) and many others. Overuse syndromes account for 82.60% of all injuries in classical ballet. In view of the aforementioned, the prevention of injuries of professional dancers is a very urgent problem, the role of which in the medical support of professional dancers was very accurately identified in a scientific paper: 'Injury prevention, both primary and secondary, is at the heart of dance medicine' [2,p.448].

Physical activity of professional dancers is as strenuous as that of professional athletes. Comparative analysis of the somatic type of ballerinas, competitors in rhythmic gymnastics and sports dancing did not reveal any significant differences. Similar physical activity determines not

only the building of the same muscles, but also similar pathological changes in the joints. Comparison of degenerative changes of the articular cartilage of professional ballet dancers and non-dancing athletes did not reveal any significant differences. Professional dancers used to suffer from some overuse syndromes, such as traumatic tears of the ligamentum teres, even more often than athletes. That is why the strategies for prevention and treatment of injuries of athletes and dancers do not have any fundamental differences [3]. Despite the method of kinesio taping (KT) being widely used in sports medicine lately, it is not very popular in dance medicine. KT is a rehabilitative technique that ensures maximum functionality of the injured joint or muscle by fixing with adhesive elastic tapes. The method was developed by the Japanese-born American doctor Kenzo Kase in 1973, but became well known only after the Summer Olympic Games in 1988 in Seoul. Nowadays it is widely accepted in many countries. Numerous studies of using KT in sports medicine describe its positive influence on muscle strength, joint motion and juxta-articular microcirculation [4]. That is why it is particularly important to study the possibilities of KT to prevent and treat dance-related injuries.

2. Methods

The methodology of this study is consistent with preferred reporting items for systematic reviews and meta-analyses:

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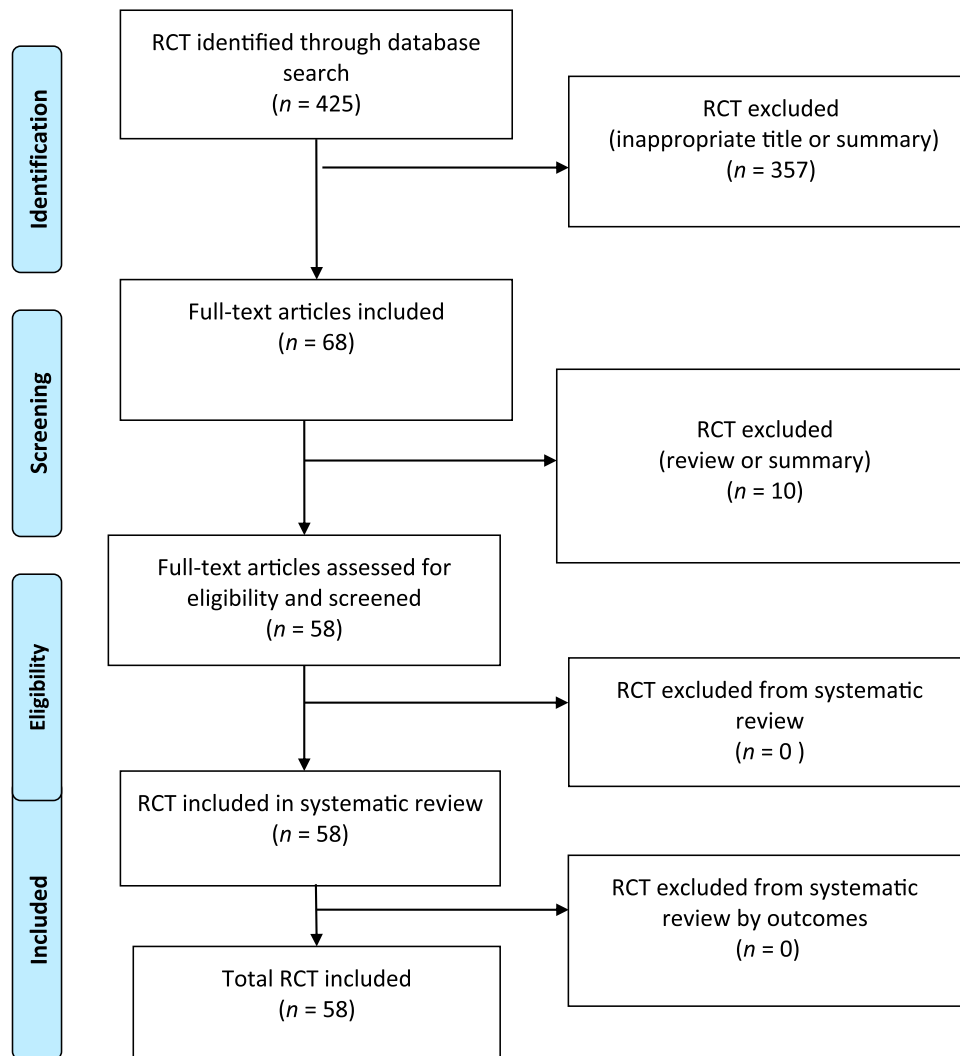


Figure 1. PRISMA flow diagram for this study.

Note: PRISMA = preferred reporting items for systematic reviews and meta-analyses; RCT = randomized controlled trial.

the PRISMA statement (Figure 1). The study analyzed scientific studies over the period of 2015–2017 relating to the use of KT among dancers and athletes (in sports implying similar physical activity). Having searched in PubMed (Medline), Web of Knowledge (Web of Science) and SciVerse Scopus, we selected 58 publications (only full-text articles) closely related to the aforementioned issue (only randomized controlled trials [RCTs] involving at least 30 subjects). The search was performed either on the title and abstract fields or on all fields. For certain databases, the search was limited to peer-reviewed articles in English. Keywords searched for were ‘kinesio taping’, ‘dance-related injury’ and ‘prevention overuse injuries’. The outcomes of RCTs of the influence of KT were improvement of proprioception (18 studies), increase in muscle strength and endurance (21 studies) and pain relief (19 studies).

3. Characteristics of the KT method

The opportunities of KT make this method particularly attractive for dancers. Depending on how the tape is applied (stretched or outstretched), it may either immobilize ligaments or stretch them. In both cases, skin over the edematous area is mechanically ascending, which optimizes lymphatic drainage and as a result reduces pain. Due to the thermosensitive adhesive layer, the kinesio tape adheres tightly to the skin and stimulates the receptors: simultaneous skin, articular and juxta-articular innervation determines the activation of proprioceptors of muscles and joints. As a result of such stimulation, the microcirculation in the area of application of KT is activated, as well as improving fascia, tendon and muscle compliance [5]. Improving muscle strength when performing a jump or support along with enhancing balance, prevention of joint traumas and instability, fast rehabilitation and ability to

continue performance after getting injured and many other benefits of KT could significantly improve the quality of dance medicine and ensure its further development. However, not all of these effects have shown their worth, which is why this method raises doubts among some researchers [6]. A great number of studies conducted in the last 2 years to verify every mentioned effect of KT (both among athletes and healthy volunteers and people with musculo-skeletal disorders) allow estimation of the efficacy of the method and assess its applicability in dance medicine.

4. The impact of KT on joint proprioception

Due to the fact that KT has positive impact on proprioception of the joints, its use would be highly efficient for professional dancers. Joint proprioception is one of the most important factors determining stability of the joint and the dancer's motion coordination. Numerous studies have found a correlation between perception of the dancers and biomechanical precision of their movements [7]. Good joint proprioception significantly reduces the risk of injury. Evaluation of proprioceptive sensitivity of each joint is performed by specially developed protocols and is used not only for identifying the competence of the dancer, but also for preventing joint injuries. Training programs of dancers include exercises aimed at increasing proprioceptive sensitivity, since the ability to maintain good static and dynamic balance is an extremely important professional quality developed in the process of ballet training. Moreover, there are special requirements for the training hall flooring and ballet footwear. The use of special ballet footwear with textured insoles has shown a positive impact on joint proprioception of the dancers, which improves static and dynamic postural stability and reduces the risk of injuries. Due to weakened or distorted proprioception, caused by pain syndrome, a dancer may lose the ability for self-localization and coordination, which consequently increases the risk of being injured. Overuse syndromes and dance-related injuries are usually accompanied by severe pain, which makes already existing motor disorders worse, distorts joint proprioception and disrupts neuromuscular control of posture and movement [8]. The clinical manifestations of such disorders may vary, beginning with a moderate uncoordination of isolated muscles and ending up with complete avoidance of movement. The joint range of motion may vary from hypermobility to hypomobility. Neuromuscular disorders may occur even after taking pain relief medicines. Such disorders severely affect motion coordination, making dancers totally unfit during the period of pain syndrome. A specific training system has been developed to restore the distorted proprioception [9]. However, KT looks more attractive as a method of restoring the movement control of professional dancers due to its obvious advantages.

In spite of all the mentioned advantages, there is no convincing evidence for a significant effect of KT on

knee joint proprioception among healthy individuals [10]. Enhanced coordination when performing complex movements could drastically improve the professional skills of both beginners and experienced ballet dancers, and – what is more important – reduce the risk of getting injured. However, significant benefits of the method have not been found: having studied sensorimotor coordination of healthy people using different ways of applying kinesio tape, we have not obtained reliable information for improving sensorimotor synchronization in reaction to sound stimuli. Electromyographic studies showed no significant effect of kinesio tape on the knee joint proprioception of healthy people both at rest and after performing squats on one leg 'to refusal': KT did not improve balance and muscle activation either before physical activity or after muscular fatigue [11]. Long-term use of KT also did not reveal expected improvement of muscle activity and proprioceptive sensitivity of the joints of young men [12].

Whereas kinesio tape did not improve proprioceptive sensitivity of the joints of healthy individuals both at rest and during physical activity, a significant effect has been obtained during full weight-bearing stance: most perception ratings have been increasing corresponding to physical load [13]. A significant enhancement of proprioception and stability were also observed when KT was used to fix an unstable ankle joint [14]. In the case of ankle sprains, KT improved joint position sense in the inversion and dorsiflexion positions and consequently increased stability of the injured joint [15]. Muscular and articular pain syndromes inevitably distort proprioception, which makes it difficult to assess the position of the body in space. As a result of these distortions, a dancer suffers from postural balance and movement coordination disorders. Restoring normal proprioception is especially important in the case of excessive joint movements, since hypermobility of the joints (better termed joint laxity), both congenital and acquired as a result of intensive training, is frequently observed among professional dancers.

Excessive mobility of the joints is not only an important professional quality for dancers, but also a predisposing factor for joint injuries. An excessive number of joint movements during training and performances inevitably leads to systemic microtraumas of the articular surfaces and, as a result, to early destruction of the cartilage [16]. KT is one of the most effective prudent methods aimed at prevention of injuries among dancers with joint hypermobility. Prolonged use of KT to recoup hypermobility of the joints of the lower extremities among 44 professional dancers led to a significant improvement of the joints' condition. Stabilization of the joints was accompanied by an increased strength of the following muscles: quadratus lumborum, piriformis, gluteus medius, gluteus maximus, iliopsoas, biceps femoris, semitendinosus, semimembranosus and adductors [17]. Often, functional joint instability is a result of different traumas.

Another predisposing factor of dance-related injuries is a significant asymmetry in strength of knee flexion and extension, and the hamstring/quadriceps ratio (in dominant and non-dominant lower limbs). When choosing a method to reduce excessive imbalance of muscle strength of the lower extremities, the inhibitory and stimulatory effects of KT on the tone and strength of muscles enable rapid results to be obtained. Except for the aforementioned anatomical and physiological characteristics of the dancers predisposing to injuries, there are some others which can be effectively cured using KT [18].

5. The impact of KT on muscular strength and endurance

The ability of KT to boost muscular strength is of the utmost interest among dancers, since such dancing elements as jumps and supports require high stability of the lower extremity joints. Moreover, the number of work-related injuries among dancers depends on the static and dynamic strength of the muscles involved, which is why the ability of KT to improve muscle strength is of high importance nowadays. However, one-time application of KT on calf muscles of healthy individuals did not show any significant impact on their balance and muscle strength [19]. Kinesio tape applied to the femoral muscles of healthy women did not improve neuromuscular activity and static balance during physical exercising [20]. In addition, no positive impact of KT has been detected on the effectiveness of jumping exercises performed by healthy gymnasts [21]. Numerous studies of vertical jumping biomechanics have not revealed the expected increase in muscular strength of healthy athletes [22]. Likewise, different methods of kinesio tape application did not lead to improvement of vertical and horizontal jumps among healthy individuals [23]. Having failed to achieve the expected impact of KT on muscular strength, researchers were bound to look for new ways of kinesio tape application. The latest studies focus on the ability of KT to ensure unidirectional motion of the muscles and skin [24].

Electromyographic study of the calf and salens muscles during vertical jumping with kinesio tape applied did not reveal any advantages of the method among healthy athletes. At the same time, KT proved to be effective in the case of Achilles tendon tendopathy [25]. Postural stabilization and coordination disorders in the presence of chronic functional joint instability are generally manifested during jumping exercises [26]. Comparative studies of the jumping biomechanics in ballet and women's football revealed similar features, defining the high risk of injuries of the knee joint anterior cruciate ligament. Because of the similar ways of jumping in ballet, soccer and rugby professionals tend to recommend using the same exercising programs when training ballet dancers. One-time tests to assess the biomechanical stability of the knee joint during

vertical jumps in athletes with injury of the anterior cruciate ligament have revealed positive effects of KT [27]. Football athletes with knee injuries have admitted a positive effect of KT on isokinetic muscle function of the hip [28].

Another important effect of KT, which could be interesting for professional dancers, is a positive impact on exercise efficiency of the muscles. Strenuous physical activity leads to muscle damage and edema, which is accompanied by delayed-onset muscle soreness (muscle fever) and elevation of serum creatine kinase. Short-term use of KT has not provided a positive impact on muscular endurance of the quadriceps and reduction of serum creatine kinase level among healthy athletes after intense exercise [29]. However, continuous application of kinesio tape helped to ease muscle fever, decrease creatine kinase level in the blood and reduce recovery time of the isometric muscle strength after eccentric exercises [30]. A comparative study of KT, non-elastic taping and stretching (static stretching) on the recovery period of quadriceps revealed significant advantages of KT. Athletes who used kinesio tape admitted faster recovery of quadriceps strength, less pronounced muscle fever and lower levels of muscular damage physiological biomarker (serum creatine kinase) [31]. Similar results were obtained while evaluating the influence of KT on the recovery process of athletes after 100 consecutive jumping exercises [32]. The quadriceps muscle is not only the largest muscle in the human body, but also the most involved in ballet movements. That is why it is highly important for ballet dancers to improve its efficiency and shorten the recovery period after physical activity.

Professional dancing implies heavy aerobic activity while training and performing, which explains the high anaerobic threshold of the dancers. Drug-free ways to endure the exercises and increase the anaerobic threshold could significantly improve the potential of both young and experienced dancers. Having studied the impact of KT on eccentric exercise tolerance, a significant reduction of the anaerobic power recovery time has been observed [33]. Kinesio tape applied on the quadriceps positively influenced the anaerobic threshold and muscular strength of healthy athletes during bicycle exercises [34].

6. Pain-relieving effect of KT

Extensive literature overviews of KT studies proved the effectiveness of the method as another way to ease musculoskeletal pain syndromes [35]. Pain syndrome in the lumbar spine is a very common phenomenon among dancers, especially those at the end of their dancing career. The most common cause of this pain is degenerative-dystrophic disorders in the lumbar spine, which are often complicated by herniation of intervertebral discs. Drug-free treatment and easing of pain syndrome is in high demand among professional dancers.

Kinesio tape, applied on primary lumbar extensors of healthy asymptomatic adults, significantly improved the maximal lumbar and torso extension. ‘Relaxing’ techniques of KT can help to relieve muscular spasm of the thoracolumbar area and reduce pain [36]. According to the numerous studies, KT has proved itself not only as an effective way to ease LBP, but also as an additional treatment for intervertebral disk injuries [37]. Chronic LBP (lumbalgia) disrupts the posture and stereotype of motions, which significantly limits the professional capabilities of the dancers. The analyzed information about the potentials of KT and physical exercises aimed at restoring trunk stability upon chronic lumbalgia has also demonstrated the effectiveness of the method [38]. According to several studies, KT can be a self-sufficient method for treatment of non-specific lumbalgia, but it cannot compete with manual therapy and remedial exercises [39].

A large group of dance-related musculoskeletal pain syndromes can be related to the instability of the joints (usually of traumatic origin). KT proved to be a very effective method of eliminating the aforementioned pain syndromes due to its ability to fix the joint. Different methods of application of kinesio tape on the knee joint and patella of athletes have helped to significantly ease patellofemoral pain syndrome of runners with trauma due to the ability of the method to fix knee joint and activate femoral and calf muscles [40]. Patellofemoral pain syndrome is a common finding among athletes and dancers. According to research on dancers with patellofemoral pain syndrome there are predisposing features of constitution, as well as secondary disorders like hyper hip abduction, lower back and hamstring flexibility, hind-foot varus, scoliosis, limited ankle plantar flexion and limited hip internal rotation [41]. Work-related activity impedes the development of the appropriate dancing movement patterns. The injury due to knee overload (overuse injury) is manifested by pain syndrome which worsens the biomechanics of the extremity. KT helps to eliminate pain syndrome caused by moving disorders and to correct the inadequate movement pattern caused by anatomical and physiological features. Numerous studies of KT demonstrated its high efficacy in managing patellofemoral pain syndrome and restoring normal biomechanics of the lower extremities, which makes this method relevant for the prevention and treatment of dance-related pain syndromes [42].

KT was also effective in eliminating sacroiliac joint pain of recreational dancers, occurring in 13–25% of patients in the dance population [43]. Dancers and jumpers also often suffer from so-called jumper’s knee. Jumpers using kinesio tape experienced significant reduction of knee pain on landing from countermovement jumps, increasing knee flexion during the decline squat and on landing from a countermovement jump [44]. Besides, dancers may suffer from piriformis syndrome caused by irritation of the sciatic nerve due to spasm of the piriformis

muscle. The 72-h KT applied on the piriformis muscle trigger points relaxed the tensed muscle and significantly reduced pain syndrome in 33 patients [45].

Moreover, KT showed promising results in reducing medial tibial stress syndrome of professional dancers [46]. This syndrome is frequently found among dancers and can progress into a chronic form. Its treatment usually requires immobilization and suspension of exercise. KT allows shortening of the recovery period without reducing physical activity. Besides, KT increases stability of the ankle joint that was injured due to stretching of the anterior talofibular ligament and shortens the recovery period [47]. Kinesio tape used after anterior cruciate ligament reconstruction helped to fix the joint, ease pain and strengthen the quadriceps and popliteal ligaments [48].

Ligament tension is a very common injury in any type of dance. In order to assess the preventive features of KT, researchers have analyzed postural control during three types of ballet jumps (*sauté arabesque*, *sissonne ouverte de côté* and *sissonne ouverte en avant*) performed by professional dancers with kinesio tape on their ankle joints. The results showed improved joint stability in the frontal and sagittal planes [49]. A similar study of the knee joints among professional dancers also revealed a significant increase in joint stability in all planes after performing ballet jumps [50]. Misalignment of hucklebones is also commonly found among ballet dancers due to mechanical overload of the talonavicular joint. Based on the research of KT effects among dancers after repositioning of the talus bone, it has been found that KT stabilizes joints of the foot and at the same time eases pain without limiting dorsiflexion and plantar flexion motion range [51].

Impingement syndrome is another common problem among professional dancers, resulting in chronic pain in the ankle joint due to impaction of the synovial membranes after mechanical overload. This syndrome often progresses into a chronic form and sometimes becomes unmanageable [52]. Sustained traumatization leads to the formation of osteophytes on the articular surfaces. Kinesio tape used to manage posterior impingement in the ankle effectively reduced pain and speeded up recovery of the athlete. However, this method can be used for treatment of dance-related injuries as well. KT proved to be effective as a part of combination treatment for plantar fasciitis, one of the most common complications of overuse syndrome among athletes and dancers [53].

Stretching and other ballet injuries are often complicated by subcutaneous hematomas and lymphatic edema. Influence of KT on the superficial traumatic hematomas showed a significant clarification of the hematoma color along the edges of the applied tapes, as well as a reduction of edema the day after tape application [54]. Another important factor of KT is the quality of the kinesio tape. Testing the elasticity of commercially available

kinesio tape revealed significant differences in the physical characteristics of kinesio tape from various manufacturers, which influences the efficiency of the method [55].

7. Conclusion

Having analyzed numerous publications on the effectiveness of KT among professional dancers and athletes, we may conclude that the method proved to be ineffective in increasing muscle strength and improving proprioception of the joints only if it is used by healthy individuals under moderate physical activity. Studies of KT properties under strenuous physical exercises among healthy individuals have demonstrated numerous positive effects of the method, such as improvement of articular proprioception and postural stability (both static and dynamic), relieving muscle fatigue and enhancing their recovery, as well as reducing the severity of delayed-onset muscle soreness. KT turned out to be exceptionally effective for patients with different acute and chronic injuries of the musculoskeletal system. The method helped to restore impaired proprioception, stabilize joints, ease pain syndrome and improve muscle strength.

As a conclusion we can assume that KT may be useful in primary and secondary prevention of dance-related injuries and diseases of the musculoskeletal system of professional dancers. The ongoing scientific research suggests that the potential and effectiveness of the method could be substantially improved in the future.

Disclosure statement

No potential conflict of interest was reported by the author.

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