Review

A NARRATIVE REVIEW ON TENNIS-RELATED SPINAL PATHOLOGIES

B. Bauchiero[1], S. Spadafora[1], S. Legrenzi[2], G. Placella[1] and V. Salini[1]

[1]Università Vita-Salute San Raffaele, Piazza Ospedale Maggiore 3, Milan, Italy;
[2]Department of Orthopedic Surgery and Traumatology, ASST GOM Niguarda, Milan, Italy

Correspondence to:
Giacomo Placella, MD,
Department of Orthopaedics and Traumatology,
San Raffaele Hospital,
University Vita-Salute San Raffaele,
Milan, Italy
e-mail: placella.giacomo@hsronline.it

ABSTRACT

Tennis is one of Italy's most popular sports, boasting over 1 million registered players and 3 million recreational participants. Despite its asymmetrical nature, tennis involves several movements that engage the entire musculoskeletal system. While acute injuries are rare, chronic conditions related to overuse are prevalent, particularly among players over 25. Common injuries include tendinopathies, muscle strains, and lower back pain. Adolescent players exhibit a higher incidence of lower limb injuries, while adults predominantly experience spinal and overuse conditions. Spinal pathologies are a significant concern in tennis, with lumbar pain affecting 30% of players and often linked to improper technique or excessive training. Acute lumbar strain, discopathies, and isthmic pathologies such as spondylolysis and spondylolisthesis are frequently observed. These conditions can result from repetitive high-stress movements, particularly during serves and smashes, leading to mechanical imbalances, degenerative changes, or nerve root involvement. Treatment strategies emphasize rest, pain management, and rehabilitation, focusing on muscle strengthening and flexibility. Preventive measures, including biomechanical assessments, technical training, and appropriate equipment, are crucial to mitigating injury risks and maintaining players' long-term performance and well-being. This review highlights the causes, clinical manifestations, diagnostic tools, and therapeutic approaches for spine-related injuries in tennis, focusing on prevention to enhance athlete safety and longevity.

KEYWORDS: *tennis, muscle, spine, lumbar, discopathy, tendinopathy, pain*

INTRODUCTION

Traumatology of the locomotor system in tennis

In Italy, tennis has always been a widely practiced sport. According to estimates by CONI (Italian National Olympic Committee) and ISTAT (Italian Institute for Statistics), it ranked second in 2022 for the number of registered players, with growing participation, reaching the top position in regions such as Piedmont and Sicily (1). With over 1 million registered players and 3 million recreational and casual players, tennis is one of the most practiced sports in Italy, followed by over 24 million sports enthusiasts. The number of senior players is also steadily increasing (2).

This growing interest in tennis highlights the importance of addressing the impact of "tennis-related injuries" in clinical practice for physicians and athletic trainers. The incidence of acute traumatic events in tennis is low, accounting for about 0.12% of all injuries. However, the incidence of conditions related to functional overuse is significantly higher (3).

For all age groups, the most common injuries are tendon or muscle-related. In players over the age of 25, overuse injuries predominate. Among younger players, lower limb injuries are twice as common as upper limb and spinal injuries, with a high incidence of ankle sprains (4). Although the number of female players is increasing, there are no substantial

Received: 17 June 2022
Accepted: 28 July 2022

gender-based differences in injury incidence, particularly in players over 25. For adolescent athletes, however, statistics indicate a 0.6% incidence per 1,000 hours of play among females, with a prevalence of patellar conditions and lower back pain. In contrast, males show an incidence of 1.7% per 1,000 hours, with a marked prevalence of contusions, abrasions, lacerations, ankle injuries, and lumbar spine pain (5-8).

Despite being an asymmetrical sport, tennis is relatively comprehensive and features a variety of athletic movements that engage the entire musculoskeletal system (5). Tennis-related injuries include both acute traumatic injuries specific to the sport and more general injuries common to other sports.

Acute injuries, caused by trauma that exceeds the mechanical resistance of anatomical structures, are relatively rare. Tennis players are more often exposed to forces they generate endogenously rather than exogenous forces, as there is no physical contact with opponents, and the game equipment poses minimal risk (7).

Chronic injuries, on the other hand, are linked to functional overuse and can be influenced by both predisposing and determining factors:

- predisposing factors can be exogenous, such as the playing surface, footwear, equipment, or environmental conditions, or endogenous, related to the athlete's congenital or acquired abnormalities, such as asymmetries or myotendinous imbalances;
- determining factors are represented by repeated and abnormal functional stresses due to specific athletic gestures (9-11).

Tennis involves rapid player movements on the court, including sudden changes of direction, sprints, jumps, stops, and dives, which exert considerable stress not only on the spine but also on the upper and lower limbs. Additionally, the specific movements of the dominant upper limb, particularly during the serve and smash (overhead movements), involve significant exertion. If not performed correctly with proper technique, these movements can cause injuries that compromise not only athletic performance but also daily life activities (9). Such injuries, especially those due to poor execution of movements, initially manifest as reactive inflammatory phenomena, followed by regressive and degenerative changes (12).

The following sections will describe the most common trauma-based conditions affecting tennis players, focusing on the spine. Emphasis will be placed on the causes, clinical manifestations, diagnostic possibilities, treatment methods, and, most importantly, prevention strategies.

The Spine

The most common spine conditions in tennis are chronic in nature, affecting the vertebral body, intervertebral discs, or posterior arch. While the prevalence of lumbar spine conditions is not significantly different from other sports, 38% of tennis players reported missing at least one tournament due to lower back pain, and 30% suffer from chronic lumbar pain, with 85% of cases directly linked to sports activity (13-16).

A study conducted on top tennis players aged 17 to 25 revealed that 50% had experienced thoracolumbar pain lasting at least a week, and 20% had suffered severe lumbar pain (13). The lordotic segments of the spine (cervical and lumbar) are particularly vulnerable to torsional and shearing forces. These forces are experienced during the smash and serve due to the rapid hyperextension and twisting of the trunk (3).

Intense and rapid movements can cause fractures of the vertebral processes or, less commonly, the vertebral body. Repetitive and continuous movements, especially during intensive training, may lead to degenerative conditions, particularly affecting the intervertebral discs in the lumbosacral region (7) (Fig. 1).

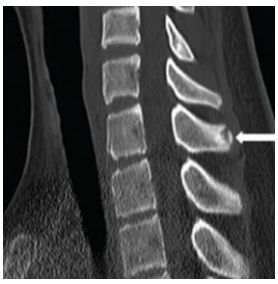

Fig. 1. *Intervertebral discs in the lumbosacral region.*

Low back pain: one pain, many causes

Low back pain refers to sacral or lumbar pain with acute onset or episodic occurrences during or after physical strain. The causes are varied, ranging from spondylitis to dysmorphisms (e.g., scoliosis, Scheuermann's disease). However, in 95% of cases, it results from imbalances in vertebral and abdominal muscles, causing spasm in the paravertebral muscles (9,12).

Certain anatomical anomalies can predispose athletes to lumbosacral imbalance or nerve root involvement, leading to chronic pain. These include megapophyses, schisis, spondylolisthesis, scoliosis, lumbarization of the first sacral vertebra, or sacralization of the fifth lumbar vertebra (8, 11).

This condition predominantly affects young adults, with a prevalence of 30%-50% among adolescents in developmental stages (8). Pain can be unilateral or bilateral,

worsening with inactivity and improving with physical activity or heat application. Players often report an increase in training intensity or duration or a recent change in technique (2). Low back pain is classified primarily based on duration:

- acute: pain lasting less than six weeks;
- sub-acute: pain lasting six to 12 weeks;
- chronic**:** pain persisting for more than 12 weeks (12).

Clinical examination typically reveals spasms in the paravertebral and hamstring muscles, with negative results for Lasègue and Wassermann signs. Traditional imaging is helpful in acute cases: X-rays rule out fractures or degenerative processes, while ultrasound is of limited value. Electromyography can aid in diagnosing radicular conditions. MRI is the gold standard for evaluating chronic or recurrent pain, particularly for disc-related or soft tissue pathologies (7, 15) (Fig. 2).

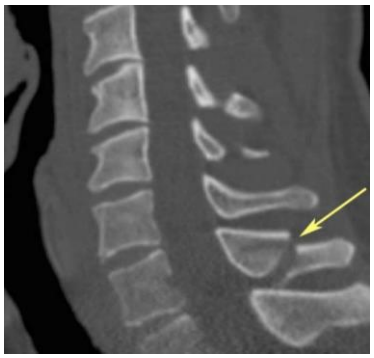

Fig. 2. *Electromyography can aid in diagnosing radicular conditions.*

Therapeutic goals focus on preventing chronicity by addressing the root cause of the pain. Recommendations include rest from sports while maintaining normal daily activities, analgesic therapy with the lowest effective dosage, manual massages along the spine if medication proves insufficient, and specific training programs for paravertebral and dorsal muscles. Severe cases may require pain therapy or botulinum toxin treatment, but these are reserved for inappropriate muscle contractions or severe chronic pain and should be managed by specialists in dedicated centers (12, 15).

Lumbar strain

Lumbar strain is the most common acute spinal injury in tennis. At-risk muscles include the erector spinae and lumbar multifidus, which are subject to repeated and continuous trunk rotation and extension. These muscles work in synergy with the abdominals, alternating between eccentric and concentric contraction to enable extreme rotational extension and trunk flexion (4).

The typical presentation is lumbar spine pain with discomfort during standing, sitting, or walking. Pain intensifies with flexion and rotation movements of the spine, which are limited in their normal range (9) (Fig. 3a, b).

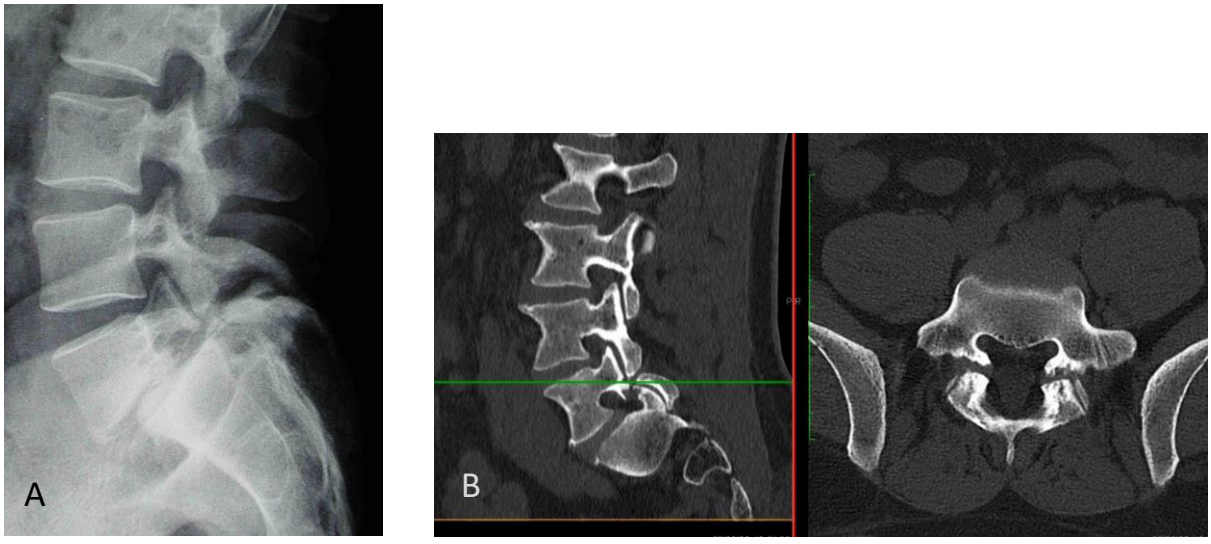

Fig. 3. *A). spondylolysis with spondylolisthesis; B): spondylolysis without spondylolisthesis*.

In uncomplicated acute phases, treatment involves rest and pain relief through cryotherapy, which competes with slow pain impulses and temporarily alleviates muscle spasms (7). Additional therapeutic approaches for persistent cases include ultrasound, manual massage, and the use of paracetamol or NSAIDs. Once pain subsides, gradual flexion exercises and specific muscle strengthening with stretching sessions are recommended. Return to sports typically occurs within a few days (3).

Discopathies: low back pain and sciatica

In tennis players, 43% of lumbar spine pain is associated with prolapse of one or more intervertebral discs (7). Lumbar disc herniation is primarily caused by sudden overloading, which damages the annulus fibrosus containing the disc's nucleus pulposus. In tennis, repetitive microtrauma, predominantly from spinal twisting and hyperextension during serves, contributes to a degenerative process culminating in herniation (6).

Disc herniation may result in isolated low back pain, isolated sciatica or cruralgia with lower limb pain, or a combination of these, manifesting as lumbosciatica or lumbocruralgia depending on the nerve roots involved. Pain may persist for days, have a relapsing-remitting nature, and become severe without apparent cause, with or without radiating pain to the lower limbs (15, 16).

Pain decreases with knee flexion and increases with positional changes or the Valsalva maneuver. Clinical examination often reveals positive Lasègue signs for L3-S1 root involvement and positive Wassermann signs for L1-L3 involvement. Diagnostic imaging includes X-rays to rule out spondylolysis, spondylolisthesis, or fractures, and MRI to assess herniation severity. Athletes with sensory or motor deficits should also undergo electromyography (12, 15).

Initial treatment includes rest, analgesics, anti-inflammatory drugs, and short-term use of orthotic supports. Severe cases may require corticosteroids (oral or epidural), short-term opioid medication, or pain-blocking injections. Physical therapy involves stretching and strengthening abdominal and paravertebral muscles to offload stress from lumbar discs. Daily postural correction exercises help athletes maintain proper spine alignment during high-risk movements. Surgery is considered only for resistant back pain or irreversible muscular paralysis (7, 16).

Isthmic pathologies: spondylolysis and spondylolisthesis

Isthmic pathologies, particularly involving the fifth lumbar vertebra, are relatively common among young tennis players. Spondylolysis, while potentially congenital, often stems from cyclic microtraumatic stress (16). This condition may be accompanied by active spondylolisthesis (with rapid progression) or passive spondylolisthesis (with slow progression), primarily affecting athletes with incomplete skeletal growth (7).

Spondylolisthesis progresses through four stages, with the most severe stage, spondyloptosis, requiring surgical intervention (2). Diagnosis relies on oblique and dynamic X-rays, with possible CT scans for further evaluation (16).

Treatment for spondylolysis without spondylolisthesis is conservative, focusing on rest, symptom relief, and specific rehabilitation. In cases of spondylolisthesis, depending on the degree of slippage, specialized braces or surgical stabilization may be necessary, potentially precluding further sports participation (4).

Spinal pathologies are often triggered by athletic movements, especially if performed incorrectly. Proper technique in strokes and optimal coordination during movements are essential. This must be supported by comprehensive athletic preparation to enable the spine to withstand the loads of sports practice (5).

Strength and endurance of paravertebral, abdominal, and lower limb muscles should be enhanced, coupled with good flexibility and functionality (6). Proper equipment and tools are crucial. Before starting competitive play, biomechanical evaluation of the athlete, including kinetic chains, joint angles, and equipment (e.g., footwear, racket types, string tension), is essential to design appropriate athletic and technical training (3).

REFERENCES

1. CONI. I numeri dello sport. www.coni.it. Published 2021. https://www.coni.it/it/i-numeri-dello-sport.html
2. Leach RE, Abramowitz A. The Senior Tennis Player. *Clinics in Sports Medicine*. 1991;10(2):283-290. doi:https://doi.org/10.1016/s0278-5919(20)30633-5
3. Perkins RH, Davis D. Musculoskeletal Injuries in Tennis. *Physical Medicine and Rehabilitation Clinics of North America*. 2006;17(3):609-631. doi:https://doi.org/10.1016/j.pmr.2006.05.005
4. Bylak J, Hutchinson MR. Common Sports Injuries in Young Tennis Players. *Sports Medicine*. 1998;26(2):119-132. doi:https://doi.org/10.2165/00007256-199826020-00005
5. Kibler WB, Safran MR. Musculoskeletal injuries in the young tennis player. *Clinics in Sports Medicine*. 2000;19(4):781-792. doi:https://doi.org/10.1016/s0278-5919(05)70237-4
6. Hjelm N, Werner S, Renstrom P. Injury profile in junior tennis players: a prospective two-year study. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2010;18(6):845-850. doi:https://doi.org/10.1007/s00167-010-1094-4
7. Marks MR, Haas SS, Wiesel SW. Low back pain in the competitive tennis player. *Clinics in Sports Medicine*. 1988;7(2):277-287.
8. Kujala UM, Taimela S, Erkintalo M, Salminen JJ, Kaprio J. Low-back pain in adolescent athletes. *Medicine & Science in Sports & Exercise*. 1996;28(2):165-170. doi:https://doi.org/10.1097/00005768-199602000-00002
9. Swärd L, Eriksson B, Peterson L. Anthropometric Characteristics, Passive Hip Flexion, and Spinal Mobility in Relation to Back Pain in Athletes. *Spine*. 1990;15(5):376-382. doi:https://doi.org/10.1097/00007632-199005000-00007

10. Abrams GD, Renstrom PA, Safran MR. Epidemiology of musculoskeletal injury in the tennis player. *Br J Sports Med*. 2012;46(7):492-498. doi:10.1136/bjsports-2012-091164
11. Cailliet R. *Low Back Pain Syndrome.* F.A. Davis; 1981.
12. Hainline B. Low back injury. *Clinics in sports medicine*. 1995;14(1):241-265.
13. Chard MD, Lachmann SM. Racquet sports--patterns of injury presenting to a sports injury clinic. *British Journal of Sports Medicine*. 1987;21(4):150-153. doi:https://doi.org/10.1136/bjsm.21.4.150
14. Dalichau S, Scheele K. Der Einfluss sportmechanischer Anforderungen im Leistungstennis auf das thorakolumbale Wirbelsäulenprofil [Influence of sports mechanic demands in competitive tennis on the thoracolumbar spinal profile]. *Sportverletz Sportschaden*. 2002;16(2):64-69. doi:10.1055/s-2002-32680.
15. Benzon HT. Epidural steroid injections for low back pain and lumbosacral radiculopathy. *Pain*. 1986;24(3):277-295. doi:https://doi.org/10.1016/0304-3959(86)90115-6
16. Ruiz-Cotorro A, Balius-Matas R, Estruch-Massana A, Vilaró Angulo J. Spondylolysis in young tennis players *Commentary. *British Journal of Sports Medicine*. 2006;40(5):441-446. doi:https://doi.org/10.1136/bjsm.2005.023960