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Return to sport after lumbar disc herniation surgery: a narrative review of surgical techniques, rehabilitation, and outcomes

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Abstract

Background. Lumbar disc herniation (LDH) is prevalent among elite athletes, reaching up to 75% in high-impact sports. Extreme physical demands accelerate spinal degeneration, making the choice between surgical and conservative management critical for rapid return to play (RTP).

Aim. This review evaluates the impact of surgical techniques, phased rehabilitation, and sport-specific factors on RTS rates and timing after surgery.

Material and methods. A qualitative synthesis of 23 sources was performed, including meta-analyses, systematic reviews, and league-specific cohort studies.

Results. RTS rates after discectomy are high (75%–100%). Minimally invasive procedures, particularly transforaminal endoscopic discectomy (TELD), offer shorter recovery times (avg. 4 months) and less back pain than microdiscectomy. Recovery is optimized through structured, four-phase rehabilitation focusing on core stabilization and "hip hinge" motor control. While surgery provides faster short-term relief, long-term functional outcomes often align with conservative management.

Conclusions. Surgery effectively enables rapid symptom resolution in elite athletes. Long-term success depends on adherence to phased rehabilitation. Endoscopic techniques represent a promising advancement in reducing morbidity and shortening recovery time in the athletic population.

Key words: return to sport, lumbar disc herniation, discectomy, athletic rehabilitation.

1. Introduction

Low back pain (LBP) is a pervasive issue in the professional athletic community, reported by over 30% of athletes during their careers (S. B. O'Connor et al., 2023). Among structural causes, lumbar disc herniation (LDH) is a leading reason for disability, with symptomatic prevalence reaching up to 75% in high-impact sports (S. Kapetanakis et al., 2026), (A. Ong et al., 2003). Elite athletes constitute a unique demographic requiring rapid return to extreme performance under significant physical stress, often dealing with accelerated disc degeneration caused by repetitive torsion and compressive forces (E. Albertazzi, 2025), (Jing. Zhang et al., 2025).

While open discectomy was historically the standard approach (C. Calikoglu & M. Cakir, 2018), microdiscectomy (MD) is currently the surgical gold standard for athletes (S. Kapetanakis et al., 2026), (P. Sedrak et al., 2021). The clinical landscape continues to evolve

with the emergence of full-endoscopic techniques, such as transforaminal endoscopic lumbar discectomy (TELD), which offers reduced tissue trauma and significantly shorter hospitalization (S. Kapetanakis et al., 2026), (E. Albertazzi, 2025).

The choice between surgical and conservative management remains a critical challenge. Although large-scale studies like the Spine Patient Outcomes Research Trial (SPORT) indicate that long-term functional outcomes for both modalities often converge over eight years, surgery is frequently prioritized in elite populations (J. D. Lurie et al., 2014), (J. N. Weinstein et al., 2006). This preference is driven by the need for faster symptom relief and a predictable timeline for return to competition (S. B. O'Connor et al., 2023), (N. Kögl et al., 2024). Notably, even massive herniations show potential for spontaneous resorption, which may guide non-operative decisions in specific cases (Z. Ma et al., 2021).

A successful return to sport (RTS) is heavily dependent on structured, phased rehabilitation protocols. Modern programs emphasize a transition from acute protection to power development, utilizing exercises that reinforce the "hip hinge" strategy to protect the operated segment (L. H. VanGelder et al., 2013). Furthermore, RTS rates and career longevity vary by discipline; Major League Baseball players often show higher return rates than National Football League linemen (R. Nair et al., 2014), (S. V. Minhas et al., 2016). Understanding individual risk factors, such as high preoperative disc height or a BMI $\geq$ 25 kg/m^2, is also essential for managing the risk of recurrence (M. E. Yaman et al., 2017). This review synthesizes current evidence on how surgical techniques and rehabilitation models interact to determine athletic recovery.

2. Research materials and methods

This paper is a narrative review designed to synthesize current evidence regarding the surgical management and physical rehabilitation of elite athletes suffering from lumbar disc herniation (LDH). Unlike systematic reviews, this narrative approach allows for a broader integration of clinical commentaries, discipline-specific cohort studies, and evolving surgical techniques to provide a comprehensive overview of the return-to-sport (RTS) process.

2.1. Literature Search and Selection

The evidence base for this review was identified through a qualitative search of major electronic databases, including PubMed/MEDLINE, EMBASE, Scopus, and the Cochrane Library (P. Sedrak et al., 2021), (L. Ambrosio et al., 2025). The search focused on publications from the last two decades, though landmark studies and long-term trials were also included to provide historical context and durability data. Key search terms utilized

included "lumbar disc herniation," "discectomy," "microdiscectomy," "endoscopic spine surgery," "elite athletes," and "return to play".

2.2. Inclusion Criteria and Scope

The materials selected for analysis encompass a diverse range of study designs to ensure a multidimensional perspective:

- High-level clinical trials and meta-analyses: Including the Spine Patient Outcomes Research Trial (SPORT) and network meta-analyses comparing various surgical modalities.
- Discipline-specific studies: Research focused on professional leagues such as the NBA, NFL, NHL, and MLB to address the unique mechanical demands of different sports.
- Population subsets: Evidence regarding adolescent athletes was incorporated to address etiology and treatment in younger competitors.
- Clinical Commentaries and Rehabilitation Protocols: Expert frameworks for phased recovery, specifically those transitioning from acute protection to power development.

2.3. Data Synthesis and Outcomes

The synthesis focused on three primary domains:

1. Surgical Techniques: Comparing traditional open discectomy (OD), microdiscectomy (MD), and minimally invasive options like transforaminal endoscopic lumbar discectomy (TELD) and sequestrectomy.
2. Rehabilitation Strategies: Evaluating the effectiveness of supervised versus home-based exercise and the impact of specialized programs like pilates or staged McKenzie-based movements.
3. Return-to-Sport Metrics: Analyzing objective outcomes such as RTS rates, time to return, career longevity, and post-surgical performance statistics.

3. Research results

3.1. Return to sport rates after lumbar disc herniation surgery

The clinical consensus indicates that return-to-sport (RTS) rates after surgical treatment for lumbar disc herniation (LDH) are generally high, with pooled analysis showing approximately 81% to 83% of athletes returning to competition (M. P. Reiman et al., 2016), (P. Sedrak et al., 2021). However, a significant discrepancy exists between "returning to any sport" and "returning to the pre-injury level of performance."

3.1.1 League-Specific and Discipline Variations.

RTS rates vary significantly depending on the physical demands of the sport. A comprehensive summary of return-to-sport rates across various professional leagues and specific athletic populations is provided in Table 1.

- Major League Baseball (MLB): Demonstrates the highest success, with rates reaching 97% to 98% (R. Nair et al., 2014), (M. P. Reiman et al., 2016).
- National Basketball Association (NBA): Reports show a stable RTS rate of approximately 75% to 79.4% (S. V. Minhas et al., 2016), (R. Nair et al., 2014).
- National Football League (NFL): RTS rates are slightly lower, ranging from 74% to 81%, reflecting the high-impact nature of the sport (E. Albertazzi, 2025), (P. Sedrak et al., 2021). Notably, even among NFL linemen who undergo revision surgery for recurrence, the RTS rate remains high at 85.7% (S. B. O'Connor et al., 2023).
- National Hockey League (NHL): Surgical cohorts show an RTS rate of 79%, while those treated conservatively may reach up to 90% (M. P. Reiman et al., 2016), (R. Nair et al., 2014).

Table 1. Return to Sport Rates Across Different Athletic Populations and Leagues

Population / League	**RTS Rate (Surgical)**	**RTS Rate (Non-operative)**	**Sources**
National Basketball Association (NBA)	79.4%	77.8%	(S. V. Minhas et al., 2016)
Major League Baseball (MLB)	98%	97%	(R. Nair et al., 2014), (M. P. Reiman et al., 2016)
National Football League (NFL)	74% - 78%	59%	(E. Albertazzi, 2025), (M. P. Reiman et al., 2016)
National Hockey League (NHL)	79%	90%	(M. P. Reiman et al., 2016)
High School & Collegiate Athletes	71% - 94%	N/A	(S. B. O'Connor et al., 2023), (E. Albertazzi, 2025)
Elderly Population (Age ≥65)	43.4%	N/A	(K. Goto et al., 2023)

3.1.2 Professionals vs. Amateurs and Age Factors.

Professional athletes often exhibit higher RTS rates than amateurs due to economic incentives and elite-level medical support (M. P. Reiman et al., 2016). Age is also a critical predictor: adolescents and young athletes show exceptional outcomes, with 90% to 96% resuming their sport within a year (E. Albertazzi, 2025), (Jing. Zhang et al., 2025). Conversely, in the elderly population (≥65 years), the RTS rate drops significantly to 43.4%, often due to lower physical demand and concomitant degenerative changes (K. Goto et al., 2023).

3.1.3 Level of Return.

While total RTS is high, only about 59% to 65% of elite athletes successfully return to their exact pre-operative level of play (M. P. Reiman et al., 2016), (P. Sedrak et al., 2021). Many athletes report a decline in performance metrics—such as the Player Efficiency Rating (PER) in the NBA—during the first season post-surgery, though these figures typically normalize by the second or third season (S. V. Minhas et al., 2016).

3.2. Time to return to physical activity and sport

The average timeline for returning to sport (RTS) following a discectomy ranges from 2.8 to 8.7 months (R. Nair et al., 2014), (P. Sedrak et al., 2021). This interval is highly sensitive to the surgical technique employed and the severity of preoperative symptoms. A comprehensive summary of return-to-play timelines associated with different surgical modalities is provided in Table 2.

3.2.1 Impact of Surgical Technique.

Minimally invasive and endoscopic approaches have redefined the recovery speed for elite competitors.

Full-Endoscopic Techniques (TELD/PED): These procedures allow for a remarkably swift return, with athletes often resuming competition within 2 to 4 months (P. Sedrak et al., 2021), (S. Kapetanakis et al., 2026). This acceleration is attributed to reduced hospitalization (6.6 hours for TELD vs. 17 hours for MD) and minimal disruption of the paraspinal musculature (S. Kapetanakis et al., 2026).

Microdiscectomy (MD): The traditional gold standard requires a longer recovery, averaging 5.2 to 6.5 months (P. Sedrak et al., 2021), (E. Albertazzi, 2025).

Open Discectomy (OD): Historically associated with the longest recovery times, often extending to 8.7 months in high-demand sports like baseball (R. Nair et al., 2014).

Table 2. Comparison of Surgical Techniques and Mean Time to Return to Play (RTP)

Surgical Technique	**Mean Time to RTP (Months)**	**Primary Clinical Advantages**	**Sources**
Open Discectomy (OD)	5.2 – 8.7	Cumulative surgeon experience; shorter learning curve	(R. Nair et al., 2014), (C. Calikoglu & M. Cakir, 2018)
Microdiscectomy (MD)	5.2 – 6.5	Effective neural decompression; standard of care	(P. Sedrak et al., 2021), (E. Albertazzi, 2025)
Endoscopic Discectomy (TELD/PED)	2.0 – 4.0	Minimal tissue trauma; reduced hospitalization; faster RTP	(P. Sedrak et al., 2021), (S. Kapetanakis et al., 2026)
Microendoscopic Discectomy (MED)	~2.5	Minimal invasiveness; preserved spinal integrity	(P. Sedrak et al., 2021), (S. Kapetanakis et al., 2026)

3.2.2. Clinical and Preoperative Predictors.

Symptom duration prior to intervention is a vital factor in determining the speed of recovery. Athletes treated within 6 months of symptom onset tend to achieve better functional outcomes and faster RTS (N. Kögl et al., 2024). Furthermore, the presence of severe neurological deficits (MRC grade $\leq$ 3/5) can delay RTS, as nerve root recovery may take months to normalize (N. Kögl et al., 2024).

3.2.3 Sport-Specific Demands.

Time to RTS is also dictated by the specific mechanical loads of the sport. Baseball players often require more time (8.7 months) to return to full performance compared to other athletes, as their discipline demands extreme torsional spinal stability for pitching and hitting (R. Nair

et al., 2014). In contrast, athletes in sports with lower axial loading may return in as little as 1 to 3 months after endoscopic procedures (S. Kapetanakis et al., 2026). For conservative management, the average time to RTS is approximately 4.1 to 4.8 months (P. Sedrak et al., 2021), (J. Iwamoto et al., 2011).

3.3. Influence of surgical technique on return to sport

The choice of surgical modality significantly impacts the recovery trajectory and the timeline for return to sport (RTS). While microdiscectomy (MD) remains a widely used standard, minimally invasive and endoscopic techniques have demonstrated advantages in accelerating the return to competitive levels (P. Sedrak et al., 2021), (S. Kapetanakis et al., 2026).

3.3.1 Endoscopic vs. Microdiscectomy.

Comparative studies between transforaminal endoscopic lumbar discectomy (TELD) and conventional MD in elite athletes show that while both techniques achieve a 100% RTS rate, TELD results in a significantly shorter return time (mean 4 months vs. 5.6 months for MD) (S. Kapetanakis et al., 2026). This is attributed to the "pure" minimally invasive nature of TELD, which minimizes paraspinal muscle trauma, reduces epidural scarring, and preserves spinal stability (S. Kapetanakis et al., 2026). Pooled data further support this, showing mean return times of 2.06 months for percutaneous endoscopic discectomy (PED) and 2.52 months for microendoscopic discectomy (MED), compared to 6.5 months for MD (P. Sedrak et al., 2021).

3.3.2 Discectomy vs. Sequestrectomy.

Evidence suggests that sequestrectomy (removing only the herniated fragment) may be a viable alternative to aggressive discectomy (L. Ambrosio et al., 2025). Meta-analyses indicate no significant differences in reherniation or reoperation rates between the two (L. Ambrosio et al., 2025). However, sequestrectomy is associated with shorter operative times and marginally better long-term pain improvement (1–2 years), likely because it avoids damaging the cartilaginous endplates and other stabilizing structures (L. Ambrosio et al., 2025).

3.3.3 Minimally Invasive Fixed Procedures.

Emerging techniques like endoscopic discectomy with internal fixation (EDF) have shown high efficacy in pain relief and disability recovery (K. Song et al., 2025). Network meta-analyses rank EDF highest for post-surgical pain relief, suggesting that restoring posterior spine chain stability may benefit certain athletic cohorts (K. Song et al., 2025).

3.4. Rehabilitation protocols and their impact on recovery

A structured, evidence-based rehabilitation program is essential for a successful RTS, as many standard prescriptions fail to address the specific motor control and postural demands of elite athletics (L. H. VanGelder et al., 2013).

Phased Rehabilitation Framework. Modern protocols are typically divided into four clinical phases aligned with tissue healing (L. H. VanGelder et al., 2013), (S. B. O'Connor et al., 2023):

Phase I (Acute/Protective): Focuses on pain management, neural mobilization, and early core activation (e.g., transversus abdominis hollowing) while avoiding rotation and flexion (L. H. VanGelder et al., 2013), (S. Kapetanakis et al., 2026).

Phase II (Repair): Introduces controlled flexion and isometric resistance to rotation. A key objective is the education of the "hip hinge" strategy, which allows athletes to dissociate hip flexion from lumbar flexion to protect the disc (L. H. VanGelder et al., 2013).

Phase III (Remodeling/Power): Integrates dynamic rotation, power development (e.g., kettlebell swings), and sport-specific drills to facilitate fiber reorientation in the annulus (L. H. VanGelder et al., 2013).

Phase IV (Full Return): Gradual transition to unrestricted competition and power-lifting mechanics (L. H. VanGelder et al., 2013).

While evidence for specific protocols is often sparse, high-certainty evidence indicates that adding pilates exercise to routine care improves function in patients with post-surgical fear of movement (H. Yu et al., 2024). Furthermore, supervised exercise has been found superior to non-supervised or home-based programs in maintaining long-term adherence and motivation (T. Oosterhuis et al., 2014), (H. Yu et al., 2024). High-intensity programs may also lead to a faster decrease in short-term pain compared to low-intensity alternatives (T. Oosterhuis et al., 2014).

3.5. Functional outcomes and patient-reported measures

The success of surgical intervention for lumbar disc herniation (LDH) in the athletic population is measured not only by the resolution of radicular symptoms but also by the restoration of peak performance and overall health-related quality of life (S. Kapetanakis et al., 2026), (S. V. Minhas et al., 2016). Validated outcome tools, such as the Medical Outcomes Study Short-Form Health Survey (SF-36) and the Oswestry Disability Index (ODI), consistently show substantial post-surgical improvements in physical functioning and pain scores (J. D. Lurie et al., 2014), (S. Kapetanakis et al., 2026). Comparative clinical data

indicates that athletes undergoing transforaminal endoscopic lumbar discectomy (TELD) report significantly higher SF-36 scores and lower visual analog scale (VAS) scores for back pain from the fourth postoperative month through a three-year follow-up compared to those treated with traditional microdiscectomy (MD) (S. Kapetanakis et al., 2026). These surgical benefits appear to be durable over time, as eight-year results from the landmark SPORT trial demonstrate that improvements in physical function and bodily pain persist well into the second decade of recovery (J. D. Lurie et al., 2014).

Beyond subjective pain scales, objective performance metrics provide a discipline-specific view of functional recovery. In the National Basketball Association (NBA), surgically managed players often experience a temporary decline in games played and their Player Efficiency Rating (PER) during the first postoperative season (S. V. Minhas et al., 2016). However, these performance statistics typically normalize and return to levels comparable to healthy age-matched controls by the second or third seasons (S. V. Minhas et al., 2016). In contrast, Major League Baseball (MLB) pitchers often face a more prolonged recovery of their performance statistics, with some studies reporting statistically poorer earned run averages (ERA) and walks plus hits per inning pitched (WHIP) for up to three years following intervention (S. B. O'Connor et al., 2023).

Several preoperative clinical factors serve as critical predictors for these functional outcomes. The duration of symptoms prior to surgery is paramount; athletes treated within six months of symptom onset generally achieve significantly better long-term activity levels and functional scores (N. Kögl et al., 2024). Conversely, athletes with mild preoperative leg pain (NRS $\leq$3) may report less satisfactory surgical outcomes (F. G. Sigmundsson et al., 2020). This phenomenon occurs because patients with lower baseline disability have less statistical room for clinical improvement compared to those presenting with severe radiculopathy, emphasizing the need for highly individualized surgical counseling (F. G. Sigmundsson et al., 2020). Furthermore, achieving a high degree of postoperative satisfaction is strongly linked to reaching the threshold for a minimally important clinical difference (MICD) in back pain and disability scores (F. G. Sigmundsson et al., 2020).

3.6. Risk factors affecting return to sport

The capacity of an athlete to successfully return to their prior level of competition is determined by a multifactorial interplay of anthropometric, clinical, and sport-specific variables (E. Albertazzi, 2025), (S. V. Minhas et al., 2016). Identifying these factors preoperatively is essential for managing expectations and tailoring recovery pathways for elite competitors (N. Kögl et al., 2024). In professional basketball, specific physical characteristics

such as increased player height and playing the position of center have been identified as significant negative predictors for return to play (S. V. Minhas et al., 2016). Similarly, a higher Body Mass Index (BMI) serves as a primary risk factor for less favorable outcomes and is strongly associated with an increased risk of post-surgical recurrence, particularly in high-impact roles like those of NFL linemen (M. E. Yaman et al., 2017), (S. B. O'Connor et al., 2023).

Clinical and radiological indicators also provide critical prognostic insights into the likelihood of a stable return. The duration of radiculopathy prior to intervention is a vital determinant, as athletes treated within six months of symptom onset typically achieve better long-term activity levels than those with chronic symptoms (J. Iwamoto et al., 2011), (N. Kögl et al., 2024). Radiologically, segments with higher preoperative disc height and the presence of Modic endplate changes indicate latent instability, which significantly complicates the return-to-sport process and heightens the tendency for reherniation (M. E. Yaman et al., 2017). Furthermore, the severity of preoperative neurological status, specifically motor deficits graded MRC $\leq$ 3/5, may indicate a risk for incomplete nerve recovery that could preclude a return to high-demand athletics (N. Kögl et al., 2024).

The nature of the athletic discipline and the patient's psychological profile further influence recovery success. High-contact and collision sports, such as American football or hockey, impose much greater axial and rotational loads on the operated segment, often resulting in lower return rates compared to non-contact activities like swimming (E. Albertazzi, 2025), (S. B. O'Connor et al., 2023). Beyond physical metrics, psychological readiness is a cornerstone of the return-to-play process. High levels of personal motivation and the absence of kinesiophobia (fear of re-injury) are essential for completing intensive rehabilitation, whereas a loss of motivation is frequently cited as a primary reason for premature career termination (J. Iwamoto et al., 2011), (E. Albertazzi, 2025).

3.7. Complications and recurrence rates in physically active patients

While lumbar discectomy is generally considered a safe procedure for the athletic population, physically active patients face unique risks due to the repetitive mechanical stresses they place on the operated spinal segment (P. Sedrak et al., 2021), (S. B. O'Connor et al., 2023). The most frequent intraoperative complication reported in the literature is an incidental durotomy (dural tear), occurring in approximately 1.4% to 3.3% of cases (C. Calikoglu & M. Cakir, 2018). Other reported perioperative issues include superficial wound infections and temporary postoperative dysesthesia, although major complications like permanent nerve root injury remains rare in elite athletic cohorts (C. Calikoglu & M. Cakir, 2018), (S. Kapetanakis et al.,

2026). Full-endoscopic techniques, such as transforaminal endoscopic lumbar discectomy (TELD), have been shown to further reduce these risks by minimizing paraspinal tissue trauma and limiting the extent of epidural scarring (S. Kapetanakis et al., 2026).

The reported recurrence rate of LDH in the general population typically ranges from 5% to 15% (M. E. Yaman et al., 2017). In professional athletes, these figures appear comparable, with studies in the National Football League (NFL) reporting recurrence frequencies of 8.3% to 8.7% (S. B. O'Connor et al., 2023), (P. Sedrak et al., 2021). However, certain high-risk athletic subgroups, such as NFL linemen, demonstrate higher recurrence rates of approximately 13.5%, likely due to the extreme axial and torsional forces and repetitive hyperextension required by their specific playing positions (S. B. O'Connor et al., 2023). Beyond mechanical loading, lifestyle choices and radiological markers significantly impact the likelihood of a second herniation. Active smoking is associated with an approximately 50% higher recurrence rate, potentially due to compromised disc nutrition and increased intradiscal pressure (M. E. Yaman et al., 2017). Additionally, athletes with preserved preoperative disc height or the presence of Modic endplate changes are at a higher risk of recurrence because the spinal segment remains dynamically unstable (M. E. Yaman et al., 2017).

Despite the emotional and physical blow of a recurrence, the prognosis for returning to play after a second procedure remains remarkably high. For instance, data indicates that 85.7% of NFL linemen who required a revision discectomy for recurrence successfully returned to professional competition (S. B. O'Connor et al., 2023), (P. Sedrak et al., 2021). This suggests that with meticulous surgical technique and subsequent adherence to a rigorous, structured rehabilitation protocol, a recurrence does not necessarily signal the end of an elite athletic career (S. B. O'Connor et al., 2023), (E. Albertazzi, 2025). Successful career preservation in these cases emphasizes the need for individualized treatment plans and carefully managed expectations for revision outcomes (E. Albertazzi, 2025), (M. E. Yaman et al., 2017).

4. Discussion

The surgical management of lumbar disc herniation (LDH) in elite athletes represents a complex intersection of clinical precision and high-performance requirements. The primary goal of treatment in this population—restoring pre-injury performance levels as quickly and safely as possible—often drives the decision-making process toward operative intervention, despite evidence that long-term outcomes for surgical and conservative management may converge (P. Sedrak et al., 2021), (J. D. Lurie et al., 2014).

4.1. Surgical Evolution and Return to Sport Speed

The evolution from open discectomy (OD) to full-endoscopic techniques has significantly altered the recovery trajectory for athletes. While OD and microdiscectomy (MD) remain effective, they are associated with greater paraspinal muscle trauma and potential fibrosis, which can contribute to postoperative chronic low back pain (S. Kapetanakis et al., 2026). In contrast, transforaminal endoscopic lumbar discectomy (TELD) and percutaneous endoscopic discectomy (PED) demonstrate a clear advantage in reducing the time to return to play (RTP), often facilitating a return within 2 to 4 months compared to 5 to 8 months for traditional techniques (P. Sedrak et al., 2021), (E. Albertazzi, 2025). This acceleration is likely due to the "keyhole" nature of the approach, which preserves the integrity of the posterior musculature and osseoligamentous structures essential for athletic stabilization (S. Kapetanakis et al., 2026). Furthermore, emerging data from network meta-analyses suggest that endoscopic discectomy with internal fixation (EDF) may offer superior pain relief and recurrence prevention by reestablishing segmental stability (K. Song et al., 2025).

4.2. Return to Play Rates: Motivation and Performance

A striking finding across the literature is the disparity between overall RTS rates and the rate of return to the same competitive level. While professional athletes achieve high RTS rates (75%–100%), only approximately 59% to 65% successfully resume their prior level of performance (M. P. Reiman et al., 2016), (P. Sedrak et al., 2021). Professional athletes demonstrate higher RTS rates than amateurs, a trend attributed to their extreme motivation, financial livelihood, and access to centralized, intensive rehabilitation (M. P. Reiman et al., 2016). However, performance outcomes are highly sport-specific; for instance, Major League Baseball (MLB) players often show the highest RTS rates and longevity, whereas National Football League (NFL) athletes, particularly linemen, face lower RTS rates and shorter careers due to the massive axial and torsional loads inherent in their positions (R. Nair et al., 2014), (S. V. Minhas et al., 2016).

4.3. The Necessity of Phased Rehabilitation

The success of surgical intervention is inseparable from the postoperative rehabilitation protocol. Traditional recovery advice often proves insufficient for the demands of elite sport. Modern evidence supports a four-phase framework that transitions from acute protection to power development (L. H. VanGelder et al., 2013). A critical component of this process is the education of the "hip hinge" strategy, which allows athletes to dissociate hip movement from lumbar movement, thereby protecting the operated disc from repetitive flexion stresses (L. H.

VanGelder et al., 2013). While the evidence for specific exercises is still evolving, high-certainty data indicates that supervised programs, including pilates, significantly improve functional status in athletes experiencing kinesiophobia (H. Yu et al., 2024), (T. Oosterhuis et al., 2014).

4.4. Prognostic Factors and Risk of Recurrence

Identifying risk factors for recurrence is vital for preoperative counseling. Athletes with a higher preoperative disc height and Modic changes are at a statistically higher risk for recurrent herniation because the segment remains dynamically unstable (M. E. Yaman et al., 2017). Additionally, a BMI ≥ 25 kg/m² and active smoking serve as significant predictors of poor outcome and recurrence (M. E. Yaman et al., 2017), (S. B. O'Connor et al., 2023). Interestingly, a recurrence does not necessarily preclude a professional career; revision discectomies in NFL linemen have shown successful RTP rates as high as 85.7% (S. B. O'Connor et al., 2023).

4.5. Surgery vs. Conservative Management

Finally, the choice between surgery and conservative care remains nuanced. Large-scale trials such as SPORT indicate that while surgery provides significantly faster pain relief and functional improvement in the short term, long-term results (up to 8 years) show substantial improvement in both groups (J. D. Lurie et al., 2014), (J. N. Weinstein et al., 2006). For the elite athlete, however, the "short-term" is often the most critical period of their career, making the faster resolution provided by surgery a compelling option when conservative measures fail after 6 weeks (S. B. O'Connor et al., 2023), (N. Kögl et al., 2024). Furthermore, clinical studies on massive disc herniations have shown that even giant LDHs (protrusions >50%) have a significant potential for spontaneous resorption, with an overall success rate of 84% for conservative management in selected cohorts (Z. Ma et al., 2021).

4.6. Limitations of Current Evidence

It must be noted that the current evidence base is predominantly composed of level III and IV studies, with a significant lack of randomized controlled trials (RCTs) specifically targeting the elite athletic population (P. Sedrak et al., 2021), (R. Nair et al., 2014). Furthermore, the heterogeneity in how "return to play" is defined across different leagues complicates the ability to reach high-powered, definitive conclusions (M. P. Reiman et al., 2016), (P. Sedrak et al., 2021). Future research should prioritize standardized outcome reporting and explore the long-term impact of emerging minimally invasive fixed procedures (EDF) on athletic career longevity.

5. Conclusions

Synthesized clinical evidence indicates that surgical intervention for lumbar disc herniation (LDH) in elite athletes facilitates a high overall return-to-sport (RTS) rate, typically ranging from 75% to 100% (R. Nair et al., 2014), (P. Sedrak et al., 2021). However, it is imperative for clinicians and athletes to distinguish between a general return to activity and a return to the exact pre-injury level of performance (M. P. Reiman et al., 2016), (P. Sedrak et al., 2021). Pooled estimates suggest that the rate of return to the same competitive level is notably lower, estimated at approximately 59% to 65% (M. P. Reiman et al., 2016), (P. Sedrak et al., 2021). Professional athletes often exhibit higher RTS rates than amateurs, driven by significant personal motivation, financial livelihood, and access to elite medical resources and intensive rehabilitation (M. P. Reiman et al., 2016).

The choice of surgical technique plays a decisive role in the speed of recovery and the timing of return to play (S. Kapetanakis et al., 2026). While microdiscectomy (MD) remains the clinical gold standard for symptomatic LDH in athletes, full-endoscopic procedures such as transforaminal endoscopic lumbar discectomy (TELD) have been shown to significantly accelerate the recovery timeline (S. Kapetanakis et al., 2026), (P. Sedrak et al., 2021). This advantage is primarily attributed to the minimally invasive nature of the endoscopic approach, which reduces paraspinal muscle trauma, limits the extent of epidural scarring, and preserves the osseoligamentous structures essential for athletic spinal stability (S. Kapetanakis et al., 2026).

Long-term success after surgery is inseparable from adherence to a structured, phased rehabilitation protocol (L. H. VanGelder et al., 2013). Effective programs transition through four clinical phases – from acute protection to the development of rotational power – focusing on core stabilization and "hip hinge" motor control strategies (L. H. VanGelder et al., 2013). Educating the athlete to dissociate hip movement from lumbar flexion is vital for protecting the operated segment from repetitive mechanical stress during high-level competition (L. H. VanGelder et al., 2013). Furthermore, supervised interventions, including Pilates, have demonstrated high-certainty evidence for improving immediate postoperative functional status, particularly in patients dealing with fear of movement (H. Yu et al., 2024).

The prognosis for an athlete is further influenced by individual biometrics and the specific demands of their discipline (R. Nair et al., 2014), (E. Albertazzi, 2025). High-impact and collision sports are associated with lower RTS rates and shorter post-surgical careers compared to non-contact sports like baseball (R. Nair et al., 2014). Anthropometric factors,

such as a higher Body Mass Index (BMI), increased height, or playing the position of center in basketball, serve as negative predictors for a successful return (M. E. Yaman et al., 2017), (S. V. Minhas et al., 2016). Additionally, radiological markers like high preoperative disc height or the presence of Modic endplate changes indicate latent instability and a higher risk of recurrent herniation (M. E. Yaman et al., 2017).

While large-scale trials demonstrate that long-term functional outcomes for surgical and conservative management often converge over an eight-year period, the decision for surgery in elite athletes is frequently justified by the need for rapid symptom resolution (J. D. Lurie et al., 2014), (J. N. Weinstein et al., 2006). For a time-limited professional career, the faster relief of radicular pain and disability provided by surgery can be the critical factor in preserving an athlete's livelihood (P. Sedrak et al., 2021). Nevertheless, due to the current predominance of level III and IV evidence and a lack of randomized controlled trials specifically targeting the elite athletic population, there remains a pressing need for standardized research and reporting of performance metrics to optimize treatment algorithms (P. Sedrak et al., 2021), (R. Nair et al., 2014).

Disclosure

Supplementary Materials

Not applicable.

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Declaration of use of artificial intelligence (AI)

Artificial intelligence (AI) tools were integrated into the manuscript preparation process solely to provide linguistic refinement and translation assistance, ensuring the work adheres to established academic English writing standards. These technologies functioned exclusively as assistive instruments under the continuous supervision of the human author. The primary creative and analytical components – including the review's conceptualization, the critical interpretation of scientific evidence, the categorization of prognostic risk factors, and the deduction of final clinical conclusions – were entirely determined and generated by the human researcher.

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