FLOWING BACK TO STABILITY: HYDROKINETOTHERAPY AND HUR PLATFORM EMPOWER ACHILLES TENDON REHABILITATION – A CASE STUDY

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Abstract: Achilles tendon rupture often requires surgical repair, making postoperative rehabilitation essential for restoring mobility and balance. Proprioception and balance exercises are vital for neuromuscular control and injury prevention. This case report examines the effects of incorporating water-based proprioceptive and balance training into the rehabilitation process to speed up gait recovery and postural stability. The patient underwent Achilles tendon repair and participated in a tailored hydrotherapy program utilizing the water environment for safe early-stage rehabilitation. Assessment methods included single-leg balance tests, weight distribution analysis, and knee flexion at 30° and 60°, monitored throughout recovery. Results showed that exercises focused on proprioception and balance led to a faster return to normal gait, with significant improvements in postural stability, weight-bearing capacity, and neuromuscular control compared to standard physiotherapy. The early implementation of these exercises shortened rehabilitation duration and enhanced functional outcomes while reducing re-injury risk. In conclusion, integrating water-based proprioceptive and balance training into postoperative protocols accelerates gait re-education and balance recovery, promoting safer and more efficient return to daily activities. This approach supports the routine use of multidisciplinary, individualized rehabilitation strategies for Achilles tendon injuries, ultimately improving patient outcomes and rehabilitation efficiency.

Keywords: *Achillean rupture, balance, proprioception, surgery, rehabilitation, hydrotherapy*

Introduction

Achilles tendinopathy is one of the most common musculoskeletal conditions identified in athletic settings, in addition to being identified in general settings. It has been epidemiologically documented that athletes have nearly a 24 % lifetime risk, with 18 % in those below 45 years (Kujala et al. 2005). Of particular concern is that Achilles tendinopathy affects about 6-17 % of running injuries, with regard to overall running injuries, while 7 % in military personnel have been identified to acquire such injuries (Milgrom et al. 2003, Fahlström et al. 2003, Lopes et al. 2012).

From an anatomical perspective, there are generally two different types of Achilles tendinopathies, which differ based on their location. Insertional tendinopathy affects the junction between the tendon and the calcaneus bone, while noninsertional, or mid-substance, affects the section of the tendon about 2-6 cm from its insertion on the calcaneus bone, in which there is less vascularity. It is generally observed that the rate of noninsertional tendinopathy is significantly higher, which is close to 75 % in total incidences. For those between 21-60 years, its overall rate per 1,000 is 2.35 for the Achilles tendon (de Jonge et al. 2011).

Approximately 24- to 45% of patients with chronic Achilles tendinopathy undergoing treatment will ultimately require surgical reconstruction, primarily involving tendon debridement with subsequent tendon reconstruction/repairs. More recently, there have been promising clinical results incorporating the 'suture bridge' method, resulting in four fix points for the tendon (Witt and Hyer et al., 2012, Greenhagen et al., 2013). If there is a need for supplementary structural support, FHL tendon augmentation has proved to be beneficial for optimal outcomes (DeOrio & Easley, 2008; Schon et al., 2013).

Ankle surgery is recommended for several reasons, including stabilization of a severe fracture, sometimes accompanied by a rupture of the ankle ligaments. Another condition that requires reconstruction is Achilles tendon rupture, as is the case with the subject presented in this article.

A key physical therapy approach after surgical reconstruction of the Achilles tendon is the neuromechanical aspects, and in particular proprioception or proprioceptive sense. This goal should be a standard priority, just like those regarding pain relief, decreased mobility deficit, and increased muscle strength in order to limit the persistence of functional limitations.

Improving balance may be one of the therapeutic goals as early as 2-3 weeks after surgery, in addition to the range-of-motion and strength-building exercise program (Ivins et al., 2006) that the patient should already be doing. It is recommended that isolated proprioceptive exercises to be included in the rehabilitation program after Achilles tendon reconstruction (Kaya et al., 2012).

Proprioceptive training should not be neglected in ankle injuries. The purpose of this case report is to provide some examples of functional and proprioceptive exercises applied after ankle structures surgery. The effects of exercises that specifically aim to increase the proprioceptive level can prevent future complains and injuries, maintain functionality, and provide an expanded connection between the brain, joint, and different ground surface.

Case presentation – Clinical and Diagnostic findings

Patient Information

A 63-year-old female, (Height: 167 cm, Weight: 69 kg, BMI= 24.2) presented to the Emergency Department (UPU) of Constanța County with left posterior ankle pain, functional impairment, and localized swelling following trauma.

Occupation: Retired

Clinical findings and diagnostic assessment

On admission, the patient exhibited classic signs of Achilles tendon rupture, including:

- Palpable gap over the Achilles region;
- Positive Thompson test;
- Loss of plantar flexion strength.

The diagnostic coding indicated:

- Injury of Achilles tendon;
- Unspecified place of occurrence of the external cause.

Secondary diagnoses included:

- Other disorders of electrolyte balance;
- Haemorrhage and hematoma complicating a procedure.

Therapeutic intervention

On August 6, 2025, surgical intervention was performed consisting of tenorrhaphy of the left Achilles tendon using the Krakow suture technique and postoperative hematoma evacuation.

Postoperatively, the patient received:

- Analgesic and anti-inflammatory therapy;
- Antibiotic prophylaxis;
- Anticoagulant therapy.

Follow-up and outcomes

The patient's hospital course was favourable.

She was discharged on August 7, 2025, with an improved general condition.

Discharge recommendations included:

1. Sterile wound dressing every 2 days or as needed;
2. Removal of sutures at 16–18 days postoperatively;
3. Avoidance of physical exertion or local trauma;
4. After 3 weeks of rest and only passive flexion starts rehabilitation procedures.

Materials and Methods

The patient started rehabilitation at Visa Med Clinic, Mamaia, Constanta, on October 1, 2025. Initially, the rehabilitation protocol recommended beginning therapy promptly after 3 weeks post-surgery. However, the patient delayed initiation and began approximately 8 weeks post-operation. At this stage, the patient was expected to walk independently without the aid of frames or crutches and to manage daily partially activities autonomously.

Based on these test results, an individualized hydrotherapy protocol was developed. This approach aimed to accelerate the rehabilitation process, focusing on gait retraining, postural re-education, balance restoration, and independence in daily activities. The hydrotherapy setting was chosen for its safe environment and the beneficial properties of water, including drainage, edema reduction, and decreased pain perception.

The HUR Balance Platform, utilized for assessments, and the specialized hydrotherapeutic pool facility collectively contribute to the academic rigor of the program.

Tests conducted:

a) Weight distribution test 15 centimetres leg width stance- bipodal position with eyes open and closed,

b) Squat weight distribution test – on 0° squat (bipodal position) / 30° squat / 60° squat /90° squat,

c) Romberg balance test on 30” period on single leg stance – left/right leg and capacity of loading,

d) Stability limits – controlled balance inclinations of the body in front/back/left/right directions, keeping the foots on the platform without the need for and additional step for rebalancing,

e) VAS Pain Scale – for all the test and movement performed.

Rehabilitation protocol

Table 1- International protocol timeline for Achilles Tendon surgery (Doral et.al. 2009).

0 – 3 weeks	**Range of motion:** 20 PF and 10 PD passively
3 – 6 weeks	In a supine position, full to neutral PF and DF neuromuscular exercises of the ankle. In a sitting position, extension of the knee. In a prone position, flexion of the knee and extension of the hip.
6 – 10 weeks	Resistance PD and PF exercises, eversion and inversion of the ankles. Standing on toes and heels. Ankle stretching exercises for calf, ankle, and toe muscles. Balance and proprioception exercises on different surface progressions from bilateral to unilateral. Controlled squats and lunge exercises. Controlled slow eccentrics versus body weight.
After 10 weeks	Start training accelerated walks, jogging and eccentric loading exercises, and physically demanding movements for daily activities

****Legend: PF- plantar flexion, PD- plantar dorsiflexion***

Table 2- Individualized hydrotherapy proprioception and balance protocol timeline for patient.

8-10 weeks	**Range of motion:** Start doing exercises in pool for gaining ROM, reduce de pain of the ankle joint, and training all the natural movements of the ankle (PF, PD, inversion, eversion) with and immersion level in water to shoulders line reducing the bodyweight eta. 90%. When walk on land the patient will use only one crutch. Kneipp cure in the end of every hydrotherapy session.
10-12 weeks	Neuromuscular exercises of the ankle, knees flexion and extensions, hips movements and start regaining the control of contractions for all muscles in lower extremity. Start using the resistance of the water for muscle conditioning. Controlled balanced movements, SL stances with ISO-hold contractions for support limbs with EO and EC. Controlled squats with different immersions level (Chest level, Hips Level), and lunges exercises. Passive PF and PD in hot water (34-36 degrees Celsius) for a light stretch to improve de ROM. Start to walk on land without crutches.
12-14 weeks	Balance and proprioception exercises, with plyometrics exercises applied bilateral and then to unilateral. Reduced immersion level (hip line) and do ISO hold on toes and heel. Swimming exercises on prone flotation position with different tempos execution to add more water resistance. Easy cardio-trainings to improve effort capacity.
After 14 weeks	Start using accelerated tempos on exercises and walking, a maximum immersion level on the hip line (50% bodyweight) for all exercises (ROM exercises, Balance and proprioception, plyometrics). Start using fins to add more resistance for swimming exercises. Full PF and PD passively and active stretches to the end of the sessions.

****Legend: SL- single leg , EC- eyes closed, ISO- isometric, ROM- range of motion, EO- eyes open***

The first table (table 1) presents an internationally recognized postoperative rehabilitation protocol for Achilles tendon surgery described by (Doral et al., 2009), which outlines a structured progression from early protected passive mobility (0–3 weeks, allowing approximately 20° plantarflexion and 10° dorsiflexion) to neuromuscular activation in non-weight-bearing positions (3–6 weeks), followed by active strengthening, proprioceptive training, controlled squats, lunges, and slow eccentrics (6–10 weeks), and ultimately accelerated walking, jogging, **and increased eccentric loading after 10 weeks**; when integrating the second table (table 2) into this framework.

The individualized hydrotherapy protocol beginning at **8–10 weeks** aligns with the late strengthening phase of the international guideline by using shoulder-level immersion to regain range of motion with 90% body-weight reduction, initiating natural ankle movements (plantar flexion, dorsiflexion, inversion, eversion), walking on land with one crutch, and applying Kneipp therapy, while the **10–12-week** stage overlaps with the early functional loading period by introducing neuromuscular re-education of the ankle, knee, and hip through water resistance, single-leg stance isometric holds with eyes open or closed, controlled aquatic squats and lunges at varying immersion depths, passive Plantar flexion/Dorsiflexion in warm water for range of motion optimization, and the transition to full walking without crutches.

The **12–14-week** phase corresponds to the advanced proprioceptive and early plyometric period of the international protocol through reduced immersion to hip level, bilateral-to-unilateral plyometric drills, isometric holds on toes and heels, swimming-based resistance work, and introductory cardiovascular conditioning, while the **post-14-week** period mirrors the international "after 10 weeks" functional progression by increasing walking and exercise tempos, maintaining hip-level immersion (~50% bodyweight), adding swim fins for higher resistance, and performing full active and passive Plantar flexion/Dorsiflexion stretching at the end of each session, resulting in a hydrotherapy-supported timeline that follows the same biological and functional milestones established in the standard orthopaedic guideline.

Table 3 provide a summary of therapeutic objectives for the individualized protocol used, structured by intervention domain, clinical level, goal, physical therapy exercise type, and operational notes.

Table 3. Individualized protocol structure with objectives (example).

Domain	Initial Level	Goal	Type of Exercise	Operational Notes
Joint mobility	Limited ROM and pain on ankle joint. Light pain on hip joints and limited abduction.	Increase range in dorsiflexion, plantar flexion, inversion and eversion. Hip joint full abduction.	Slow exercises with support and pause at end ROM. Controlled squats, lunges.	Monitor pain, frequency, breathing
Static balance	Marked instability on ankle joint, instability feeling on left knee joint.	Improve postural control in stillness, single leg stance, and for stairs walk.	Walking with support and direction variation. Functional training with obstacle and stairs simulations.	Intensify only after visual adaptation
Muscle strength	Quadriceps weakness. Glutes weakness, and gastrocnemius and solear muscles weakness.	Isometric then active strengthening	Partial weight-bearing contractions	Avoid concentrated loads
Breathing	Reduced thoracic excursion	Expand diaphragmatic breathing	Expansions with prolonged exhalation	Avoid apnea and hyperventilatio n
Water autonomy	Partial autonomy with insecurity	Improve safety and body management in water	Postural transitions and vertical recovery	Watch for panic and cold

Results

The first day of test was conducted on 01/10/2025, and the second test was conducted 17/10/2025. The tests were done using the HUR Balance Platform and HUR Ecosystem software.

The comparative analysis between the initial and follow-up testing sessions (Table 4 and Table 5) demonstrates substantial functional improvement following the implementation of the hydrotherapy program. During the first assessment, the patient exhibited marked asymmetry in load distribution across all squat angles (0°, 30°, and 60°), with the right limb consistently bearing a higher proportion of body weight. These asymmetries were accompanied by elevated pain levels, with VAS scores ranging from 7 to 9, and the patient was unable to perform the 90° squat due to movement limitations.

Table 4 **–** Test result Weight distribution tests with feet stance at 15 centimetres width with eyes open and close.

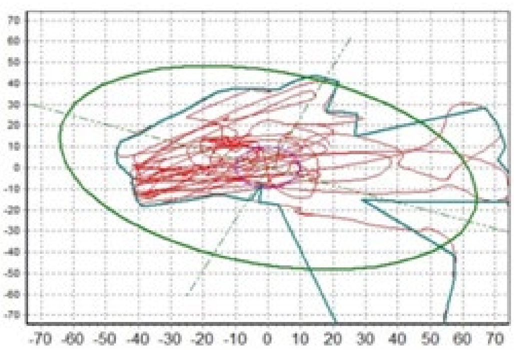
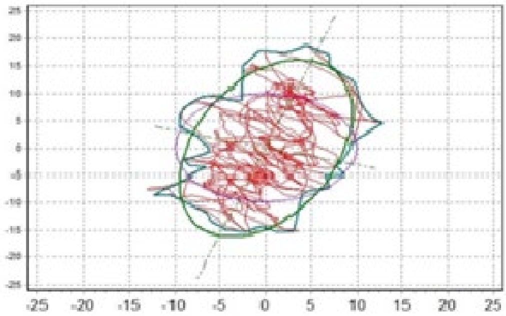
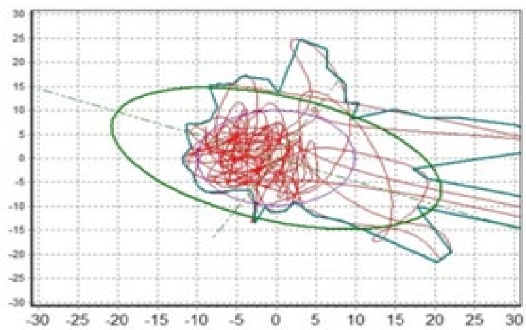
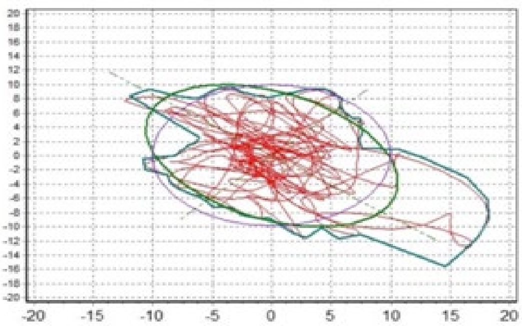
	Weight distribution Eyes Open	Weight distribution Eyes Closed
First test	*Left:* 46.79% *Right:* 53.21% *VAS:7*	*Left:* 47.42% *Right:* 52.58% *VAS:7*
Second test	*Left:* 50.79% *Right:* 49.21% *VAS: 0-1*	*Left:* 50.99% *Right:* 49.01% *VAS:0-1*

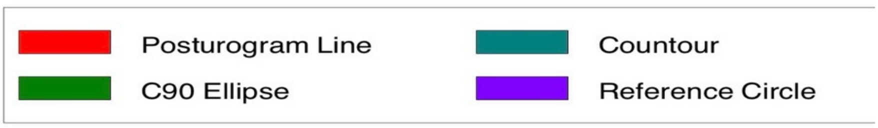
Table 5 **–** Test result Squat weight distribution test – on 0° squat (bipodal position) / 30° squat / 60° squat / 90° squat.

	0º Squat	30º Squat	60º Squat	90º Squat
First test	*Left:* 46.79% *Right:* 53.21% *VAS: 7*	*Left:* 44.09% *Right:* 55.91% *VAS:8*	*Left:* 44.96% *Right:* 55.04% *VAS:9*	*Not conducted due incapacity of movement*
Second test	*Left:* 50.79% *Right:* 49.21% *VAS:0-1*	*Left:* 47.46% *Right:* 52.54% *VAS:2-3*	*Left:* 49.56% *Right:* 50.44% *VAS:5-6*	*Left:* 49.12% *Right:* 50.88% *VAS:7-8*

In contrast, the second testing session revealed a clear normalization trend in limb loading patterns. Bilateral weight distribution became significantly more symmetrical across all tested angles, with differences narrowing to within 1–3 %. Concurrently, the patient reported a substantial reduction in pain, with VAS scores decreasing to 0–1 at 0°, 2–3 at 30°, 5–6 at 60°, and 7–8 at 90°, indicating improved tolerance to deeper flexion. Notably, the patient was able to successfully perform the 90° squat during the second assessment, reflecting enhanced mobility, strength, and neuromuscular control.

Table 6 – Test result Romberg balance test on 30” period on single leg stance – left/right leg and capacity of loading.

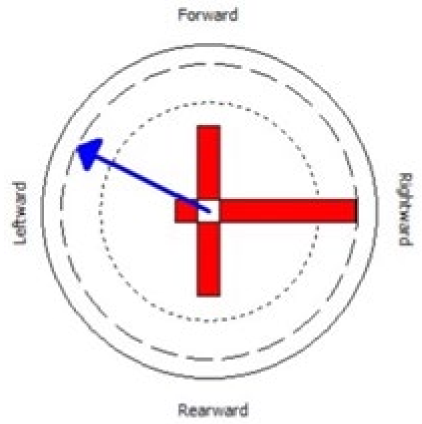
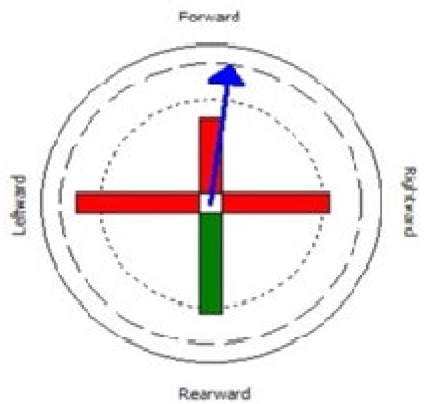
ITEM	Left leg single stance	Right leg single stance	Test diagram
First test	*Left: 64.02 %* *Right: 35.98%* *(not able to maintain single leg stance always styed with the leg as second point of support)* *VAS:8 (ankle joint pain)*	*Left:70.70%* *Right:29.30%* *VAS:0*	*Left:*  *Right:* 
Second test	*Left:71.71%* *Right:28.29%* *VAS:8 (ankle join paint)*	*Left: 42.21%* *Right:57.79%* *VAS:6 (right knee pain)*	*Left :*  *Right:* 



**Legend: Lines meaning*

In the first evaluation, the diagrams revealed widely dispersed radial lines extending beyond the circular perimeter, indicating significant postural oscillations caused by impaired balance and an overreliance on compensatory strategies to maintain stability (table 6). These deviations correlate with the patient's inability to hold a consistent single-leg stance on the right side and with elevated VAS pain scores, particularly at the ankle joint. The asymmetrical loading patterns, with the left limb bearing a markedly higher proportion of weight, further reflect the patient's compromised neuromuscular control during the initial test. In contrast, the second assessment illustrates a clear improvement. The radial lines in the diagrams are more centrally clustered, forming a tighter, more uniform circular pattern. This demonstrates enhanced balance, reduced sway, and a more efficient postural stabilization strategy. Although some lines still approach or slightly breach the perimeter—suggesting episodic imbalance—the overall reduction in amplitude signifies a meaningful increase in the patient's equilibrium and proprioceptive integration. Correspondingly, the patient exhibited improved single-leg stance performance, a more balanced distribution of load between limbs, and lower pain levels, especially at the knee and ankle.

Table 7 **–** Test result Stability limits – controlled balance inclinations of the body in front/back/left/right directions, keeping the foots on the platform without the need for and additional step for rebalancing.

	Forward lean	Backwards lean	Left lean	Right lean	Diagram
First test	3.73	3.81	1.12	5.98	
Second test	3.94	5.35	5.58	5.48	

*** Legend: Blue arrow meaning:*** **Weakest direction**

The comparison between the first and second Limits of Stability tests indicates substantial improvement in the patient's multidirectional postural control. In the **forward direction**, stability increased from 3.73 to 3.94, representing an improvement of approximately **5.6 %**.

The **backward inclination** demonstrated an even more pronounced enhancement, rising from 3.81 to 5.35, corresponding to a **40.4 % increase**, indicating a markedly improved ability to control posterior sway. The most significant progress occurred in the **left direction**, where stability increased from 1.12 to 5.58—an exceptional improvement reflecting a dramatic recovery of lateral postural control. Stability in the **right direction** also improved, increasing from 5.98 to 5.48, a slight change amounting to approximately **8.4 %**, still reflecting a more controlled and symmetrical lateral balance profile.

These improvements are clearly reflected in the evolution of the stability diagram, where the second test shows a more balanced and symmetrical reaching pattern with reduced dominance of the weakest direction (previously indicated by the blue arrow). The patient demonstrates greater ability to shift the center of mass toward all four boundaries without requiring compensatory steps for rebalancing, highlighting improved neuromuscular efficiency.

Discussion

Such progress strongly underscores the therapeutic value of **hydrotherapy**, which provides a controlled environment where buoyancy reduces joint loading while water resistance enhances neuromuscular activation. This allows the patient to practice safe yet challenging weight-shifting tasks essential for restoring balance. Additionally, **neuro-proprioceptive training**, integrated throughout the rehabilitation process, played a central role in refining postural reactions, enhancing sensory–motor integration, and improving the patient's capacity to anticipate and control body sway.

The combined use of hydrotherapy and proprioceptive neuromuscular training has yielded measurable gains in stability across all directions, demonstrating their critical role in restoring functional balance and reducing instability-related risks.

The next stage after surgical reconstruction of the Achilles tendon has as its central element the active physiotherapy, instituted early to obtain post-tibial/medial stabilization and peroneal/lateral stabilization.

The effects of prolonged immobilization with a rigid plaster cast or orthosis can produce major muscle atrophy of the injured lower limb, joint stiffness and especially loss of proprioception. The role of postoperative immobilization should not be denied, but the therapist must know the difference between the effects of immobilization and unloading or non-weight bearing of the limb structures, these concepts do not have synonymous purposes in the therapeutic plan.

It has been shown that during the postoperative healing process, early mobilization improves the level of collagen in the tendon, decreases the risk of adhesions in the muscles that are located in the vicinity of the tendon (Sorrenti, 2006; James et al., 2008).

In the case of identical surgical interventions, compared to continuous postoperative immobilization, early mobilization of the surgically reconstructed tendon results in a faster restoration of the functional properties of the tendons (Pneumaticos et al., 2000). Sorrenti (2006) reported positive results in 64 patients with Achilles tendon ruptures who were treated surgically and in whom mobilization was applied early.

In the immediate postoperative stage, there is a risk of damage to the operated tendon and for this reason eccentric exercises should be avoided. For ankles this type of training can be applied 8 weeks postoperatively and to minimize the risks due to immobilization the use of hydrotherapy can be a good option. Water and its pressure reduce the adverse effects of eccentric contraction especially in the early stages of ankle joint rehabilitation. Neuromuscular rehabilitation in the aquatic environment is an optimal solution for patients who require joint protection, while ensuring rapid functional recovery (Aphale et al., 2024).

Proprioception is the result of the central integration of sensory signals, helps us feel muscle movements, is directly involved in maintaining total posture (postural balance of the body) or segmental (joint stability). Proprioceptors located in multiple structures such as muscles, tendons, ligaments and other soft tissues of the body transmit signals that, when analysed by central nervous system, underlie the kinesthetic sense of joint position, tissue pressure and muscle stretch (Feuerbach et al., 1994).

An injury to the anatomical structures of the ankle disrupts the functions of these proprioceptors. In the case of an optimal proprioceptive sense, it will facilitate neuromuscular control during dynamic movements essential for joint stability with the

guarantee of the integrity of the joint component structures.
For this reason, functional and proprioceptive exercise training could make significant contributions to increasing ankle stability by maintaining and improving neuromuscular control.
An isolated proprioceptive training protocol is usually structured on three essential pillars: sensory reeducation of the joints, postural stability (balance) and optimization of neuromuscular control. (Irrgang & Neri 2000; Eils & Rosenbaum, 2001). Proprioceptive exercise programs vary in terms of methodology or duration of application, intensity of effort, but protocols report similar results in decreasing ankle sprain recurrence, decreasing muscle response time, and increasing proprioception (Kynsburg, 2006; Mohammadi, 2007).

The central element of therapy programs for subjects with ankle instability should be, according to Tedeschi et al. (2024) programs of exercises that improve balance and proprioception because this type of approach improves both balance and functional stability. This approach is essential because it simultaneously optimizes postural control and functional stability of the joint.
Although the benefits are clear, the ideal “recipe” in terms of duration and specific mix of exercises remains to be found in future research (Jastifer, 2025).
An injury to the anatomical structures of the ankle disrupts the functions of proprioceptors. In the case of an optimal proprioceptive sense, neuromuscular control is facilitated during dynamic movements that are essential for joint stability with the guarantee of the integrity of the component structures.

Conclusion

This case underscores the significant benefits of incorporating a hydrotherapy program, emphasizing proprioception and balance training, into the rehabilitation of patients following Achilles tendon rupture repair. The integration of water-based exercises, coupled with precise, data-driven assessment via the HUR Balance Platform, not only facilitated improved weight distribution and postural stability but also demonstrably accelerated the patient's return to functional independence. The objective metrics, including weight distribution symmetry, enhanced Romberg balance scores, and expanded stability limits, provide compelling evidence of the patient's progress in regaining neuromuscular control and confidence. Despite the initial delay in commencing rehabilitation, the individualized hydrotherapy protocol effectively addressed the patient's specific deficits and limitations, leveraging the unique properties of water to promote healing and functional restoration. These findings advocate for the adoption of targeted, multimodal hydrotherapy approaches as a cornerstone of rehabilitation strategies for patients recovering from Achilles tendon surgeries, offering the potential to optimize outcomes, minimize recovery time, and enhance long-term functional success. In contemporary rehabilitative science, aquatic therapy represents a uniquely advantageous medium, particularly for elderly individuals, whose functional reserves and articular integrity are often compromised by age-related degenerative processes. The intrinsic buoyancy of water substantially reduces gravitational load, thereby diminishing joint compression forces and enabling controlled movement patterns that would otherwise be painful or mechanically unsafe on land. Simultaneously, the fluid’s hydrostatic pressure enhances circulatory dynamics and proprioceptive feedback, facilitating more efficient neuromuscular recruitment during therapeutic exercise. Moreover, the viscosity of water provides a gentle yet continuous resistance, supporting progressive strengthening without imposing excessive mechanical stress on vulnerable joints. Collectively, these properties position water-based rehabilitation as a profoundly effective and scientifically justified modality for promoting mobility, mitigating discomfort, and preserving musculoskeletal function in the aging population.

Author contributions

All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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