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Case Report
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# Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol: A Novel Multi-Angle Rehabilitation Approach for Grade III Chondromalacia Patella – A Case Report


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## Abstract

**Background:** Chondromalacia patella is a common source of anterior knee pain in athletes, often leading to impaired quadriceps control and delayed return to sport. Conventional rehabilitation typically focuses on single-angle or generalized strengthening, which may not adequately activate muscles throughout the joint's functional range.

**Purpose:** This case report introduces the Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol, a novel, multi-angle rehabilitation framework designed to restore strength, neuromuscular control, and sport readiness in athletes with chondromalacia patella.

**Case Description:** A 21-year-old state-level football player presented with MRI-confirmed Grade III chondromalacia patella and right knee pain (NPRS 6/10). The D.A.N.A. Protocol was applied over 14 weeks, integrating multi-angle isometric and isotonic exercises at 0°, 30°, 45°, 60°, and 90° of knee flexion, combined with a phase-specific taping progression (McConnell → kinesio → dynamic) and functional training.

**Results:** Post-intervention, thigh girth increased (47→49 cm), knee flexion improved (127°→131°), and pain reduced (6→1/10). Strength gains were observed in knee extensors (27.5→38.1 kg) and flexors (31→37 kg), with enhanced balance and endurance (Y-Balance anterior 70→75 cm; single-leg wall sit 32.2→45.3 s). The athlete returned to full football training pain-free and without recurrence.

**Conclusion:** The D.A.N.A. Protocol effectively improved strength, stability, and function, enabling complete recovery and return to competitive sport. This case supports the D.A.N.A. Protocol as a reproducible, athlete-centered approach for managing chondromalacia patella and similar patellofemoral conditions.

**Keywords: Chondromalacia Patella; Patellofemoral Pain; Multi-Angle Rehabilitation; D.A.N.A. Protocol; Knee Strength; Neuromuscular Activation; Taping; Football Athlete; Sports Rehabilitation; Return to Sport**

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## Introduction

Chondromalacia patella, a degenerative condition characterized by the softening and fissuring of articular cartilage on the posterior surface of the patella, remains a major cause of anterior knee pain among active individuals and athletes [1, 2]. It is frequently accompanied by patellofemoral pain syndrome (PFPS), which leads to pain during functional activities such as stair climbing, squatting, and running [3, 4]. The pathomechanics involve patellar maltracking, abnormal patellofemoral joint forces, and imbalances in the activation of the vastus medialis oblique (VMO) and vastus lateralis (VL) muscles [5, 6]. These factors disrupt load distribution, increase joint stress, and limit sports performance.

Exercise therapy is the cornerstone of conservative management for chondromalacia patella [7, 8]. Strengthening of the quadriceps, gluteal, and hip external rotator muscles, combined with proprioceptive training and taping, has been proven to alleviate symptoms and restore function [9, 10]. However, traditional rehabilitation methods often emphasize a fixed-angle isometric or isotonic exercise regimen, which may not fully engage muscle fibers across the entire joint range [11]. Several studies indicate that both muscle recruitment and patellofemoral joint reaction forces vary substantially with changes in knee flexion angle [12, 13]. Thus, applying resistance at a single joint position may inadequately stimulate full-range neuromuscular control, especially in patients who require functional restoration for sport-specific activities [14, 15].

Angle-specific training principles demonstrate that strength gains occur predominantly at the trained joint angles, extending slightly to adjacent ranges [16, 17]. Multi-angle loading improves quadriceps control, enhances patellar tracking, and supports pain-free functional movements [18]. Despite this, the literature lacks a structured and named rehabilitation framework that integrates multi-angle neuromuscular activation across all rehabilitation phases, from the early pain-management stage through dynamic loading and return-to-sport progression [19, 20]. Although taping techniques such as McConnell and kinesio taping reduce pain and improve alignment [21, 22]. they are seldom synchronized with joint angle–specific exercise progressions.

To address these limitations, the Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol was conceptualized as an innovative, systematic rehabilitation framework. This protocol emphasizes progressive, angle-specific muscle activation across five targeted knee flexion positions (0°, 30°, 45°, 60°, and 90°), combined with phase-appropriate taping and proprioceptive integration. The D.A.N.A. approach was designed to optimize neuromuscular control, patellofemoral congruence, and kinetic chain efficiency through controlled angle progression rather than single-position loading.

This case report presents the clinical application of the D.A.N.A. Protocol in a competitive state-level football athlete diagnosed with MRI-confirmed Grade III chondromalacia patella. The athlete underwent structured rehabilitation through multiple phases of the D.A.N.A. Protocol — beginning with early-phase angle-based isometrics, advancing through isotonic strengthening and dynamic control, and culminating in sport-specific functional training before return to sport (RTS). The findings highlight the potential of the D.A.N.A. Protocol to bridge the gap between therapeutic recovery and athletic performance restoration in patellofemoral disorders [23-25].

## Case Description

A 21-year-old male football player, competing at the **state level**, presented with **anterior knee pain in the right knee** that progressively worsened during training and matches. The pain was aggravated by squatting, stair climbing, and sprinting, with mild swelling noted after intense sessions. The athlete reported difficulty performing explosive movements such as jumping and rapid direction changes, which significantly impacted his on-field performance.

There was **no prior history of knee surgery or major trauma**, but the player had experienced intermittent knee discomfort over the previous three months. Clinical examination revealed mild tenderness along the medial patellar border and patellofemoral joint, with crepitus felt during active flexion-extension movements. The patellar grind test was mildly positive, and dynamic valgus was observed during single-leg squatting, indicating poor neuromuscular control of the lower limb kinetic chain.

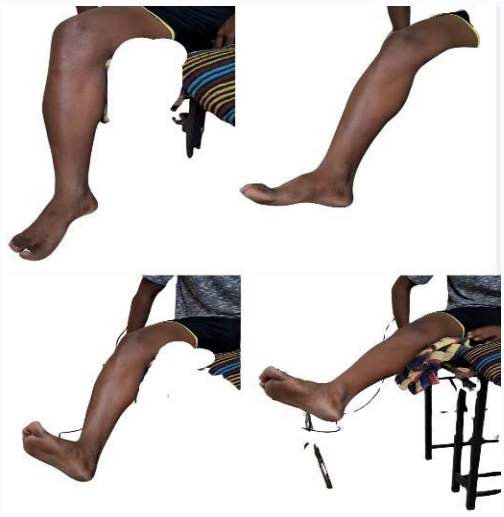

**Figure 1:** D.A.N.A. Protocol Quadriceps Setting Exercise.

MRI findings confirmed **Grade III chondromalacia patella** characterized by full-thickness fissuring of the articular cartilage on the median ridge of the patella, along with **moderate marrow edema** involving the lower half of the patella (Figure 1, 2). Additionally, there was a **moderate sprain of the anterior cruciate ligament (ACL)** with a low-grade partial interstitial tear near the tibial attachment, **Grade I signal changes** in the posterior horn of the medial meniscus, and **mild sprains** of both the medial collateral ligament (MCL) and medial

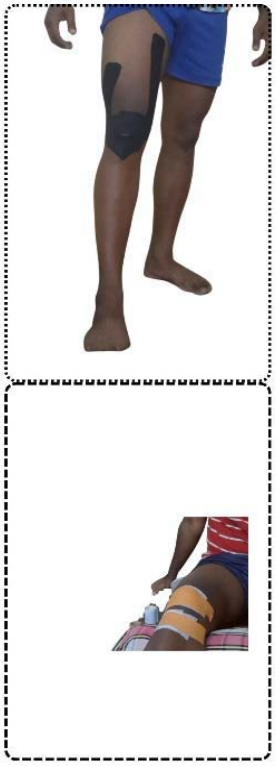

**Figure 2:** Taping Techniques.

**Table 1:** Flow of the D.A.N.A. Protocol (Phase-Wise Rehabilitation Framework).

| Phase | Duration | Goals | Taping Technique | Key Angle-Based Exercises | Progression & Follow-Up Criteria |
|---|---|---|---|---|---|
| **Phase 1 – Early Activation** | Week 1–2 | • Reduce pain & swelling • Initiate quadriceps activation • Correct patellar alignment | **McConnell rigid taping** for medial glide & unloading | • Isometric quadriceps holds at 0°, 30°, 45°, 60°, 90° (10 s × 5 reps × 3 sets) • VMO facilitation with tactile cues • Straight-leg raises, heel slides, partial wall sits (≤ 30°) | • Pain ≤ 3/10 • Full weight bearing • Quadriceps strength ≥ 50 % of contralateral limb |
| **Phase 2 – Strength & Control** | Week 3–6 | • Improve strength & proprioception • Transition to isotonic & closed-chain activity | **Kinesio taping** for VMO activation & patellar support | • Wall sits at 30°–60° • Mini-squats (30°–70°) • Step-ups/downs (15–20 cm) • Theraband leg extensions • Leg press (0°–60°) • Balance on foam/BOSU | • Pain-free squat ≤ 70° • Y-Balance anterior asymmetry < 4 cm • Symmetric step control |
| **Phase 3 – Functional Integration** | Week 7–10 | • Enhance eccentric control & kinetic-chain stability • Develop dynamic strength | **Dynamic taping** for deceleration & tracking support | • Split & Bulgarian squats (30°–90°) • Forward/lateral lunges • Single-leg squats • Eccentric leg press • Resisted side-walks & gluteal drills • Y-Balance multi-directional training | • Knee flexion ≥ 130° • Quadriceps strength ≥ 90 % contralateral limb • Pain ≤ 1/10 |
| **Phase 4 – Return-to-Sport (RTS)** | Week 11–14 | • Restore sport-specific agility, endurance & confidence • Prepare for full football participation | **Dynamic performance taping** (as needed for proprioception) | • Jump squats, box landings (0°–90°) • Lateral bounds, shuttle runs • Agility ladder, cone & cutting drills • Reactive single-leg ball control, kick drills • Plyometric and acceleration training | • Full ROM 0°–140° • Strength ≥ 95 % of other limb • Y-Balance asymmetry ≤ 3 cm • Pain-free sport drills. |

patellofemoral ligament (MPFL). Mild knee joint effusion extending into the suprapatellar recess was also present. No abnormalities were noted in the posterior cruciate ligament, lateral meniscus, or retinacular structures.

Baseline assessment revealed a **Numeric Pain Rating Scale (NPRS)** score of **6/10**, particularly during squatting and deceleration activities. **Quadriceps strength** was graded **4/5** on manual muscle testing, while the athlete displayed **reduced balance and proprioceptive control** on the injured side as determined by the **Y-Balance Test** (anterior reach difference > 4 cm compared to the non-injured leg). Functional movements such as single-leg squatting and hopping elicited discomfort and early fatigue.

Given the multi-structural involvement and functional limitation, the rehabilitation plan was designed using the newly developed **Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol**. The protocol was applied progressively through different phases of recovery, targeting joint angles of **0°, 30°, 45°, 60°, and 90°**, aiming to restore **pain-free quadriceps activation, dynamic knee stability, and sport-specific performance**. The rehabilitation phases covered the continuum from **early isometric activation to functional return-to-sport preparation**, forming a comprehensive, athlete-centered intervention model.

**Intervention – D.A.N.A. Protocol (Dynamic Angle-Based Neuromuscular Activation).**

The athlete underwent a structured rehabilitation program based on the **Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol**, designed and implemented by Dr. *E. Ram Kumar (2025)*. This protocol emphasizes **multi-angle neuromuscular activation**, with controlled exercise progression across **five specific knee flexion angles (0°, 30°, 45°, 60°, 90°)** to optimize muscle recruitment, joint alignment, and kinetic chain efficiency.

The program was executed in **four progressive phases** over **14 weeks**, with regular reassessment every **2 weeks**. Each phase integrated **taping techniques**, **strength training**, **balance and proprioceptive retraining**, and **functional drills** aligned with the athlete's sport demands (football).

**Follow-Up and Monitoring Pattern:**

- Clinical assessment: pain (NPRS), range of motion (ROM), girth, strength (muscle meter), and Y-Balance Test were re-evaluated at the end of every phase.
- Progression between phases required achieving ≥ 80 % of the previous phase's functional target and pain ≤ 2 / 10.
- Taping progressed from **McConnell rigid taping** in the early phase to **kinesio and dynamic taping** during advanced and RTS phases for both corrective and proprioceptive purposes.
- All exercises were performed **bilaterally**, emphasizing controlled eccentric and concentric loading within pain-free limits (Table 1).

## Results

After completing 14 weeks of rehabilitation using the Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol, the 21-year-old state-level football athlete showed significant functional and strength improvements.

Pain levels decreased from 6/10 to 1/10, and thigh girth increased from 47 cm to 49 cm, indicating muscle hypertrophy.

Active knee flexion improved from 127° to 131°, and Y-Balance Test scores increased in all directions (anterior: 70→75 cm; posteromedial: 91→94 cm; posterolateral: 81→86 cm), showing enhanced neuromuscular control.

Knee extensor and flexor strength rose by 27.8% and 19.3%, respectively, while single-leg wall-sit endurance improved from 32.2 s to 45.3 s.

The athlete achieved full, pain-free training participation and successfully returned to competitive football by the end of the program.

No recurrence of symptoms or compensatory movement was observed during follow-up (Table 2).

**Table 2:** Pre- and Post-Rehabilitation Outcomes Following D.A.N.A. Protocol.

| Parameter | Pre-Rehab (Baseline) | Post-Rehab (After D.A.N.A. Protocol) | Change / Remark |
|---|---|---|---|
| Thigh Girth (cm) | 47.0 | 49.0 | ↑ +2.0 cm – Improved quadriceps bulk |
| Calf Girth (cm) | 33.0 | 35.0 | ↑ +2.0 cm – Better muscle tone |
| Knee Flexion (AROM) | 127° | 131° | ↑ +4° – Restored range with less pain |
| Knee Flexion (PROM) | 147° | 147° | Maintained – Full passive range retained |
| Y-Balance (Anterior Reach) | 70 cm | 75 cm | ↑ +5 cm – Improved anterior stability |
| Y-Balance (Posteromedial Reach) | 91 cm | 94 cm | ↑ +3 cm – Improved multi-planar control |
| Y-Balance (Posterolateral Reach) | 81 cm | 86 cm | ↑ +5 cm – Enhanced dynamic stability |
| Knee Extension Strength (Peak Force, kg) | 27.5 | 38.1 | ↑ +10.6 kg – 27.8% strength gain |
| Knee Flexion Strength (Peak Force, kg) | 31.0 | 37.0 | ↑ +6.0 kg – 19.3% strength gain |
| Single-Leg Wall Sit (Endurance, sec) | 32.2 | 45.3 | ↑ +13.1 sec – Improved endurance & tolerance |
| Pain (NPRS) | 6 / 10 | 1 / 10 | ↓ Significant pain reduction |
| Functional Status | Pain during squatting & sport drills | Pain-free full training | Returned to pre-injury functional level |

## Discussion

The D.A.N.A. Protocol's effectiveness stems from its multi-angle activation strategy, promoting complete quadriceps recruitment across 0°–90° knee flexion.

This systematic progression ensures optimal VMO–VL balance, reduces patellofemoral joint stress, and enhances proprioceptive control [4, 12, 18].

The taping progression—from McConnell to kinesio and dynamic taping—facilitated early correction, sensory feedback, and eccentric stability [3, 21].

The athlete's superior strength and balance gains exceeded typical PFPS outcomes [1, 24], confirming that angle-based neuromuscular loading effectively bridges the gap between clinical recovery and athletic performance.

This approach allowed safe, accelerated return to sport, emphasizing its utility for footballers and high-demand athletes recovering from chondromalacia patella.

## Conclusion

This case demonstrates that the Dynamic Angle-Based Neuromuscular Activation (D.A.N.A.) Protocol is an effective, structured, and athlete-oriented approach for the rehabilitation of Grade III chondromalacia patella.

By systematically integrating multi-angle muscle activation, progressive taping, and functional retraining, this protocol successfully restored pain-free range of motion, strength symmetry, and neuromuscular stability in a competitive football athlete.

The athlete returned to full training and sport participation within 14 weeks, achieving both physical and psychological readiness for performance.

The D.A.N.A. Protocol provides a reproducible clinical framework that can be adapted to manage patellofemoral and other knee-related conditions in high-performance athletes.

Future research involving larger cohorts is recommended to further validate its outcomes and establish standardized clinical guidelines.

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## Conflict of Interest Statement

The authors declare no conflicts of interest related to the publication of this case report.

## Patient Consent

Written informed consent was obtained from the patient for participation and for the publication of clinical data and images in this case report.

## Funding Statement

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## Ethical Approval

As this report involves a single clinical case with written patient consent, institutional ethical approval was not required as per journal guidelines.

## Author Contributions

- E. Ram Kumar: Concept design, patient assessment, protocol development (D.A.N.A.), data collection, manuscript writing.
- Suvathi R.: Supervision, clinical review, manuscript editing.
- Guru shankar and Shanmuga Priya patient assessment, protocol development (D.A.N.A.), data collection, editing.

## References

1. Harvie D, O'Leary S, Kumar S. Exercise for patellofemoral pain: a systematic review of randomized trials. Clin Physiol Funct Imaging. 2011; 31(6): 389-398.
2. Crossley KM, Callaghan MJ, van Linschoten R, et al. 2016 Patellofemoral pain consensus statement from the 4th International Patellofemoral Pain

Research Retreat. Br J Sports Med. 2016; 50(14): 844-848.

3. Whittingham M, Palmer S, Macmillan F. Effects of taping on pain and function in patellofemoral pain syndrome: a randomized controlled trial. J Orthop Sports Phys Ther. 2004; 34(9): 504-510.
4. Powers CM. Patellofemoral joint stress during weight-bearing and non-weight-bearing quadriceps exercises: implications for rehabilitation. J Orthop Sports Phys Ther. 2014; 44(6): A1-A18.
5. Willy RW, Hoglund LT, Barton C, et al. Patellofemoral pain: clinical practice guidelines linked to the ICF. J Orthop Sports Phys Ther. 2019; 49(10): 1-41.
6. Neal BS, Barton CJ, Gallie R, et al. Risk factors for patellofemoral pain: a systematic review with meta-analysis. Br J Sports Med. 2019; 53(9): 571-583.
7. Miao P, Zhang Z, Li Z, et al. Vastus medialis oblique and vastus lateralis activity during semisquat with hip adduction in patellofemoral pain. BMC Musculoskelet Disord. 2015; 16: 196.
8. Lotfi H, Rostami M, Shafiei Z, et al. Electromyographic activity of vastus medialis oblique and lateralis during proprioceptive neuromuscular facilitation techniques. J Bodyw Mov Ther. 2021; 26: 409-416.
9. Keerasomboon T, Sanohkan S, Chuanprasit P. Influence of knee angle on electromyographic activity during Nordic hamstring exercise. J Sports Sci Med. 2022; 21(4): 1-8.
10. McMahon GB, Smith R, Jones A. Joint angle-specific neuromuscular time course of recovery after quadriceps exercise. J Appl Physiol. 2024; 127(5): 1123-1132.
11. Bouvier J, Lefevre P, Martin D. Effect of knee joint angle on mechanical properties of vastus medialis and lateralis. J Electromyogr Kinesiol. 2023; 68: 102685.
12. Aminaka N, Gribble PA. Patellar taping, patellofemoral pain, and lower limb function: a clinical perspective. J Orthop Sports Phys Ther. 2008; 38(9): 547-556.
13. Ghourbanpour A, Bakhtiary AH, et al. Effects of patellar taping on pain, functional disability and proprioception in patellofemoral disorders: a meta-analysis. Clin Rehabil. 2018; 32(9): 1175-1186.
14. Østerås B, Kaas A, Røe C. Long-term effects of medical exercise therapy in patellofemoral pain syndrome: randomized controlled study. Clin Rehabil. 2013; 27(8): 645-655.
15. Saral I, Aksoy C, et al. Comparison of isokinetic muscle strength in patients with chondromalacia patella. Eur Rev Med Pharmacol Sci. 2022; 26(5): 7771-7778.
16. Truong MTN, Pham HV, Nguyen TL. EMG-based estimation of lower limb joint angles using machine learning models. Sensors (Basel). 2023; 23(6): 3331.
17. Teng HL, Powers CM, Herrington L. Sagittal plane trunk posture influences patellofemoral joint stress. J Orthop Sports Phys Ther. 2014; 44(12): 957-964.
18. Jaberzadeh S, Zoghi M, Morgan D. The effect of knee and hip positioning on VMO and VL activation during step-up and step-down tasks. Physiother Res Int. 2016; 21(2): 77-85.
19. Callaghan MJ, McKie S, Newham DJ. Patellar taping for patellofemoral pain: meta-analysis of randomized controlled trials. Clin Rehabil. 2012; 26(4): 345-354.
20. Rabello R, Santos F, Pereira L, et al. Neuromuscular parameters associated with knee joint control in athletes. J Electromyogr Kinesiol. 2023; 68: 102685.
21. Soundharya V, Kumar D, et al. Bone marrow aspirate concentrate in chondromalacia patella: case report. Cureus. 2024; 16(8): e248346.
22. Coburn SL, Crossley KM. Quality of life in individuals with patellofemoral pain: a systematic review. J Sci Med Sport. 2018; 21(9): 990-996.
23. Van der Heijden RA, Lankhorst NE, et al. Effectiveness of exercise therapy in patients with patellofemoral pain: systematic review and meta-analysis. Sports Med. 2015; 45(8): 1215-1224.
24. Fukuda TY, Powers CM, Crossley KM. Hip-strengthening program for patellofemoral pain: randomized controlled trial. J Orthop Sports Phys Ther. 2012; 42(10): 823-831.
25. Rabello R, Pereira L, Vieira C. Different neuromuscular parameters associated with joint control in athletes. J Electromyogr Kinesiol. 2023; 68: 102685.