BREAKING MOST OF THE RULES: A CASE STUDY

RETURN TO BREAKDANCING AFTER PARTIAL MENISCECTOMY

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INTRODUCTION

Breakdancing debuted as an Olympic sport in the 2024 Olympic Games in Paris. Entrance into the Olympic games brings attention to breakdancing, but also recognizes a 30+ year transition from a hip-hop subculture to an ultra-athletic and competitive sport. For the sports medicine community, recognition as an Olympic sport hopefully triggers funding towards event, medical, and rehabilitation support but also breaking-specific research.

Limited injury epidemiology is available regarding breakdancing.[1-4] The current literature is survey-based, with various methodologies, and differing results. Knee injuries are estimated to account for 17-62% of all breakdancing injuries.[1-3; 5] However, breaking has a culture of continuing to train and battle (Table 1) through injury.[5] This means there is likely significant under-reporting of injuries, and many breakers don't seek or have access to medical care.[1; 5] While it's impossible to capture the exact diagnoses of injuries, meniscal injuries are

Table 1

Breakers/Bboy/Bgirl	*Athletes that participate in breaking.*
Breaking	*The act of breakdancing*
Top Rock	*Dance moves performed on the feet, often involving variations on skipping and jumping movements*
Footwork (also known as Down Rock or Floor work)	*Movements on the floor supported by the hands or hands and feet*
Power Moves	*Movements that require speed, momentum and acrobatics, often performed on the floor, common examples are head spins or flares (similar to the gymnastics pommel horse)*
Flips	*Acrobatic motion where the hips pass over the head without the hands touching the ground, performed either forwards or backwards.*
Flares	*Movement similar to the pommel horse in men's gymnastics, however performed on the floor*
Battles	*A breakdancing competition*

Table 1: Terminology.

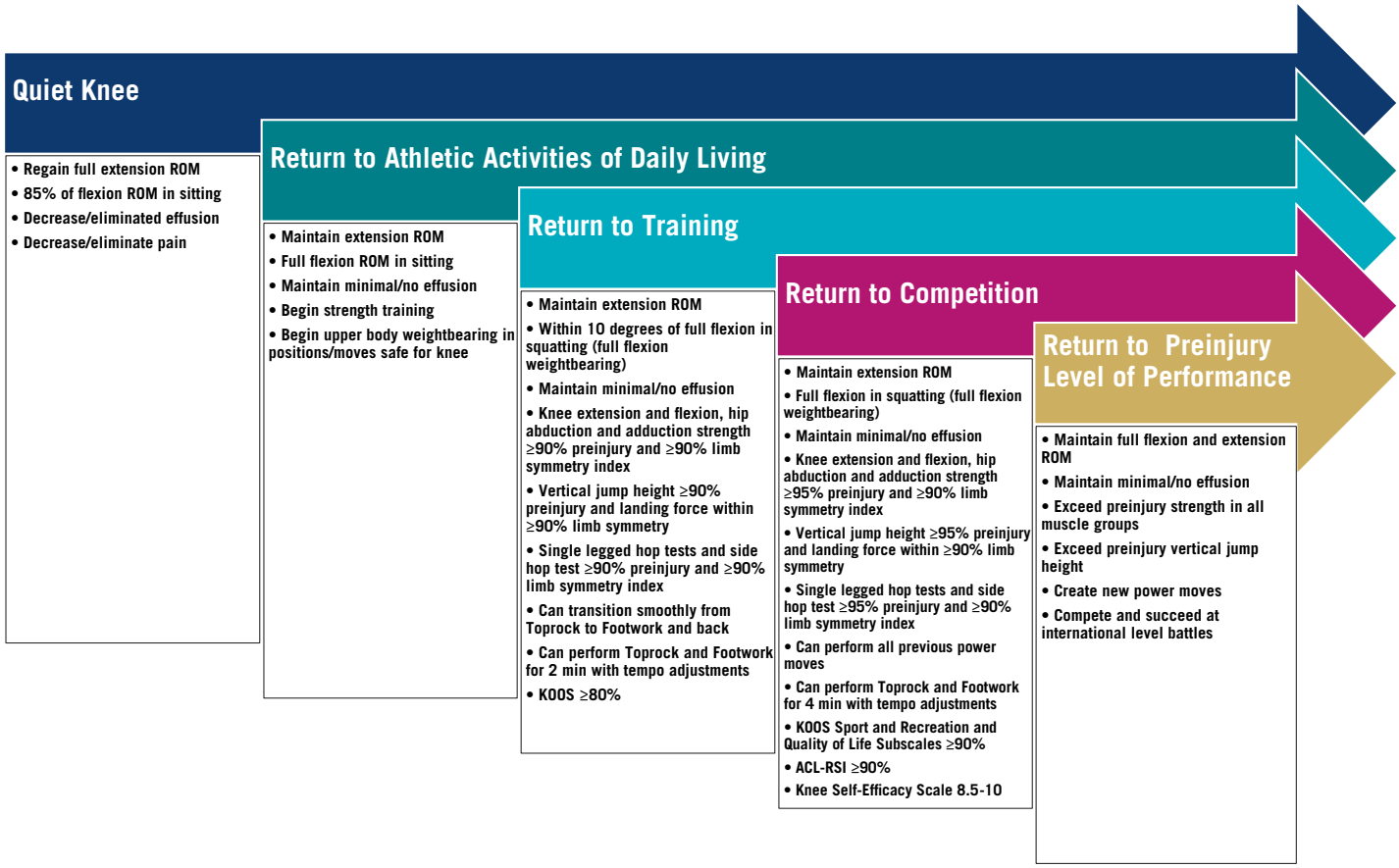

Figure 1: Return to Breaking Criteria.

likely common in breakdancing given the demands on the knee; including weight bearing in terminal flexion, large rotational forces, and high impact landings.

Very few clinicians/practitioners in elite sport are familiar with the demands of breaking. Given the paucity of literature it is difficult to create evidence-based rehabilitation plans for breakers. This case study explores the collaboration between an interdisciplinary team (IDT) and a breaker to build a successful rehabilitation after a partial meniscectomy. Generally, rehabilitation after partial meniscectomy is not considered complex, however given the demands of breaking the Bboy's leadership in this rehabilitation was integral to its success.

CASE

The Bboy was 26-years old and breaking since he was 9. He first qualified for the World Finals at age 15 and was considered a medal contender for the 2024 Olympics. The Bboy trained 5-6 hours per day, consisting of dynamic warm-ups, breaking, and stretching. His ideal was to train 5-6 days per week, however this varied based on his travel and battle schedule.

The Bboy had history of right patella dislocation (age 11) which was untreated but he had no subsequent issues. Around age 21, the Bboy began to experience the sensation of his right knee locking. When locked, his knee was painful and he was unable to flex or extend. He did not remember a single incident when the locking first started, but it happened infrequently. He reported that the first few times his knee locked it was painful and took a few days to 'unlock.' Each locking event would take a few weeks to recover from. However, over the years the locking became less painful and more frequent. He could unlock his knee by moving into hip internal rotation and tibial external rotation. His knee had not locked during competition, however over the months prior to this case his knee locked multiples times (sometimes > 10 times) per day during training.

DIFFERENTIAL DIAGNOSIS

The Bboy presented with large ranges of motion bilaterally (online supplementary Table 1). He had anterior laxity however a firm and symmetrical end feel with Lachman's test, and minimal laxity on varus and valgus stress tests. He had positive Thessaly's and McMurray's tests indicating involvement of the lateral meniscus. He had some tenderness along the lateral joint line, distal biceps femoris tendon, and proximal lateral gastrocnemius. He reported that when his knee first locked his distal biceps femoris and proximal lateral gastrocnemius would be very painful, however as the locking increased in frequency the pain in these areas decreased. He presented with hypermobile patella bilaterally, but no apprehension on either side. MRI confirmed a right lateral meniscus tear.

TREATMENT

Given the frequency of locking and functional impediment, surgical intervention was chosen. The athlete decided to undergo a partial lateral meniscectomy. His decision for a partial lateral meniscectomy over a meniscal repair was based on the small size of the tear, the faster rehabilitation timeline, and need to regain terminal flexion in weightbearing.

Table 2

Time	Goals	Milestones	Unique Aspects of Rehabilitation	Metrics
Week 0	Establish baselines	Surgery	Able to assess baseline measurements before surgery	
Week 1 At Rehab Center	Recover ROM Minimize effusion Quadriceps activation Gait training	Quiet knee and normal gait pattern	Guidelines: No breaking, handstands allowed Isometric knee extension done with and without neuromuscular stimulation* performed at full extension and 60 degree of knee flexion Isometric hip adduction was performed using isometric dynamometer**	Effusion, soreness, ROM, girth
Week 2 At Rehab Center	Use of upper extremity weightbearing positions and Footwork to facilitate knee ROM and mobility as well as strengthening/activation Reintroduce upper body power moves (flares and handstands)	Stitches removed Cleared for riding a bike and higher intensity activities based on the knee's response	Guidelines: Avoid plyometrics and in particular landing on right leg (falling or landings on left) Increased duration and load of isometric knee extension and increased duration of adductor loading Blood flow restriction introduced. Used in particular for quadriceps exercises, but also as part of wider strength and conditioning programming As Bboy was working 5 days a week in the rehab center and with many new training stimuli (endurance training, strength training, physiotherapy) weekends were focused on recovery with an easy bike ride outside on one day and one as a dedicated rest day for recovery	Effusion, soreness, ROM, girth
Week 3 At Rehab Center	Begin basic plyometrics Begin Breaking sessions	Began breaking	Guidelines: Only small pogos/basic plyometrics. Avoid high force jump landings, especially avoiding jumping and landing in > 90 degrees knee flexion, Increased load of isometric knee extension and adductor loading Breaking sessions, supervised by the physio, were introduced. These sessions were 3 times per week, with a day in between each for recovery and aimed at beginning to build Breaking specific training load. Toprock was used both to transition basic plyometrics into breaking, but also to begin building endurance. Fundamental movement components (such as squatting, planking, side planks, and bridging) were introduced by physio and followed by the Bboy expanding on those movements based on his repertoire.	Effusion, soreness, ROM, girth
Week 4 At Rehab Center	Increase volume and intensity of Breaking sessions, endurance, and strength and conditioning sessions Increase force during jumping Increase comfort landing bilaterally and unilaterally Begin breaking habit of avoiding right leg during harder tasks	First flip Began comfortably transitioning from Toprock to Footwork	Guidelines: Avoid jumping landing in > 90 degrees knee flexion Isometric adductor loading was transitioned to the Copenhagen Adductor Level II15 exercise Bboy given the option of going on a bike ride or going stand up paddleboarding over the weekend for his light recovery day Breaking sessions increased to 4x per week. Toprock continued to be used for endurance and plyometrics, but other jumping variations were also trialed	Effusion, soreness, ROM, girth
Week 5 At Rehab Center	Full knee flexion in squat Jumping and landing in greater knee flexion Stop avoiding right leg during sit-to-stand from ground (last movement where Bboy avoided right leg)	Return to training testing completed Began transitioning from Footwork back to Toprock	Guidelines: No restrictions Breaking sessions continued to be 4x per week, with Wednesday being a recovery day. IDT meeting with Bboy at end of his stay at the center to discuss experience, rehabilitation, results of testing, and planning for his return home.	Return to training criteria
Week 6+ At Home	Continue lifting Return to training Full flexion Comfort landing all previous tricks Comfort performing all previous tricks	Effusion: None Full flexion Maintain full hyper extension Flexion in Squat:	IDT checked in with athlete regularly. Plan in place for progression from Copenhagen Adductor Level II to Level III15 Bboy performed structured return to training plan, gradually building his hours Breaking back to his presurgery levels, but continuing with strength and endurance training.	Return to competition criteria

Table 2: Weekly goals, metrics, milestones and unique aspects of rehabilitation.

Rehabilitation was based at an elite performance center and the IDT supporting the Bboy included a physiotherapist, strength and conditioning coach, biomechanist, mental performance specialist, and nutritionist. Prior to surgery, baseline measures were assessed (online supplementary Table 2) and the Bboy outlined his goals and helped shape the rehabilitation criteria (Figure 1.). Rehabilitation criteria were compiled based on the evidence regarding partial meniscectomy[6] and anterior cruciate ligament reconstruction rehabilitation,[7] but were also tailored to the demands of breakdancing. In addition to returning to breaking, the Bboy's goal was begin building a healthier lifestyle.

The Bboy articulated a history of frequent consumption of takeaway meals, coupled with a desire to shift towards healthier eating habits. His reliance on takeaway food was largely attributed to his limited cooking skills and apprehension about cooking errors, particularly the fear of undercooking food, which could result in illness. The Bboy expressed a willingness to invest in kitchen appliances that could facilitate their cooking endeavors and indicated a need for instructional support in developing their culinary skills. The second segment of the nutritional assessment involved a guided visit to a supermarket, aimed at discussing the fundamentals of grocery shopping and identifying essential staples for a weekly shopping list.

A week prior to surgery the Bboy stopped smoking. Education regarding the impact of smoking on healing coupled with his dislike for the habit and goal of a healthier lifestyle lead him to abruptly stop.

The surgery had no complications or incidental finding. Day 1 post-op the Bboy began self-patella mobilization, quadriceps contractions, use of a GameReady (Avanos Medical Inc, Alpharetta, GA, USA) and compression boots (Lymphomat, BÖSL Medizintechnik, Aachen, Germany). He was discharged from the hospital without crutches on Day 2 and began physiotherapy on Day 3. Starting 7 days post-op, for the following 5 weeks, he had two physiotherapy and one strength and conditioning session each day (five days a week), as well as nutrition and mental performance sessions 2-3 times per week. The IDT met each morning to discuss the plan, which the Bboy then reviewed and when need be modified.

Table 2 elaborates on the goals of each week, the metrics used to evaluate progress, and aspects unique to this rehabilitation.

The Bboy had minimal effusion, no pain, and quickly regained non-weightbearing range of motion. Twelve days post-surgery, without thinking, the Bboy sat in a full weightbearing squat (a position that he used often in breaking and ADLs). He had pain in the position, however immediately used the GameReady, compression boots, wore a compression stocking overnight. He had no pain but minor effusion the following day limiting his flexion range of motion. Within two days, his range of motion and effusion normalized.

The Bboy and physio worked together throughout rehabilitation to deconstruct the fundamental components of breaking, implement them as appropriate, and then allow the Bboy to build upon those foundations (Table 2). For example, exclusively upper body activities, such as hand stands, that the Bboy could carefully control were deemed low risk and implemented early in rehabilitation. Flares (Table 1) require primarily upper body strength, but lower body control to slow or stop, were also deemed lower risk and implemented in week 2. Soreness and effusion guidelines were followed strictly as criteria for progression.[8; 9] The physio gradually introduced components of breakdancing movements such as squatting, weight bearing on hands and feet (both with hips facing downwards in movements such as bear walks, and with hip facing upwards in movements such as crab walks). In supervised training session the Bboy would then expand on these basic movements based on his breaking repertoire. For example, in week 3 small two footed and one footed hops/pogos as well as skips were introduced. These were

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quickly transitioned into TopRock. In week 4 plyometrics were advanced and upper body plyometrics were introduced. These movements were introduced in a controlled context, and then the Bboy was empowered to play with the movements transitioning them more into Footwork. Within each training session the Bboy was given guidelines and then allowed to explore within those restrictions. For example, in week 4 the guidelines were to avoid jump landing in >90° of knee flexion This allowed the Bboy to gain confidence in his knee, knowing he was supervised and the situation was controlled, and yet also feel that he could begin to rebuild his training routines and re-establish his repertoire of moves

Parallel to his physical rehabilitation, the Bboy also progressed towards his holistic health goal. Some of the mental performance techniques are elaborated in online supplementary Table 3. Nutritional support came in various forms. The nutritionist and Bboy had multiple cooking lessons, helping him build confidence in the kitchen and broaden his recipe bank, an issue the Bboy expressed as a previous limitation to his healthy eating. The Bboy was also provided with example meal plans which corresponded to macronutrient intakes of 2g/kg BW protein, 1g/kg BW fat and 3-5g/kg BW carbohydrate. Carbohydrate intake was adjusted according to activity and training level for the day. A supplement plan was also provided, consisting of 2000 mg omega-3 fatty acids (460 mg DHA and 1040 mg EPA), 20 g type 1 & 3 collagen and 5 g creatine monohydrate (Healthspan Elite (UK), tested under Informed Sport)

The athlete passed all return to training criteria at week 5 and was cleared to progressively build back into his full training program. At this point the Bboy left the performance center and returned home and performed the duration of his rehabilitation remotely. His remote support included weekly check ins with the physiotherapist, programming set out by the strength and conditioning coach as well as calls with the nutritionist and mental performance coach when needed. Late-stage rehabilitation was focused on achieving the terminal flexion range of motion in weight bearing and building back in to full unrestricted training. Guidance on weekly loads, including recommended training duration, strength and endurance training, was included in the Bboy's strength and conditioning programming.

OUTCOMES

Primary outcome measures included pain, effusion, range of motion, and quadriceps girth (online supplementary Table 1). Pain was tracked using a visual analog scale, effusion using the sweep test of the medial sulcus.[9] Pain and effusion guidelines were used as markers for progression[8].

Functional outcomes included strength of the quadriceps, hamstrings, hip abductors, and hip adductors (online supplementary Table 2). Quadriceps and hamstring strength were tested concentrically on an isokinetic dynamometer at 60°/s for 5 reps (IsoMed 2000, D&R Ferstl GmbH, Hemau, Germany). Hip ab-/adductor strength were tested using a fixed frame dynamometer (KT360, Kangatech Pty Ltd, Melbourne, Australia) using the max torque of three 5 second trials. Single legged hop tests[10] as well as the side hop test,[11] were used to assess horizontal plyometric ability (online supplementary Table 2). Counter movement jump, and squat jump were used to assess vertical plyometric ability (online supplementary Table 2)[5].

Breakdance related outcomes included the ability to transition easily from Toprock to Footwork and back, as well as the ability to break continuously in different positions for 4 minutes, while adjusting to the tempo of the music. These measures were assessed by the Bboy and another experienced breaker. Although these measures were subjective, they served as both endurance measures and a challenge of breaking-related cognitive demands.

Patient reported outcome measures included the Knee Osteoarthritis Outcomes Survey[12] (KOOS), the Anterior Cruciate Ligament Return to Sport Index[13] (ACL-RSI), and Knee Self-Efficacy Scale[14] (online supplementary Table 4).

FOLLOW UP

Although planned every week, due to the athlete's schedule follow-up calls with the physiotherapist were closer to every other week. The athlete rigorously adhered to his training, strength and conditioning programming as well as the recommendations of the nutritionist and mental performance specialist. Approximately 12 weeks post-surgery, the athlete reported to the nutritionist that he felt he was getting too "bulky." He had added approximately 4 kg and although he felt very strong, he felt this added mass was inhibiting his movement. The nutritionist and strength and conditioning coach worked together to adapt his diet and training to achieve his ideal body weight while maintaining his strength gains.

The Bboy returned to the performance center to complete return to breaking testing at week 18. The Bboy passed his return to breaking criteria, with the exception of his patient reported outcome measures. The Bboy felt that he couldn't fully grade himself on the ACL-RSI and KOOS until he had competed and tested him knee in a battle. In discussion amongst the IDT and with the Bboy these patient reported outcome measure scores were not justification to hold him back and he was therefore cleared for competition. The Bboy also achieved his goal of building a healthier lifestyle, successfully changing his diet and maintaining his smoking cessation. He returned to competition 20 weeks after surgery, winning two battles, and competed in the World Finals, 22 weeks after surgery.

All of the recommendations related to menisectomies and meniscal repairs in the 2018 Clinical Practice Guidelines revision were followed.[6] The only exception was the ACL-RSI and Knee Self-Efficacy scale were used in place of Tegner scale or Marx Activity Rating scale, as the authors' deemed assessing the Bboy's confidence, self-efficacy, and readiness to return to sport more important.

DISCUSSION

To the authors knowledge, this is the first return to breakdancing case report after any injury. The rehabilitation described took place in an elite performance center, thus not all aspects can be recreated with other breakers. However, the authors' hope that this case provides resources for future physios and breakers, as well as demonstrates how IDTs working athletes in sporting disciplines to which they are not initially familiar can build successful rehabilitation plans.

The Bboy was involved intimately in planning and goal setting, and crucial to this process was that his goals were not entirely related to his knee. While at the performance center the IDT met daily and the Bboy had feedback on his daily plan. Acknowledging and addressing goals that

were lifestyle related was integral to this rehabilitation. The Bboy acknowledged that at a few points, particularly when he had added weight, he considered just stopping strength training and no longer taking protein. However, the relationships he had built with the IDT meant that for the first time he felt he had a team whom he could ask questions of and work with to adapt his training and diet as needed.

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