Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

Anti-Gravity Treadmill in Rehabilitation after Hip Labral Repair Arthroscopy

Key Points:

- There is no consistency in the literature regarding anti-gravity treadmill use.
- Consider the Alter-G as a bridge between “no running” and “on-ground running.”
- This case report shows that functional status may improve with Alter-G use.
- Further research needs to be done to advance post hip arthroscopy rehabilitation.

Key Words:

- Body-weight supported treadmill, hip arthroscopy, running progression, FAI

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

Anti-Gravity Treadmill in Rehabilitation after Hip Labral Repair Arthroscopy

Abstract

Anti-gravity treadmills are being used in rehabilitation programs but have not been used consistently with post-hip labral repair arthroscopy surgeries. The purpose of this study was to review the post-hip labral protocol used by eight NCAA Division I collegiate athletes (all ages 18-21) from multiple sports that used the anti-gravity treadmill as a bridge between "no running" and "on-ground running." We found that athletes who did this returned to play between 4.5- 7 months, had a better overall functional status, and had no re-injuries. This is the first known study of its kind available in the literature.

Introduction

Hip arthroscopy has been shown to be an effective treatment in athletes with chronic groin pain as the result of femoral acetabular impingement (FAI) and/or labral lesions.[1–3] FAI is the result of repetitive forces on the growing joint, and bony changes (impingement) that occur as the result of the repetitive traumas to the joint. This has been known to be closely associated with acetabular labral lesions.[1–4] When an athlete is experiencing groin pain and is not responding to conservative rehabilitation, FAI (cam and pincer impingements) and/or labral lesions must be considered as a diagnosis. Cam impingements are known to be the result of an uninviting surface located on the head/ neck junction of the femur that is unable to move smoothly within the acetabulum.[5] A pincer impingement is a bony defect located on the acetabular rim that hinders adequate movement of the femoral head within the acetabulum.[5] Physical examination and imaging guide the treatment process.

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

Rehabilitation after hip arthroscopy is critically important in getting the athlete back to sport. There is a considerable amount of variability between hip arthroscopy protocols,[6] so it is imperative to follow sound post-operative principles. It is crucial that the athlete's joint is protected but stressed appropriately to obtain the return to sport goal,[7] which has been widely reported to range from 4-10 months.[8–13] Addressing gait patterns in the early post-operative phase is critical to prevent complications as rehabilitation progresses.[7] As the athlete is able to restore proprioception and strength, initiating running gait would be the next step. Due to the amount of variability between rehabilitation protocols, timelines to initiate running progressions range from 1-6 months post-procedure.[5,14–18] Even though that range is fairly large, a survey conducted by Rath et al. of 26 arthroscopy surgeons at the international society for hip arthroscopy (ISHA) in 2015 identified that most protocols allow for running at the 3-4 month timepoint.[16]

The anti-gravity treadmill (Alter-G) has been shown to promote normal muscle firing with reduced joint stresses on the lower extremity to help restore normal gait patterns.[19–21] The Alter-G is a treadmill apparatus used to provide body weight support while walking/jogging.[22] It consists of a treadmill with an airbag structure attached and an air pump, which inflates the bag to counteract the air pressure outside of the bag. This ultimately decreases the participant's body weight while using the machine.[22,23] There are a limited number of studies published that have examined the Alter-G's impact on rehabilitation.[24–26] One study performed by Saxena et al. looked at the use of the Alter-G in rehabilitation post-Achilles tendon surgery. Subjects in the Alter-G group returned to on-ground running about two weeks faster than the non-Alter-G group.[26] This expedited return to on-ground running has been theorized to lead to decreased

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

muscle atrophy and more time for sport acclimatization.[22] Furthermore, there is a significant gap in the literature when it pertains to using the Alter-G in post-hip arthroscopy rehabilitation.

Anti-gravity treadmills have been used in post-labral repair rehabilitation in our athletic training facility since March of 2017. The athletic training staff and team orthopedic physician at our university developed a new post-hip arthroscopy rehabilitation protocol at that time. It was theorized that gradual loading of the lower body using an anti-gravity treadmill would allow the athlete to engage the appropriate muscle groups and enhance their recovery. The rationale for including the Alter-G at the 6-week mark is based on one of the author's surgical experience gained from working with more than 500 patients undergoing these procedures, in addition to his experience working as a physical therapist (prior career). This took into account the timing of biologic healing, restoration of range of motion, minimal pain, and readiness of the hip-pelvic musculature to promote gradual weight bearing stress. Therefore, the purpose of this case series is to take an evidence-based approach to applying the anti-gravity treadmill in rehabilitation after hip arthroscopy.

Case Presentation

Patients

Eight NCAA Division I collegiate athletes (all ages 18-21) have had 10 FAI hip surgeries and followed our post-hip labral repair protocol (**Table 1**). Six of the athletes included in our study were female (track, swim, volleyball, field hockey, soccer, and rowing) and two were male (baseball and lacrosse). All of these athletes presented initially with complaints of hip pain with previous medical history of hip related injuries (adductor/ hip flexor strains, general hip soreness/ tightness) who had not responded to conservative treatment. Physical examination was positive

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

for groin pain with hip provocative testing as well as imaging (x-rays, Magnetic Resonance Imaging), which confirmed FAI and labral lesions.

Furthermore, we completed a focused, individual case study of one of the eight athletes who completed Alter-G jogging as part of their return to play protocol. The case study gives a full account of what the athlete completed at each step of the rehabilitation process and how the Alter-G was beneficial to their recovery.

Intervention

The athlete was started at 6-weeks post-surgery, as long as the athlete met the following criteria:

1. Pain-free active/ passive range of motion within normal limits bilaterally.
2. Proper control of hip musculature (able to complete SL bridges, side planks, and similar hip exercises without deficits/ pain).
3. Success with lower body rehabilitation program (able to complete assisted SL squats, SL balance, and similar lower body exercises without deficits/ pain).

Guidelines once starting Alter-G:

1. Duration and speed were sport-dependent.
2. The protocol was altered in the event of pain. Ex: If someone had pain during one session, he/ she would not increase the body weight % next session. Instead, he/ she would start at previous level or take a step back.
3. Body-weight progressively increased over two weeks (Started jogging at 50% body-weight and increased by ~5% body-weight with each session and no more than 10% per session). Must reach 90-95% body-weight pain-free prior to ground running.
4. Athlete did not run on-ground prior to 8-weeks after hip procedure.

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

Comparative Outcomes

For the 10 surgeries performed, on 6 occasions the athletes were able to start Alter-G running at the 6-week mark (**Table 1**). In two of the surgeries, the athletes were unable to start at the 6-week mark secondary to another injury/ condition. The remaining two surgeries, the athletes were unable to start at the 6-week mark because they did not have access to the treadmill. When reviewing the 10 surgeries who used the new hip labral repair protocol, four athletes (5 surgeries) were able to return to play in 4.5-5 months s/p surgery. Two athletes returned at the 7-month mark, and two athletes (due to personal reasons) quit their respective teams before full return to play. Of the 4 athletes (5 surgeries) who were able to fully return to sport between 4.5-5 months, 3 athletes (3 surgeries) had started the Alter-G at the 6-week mark. At the time of writing, none of these athletes suffered a re-injury or major setback as part of their post-surgical return to sport.

In the focused, individual case study, we present a female volleyball player who met the criteria for Alter-G running 6-weeks after hip FAI surgery. She reached 95% body-weight running, pain-free in 14 days. At that point, on-ground linear running was initiated and advanced in a stepwise progression until the athlete could compete at a high level. The athlete then met all criteria for a return to competition including: full range of motion, equal strength bilaterally, successful bilateral hop testing, success with running and agility programs, and success with sport-specific non-contact activity. The athlete obtained final clearance from the surgeon for full, unrestricted activity at week 19. Lastly, the athlete's participation in team practices increased over two weeks for full integration by week 21. This allowed her to be ready to complete in full for the start of the volleyball season. This athlete did not present with any symptoms of hip pain similar to her chief complaint throughout return. In this case, and in all

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

others, athlete satisfaction was high when asked during the final post-operative surgeon visit for clearance. This is good anecdotal evidence that should not be dismissed as patient values must always be considered and may play a role in confidence during play.[27–29]

Discussion

The findings of this study deviate from the current literature in many ways. First, there is no consistent post-hip labral repair protocol recommended and clinicians appear to be returning athletes to play in a wide variation of timeframes.[8–13] Even the clinicians who are able to return athletes to play in a quick timeframe, do not account for functional status upon return to play. We felt that earlier access to anti-gravity treadmill and on-ground running allowed for a better functional status when they were able to return to sport. Second, the literature currently states that athletes typically initiate on-ground running somewhere between the 3-4 month timepoint.[14,16] With our cases, we were able to progress them to on-ground running (if they started Alter-G running at the 6-week mark) around the 8-week mark, safely. Third, the Alter-G is being used in post-surgical rehabilitation programs inconsistently. There does not appear to be a link between Alter-G use and post-hip labral repair surgery. We believe that our new hip labral repair protocol justifies starting the use of the Alter-G as a bridge between "no running" and "on-ground running" at the 6-week mark post-surgery. The comparative outcomes listed above indicate that this protocol may allow athletes to progress to competition at a faster functional pace. Six of these eight athlete returned to competition between 4.5-7 months. In the literature many individuals post-hip labral repair surgery are starting to return to sport between 4-10 months.[8–13] The majority of protocols allow return to play to start between 4-6 months, but that does not take into account resuming competition. Additionally, self-reported return to competition time points in one study were between 9-10 months, even though these athletes were

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

cleared to return to play between 4-6 months.[9] While the findings of our practice-based evidence in these cases indicate a faster return to sport and no re-injuries, we are operating with low numbers. To advance the literature, more athletes will need to go through this protocol. This case series is a good starting point for filling a gap in the literature.

Clinical Bottom Line

The Alter-G is being used in post-surgical rehabilitation programs but there is nothing consistent in the literature about when to start it or how to incorporate it. We believe that our new hip labral repair protocol with the use of the Alter-G as a bridge between "no running", and "on-ground running" is a more aggressive, but safe and novel approach for hip labral repair surgeries. This case study can serve as an impetus for further research and study in the advancement of the care of athletes with use of an Alter-G at the 6-week mark after hip arthroscopy.

Accepted Manuscript
Version of record at: https://doi.org/10.1123/ijatt.2021-0003

References

1. Perets I, Craig MJ, Mu BH, Maldonado DR, Litrenta JM, Domb BG. Midterm Outcomes and Return to Sports Among Athletes Undergoing Hip Arthroscopy. *Am J Sports Med*. 2018;46(7):1661-1667.

2. Minkara AA, Westermann RW, Rosneck J, Lynch TS. Systematic Review and Meta-analysis of Outcomes After Hip Arthroscopy in Femoroacetabular Impingement. *Am J Sports Med*. 2019;47(2):488-500.

3. Menge TJ, Briggs KK, Dornan GJ, Mcnamara SC, Philippon MJ. Survivorship and Outcomes 10 Years Following Hip Arthroscopy for Femoroacetabular Impingement. *J Bone Jt Surgery, Inc*. 2017;99-A(12):997-1004.

4. Kappe T, Kocak T, Bieger R, Reichel H, Fraitzl CR. Radiographic Risk Factors for Labral Lesions in Femoroacetabular Impingement. *Clin Orthop Relat Res*. 2011;469(11):3241-3247.

5. Spencer-Gardner L, Eischen JJ, Levy BA, Sierra RJ, Engasser WM, Krych AJ. A comprehensive five-phase rehabilitation programme after hip arthroscopy for femoroacetabular impingement. *Knee Surgery, Sport Traumatol Arthrosc*. 2014;22(4):848-859.

6. Cvetanovich GL, Lizzio V, Meta F, et al. Variability and Comprehensiveness of North American Online Available Physical Therapy Protocols Following Hip Arthroscopy for Femoroacetabular Impingement and Labral Repair. *Arthrosc - J Arthrosc Relat Surg*. 2017;33(11):1998-2005.

7. Malloy P, Malloy M, Draovitch P. Guidelines and pitfalls for the rehabilitation following hip arthroscopy. *Curr Rev Musculoskelet Med*. 2013;6(3):235-241.

8. Wilson KW, Kannan AS, Kopacko M, Vyas D. Rehabilitation and Return to Sport After Hip Arthroscopy. *Oper Tech Orthop*. 2019;29(4):1-8.

9. Weber AE, Kuhns BD, Cvetanovich GL, Grzybowski JS, Salata MJ, Nho SJ. Amateur and Recreational Athletes Return to Sport at a High Rate Following Hip Arthroscopy for Femoroacetabular Impingement. *Arthrosc - J Arthrosc Relat Surg*. 2017;33(4):748-755.

10. Byrd JWT, Jones KS, Gwathmey FW. Femoroacetabular Impingement in Adolescent Athletes. *Am J Sports Med*. 2016;44(8):2106-2111.

11. Mohan R, Johnson NR, Hevesi M, Gibbs CM, Levy BA, Krych AJ. Return to Sport and Clinical Outcomes After Hip Arthroscopic Labral Repair in Young Amateur Athletes: Minimum 2-Year Follow-Up. *Arthrosc - J Arthrosc Relat Surg*. 2017;33(9):1679-1684.

12. Malviya A, Paliobeis CP, Villar RN. Do professional athletes perform better than recreational athletes after arthroscopy for femoroacetabular impingement? Hip. *Clin Orthop Relat Res*. 2013;471(8):2477-2483.

13. Levy DM, Kuhns BD, Frank RM, et al. High Rate of Return to Running for Athletes after Hip Arthroscopy for the Treatment of Femoroacetabular Impingement and Capsular Plication. *Am J Sports Med*. 2017;45(1):127-134.

14. Domb BG, Sgroi TA, VanDevender JC. Physical Therapy Protocol After Hip Arthroscopy: Clinical Guidelines Supported by 2-Year Outcomes. *Sports Health*. 2016;8(4):347-354.

15. Chen AW, Craig MJ, Yuen LC, Ortiz-Declet V, Maldonado DR, Domb BG. Five-Year Outcomes and Return to Sport of Runners Undergoing Hip Arthroscopy for Labral Tears With or Without Femoroacetabular Impingement. *Am J Sports Med*. 2019;47(6):1459-1466.

16. Rath E, Sharfman ZT, Paret M, Amar E, Drexler M, Bonin N. Hip arthroscopy protocol: expert opinions on post-operative weight bearing and return to sports guidelines. *J Hip Preserv Surg*. 2017;4(1):60-66.

17. Voight ML, Robinson K, Gill L, Griffin K. Postoperative rehabilitation guidelines for hip arthroscopy in an active population. *Sports Health*. 2010;2(3):222-230.

18. Kraeutler MJ, Anderson J, Chahla J, et al. Return to running after arthroscopic hip surgery: literature review and proposal of a physical therapy protocol. *J Hip Preserv Surg*. 2017;4(2):121-130.

19. Gojanovic B, Shultz R, Feihl F, Matheson G. Overspeed HIIT in Lower-Body Positive Pressure Treadmill Improves Running Performance. *Med Sci Sports Exerc*. 2015;47(12):2571-2578.

20. Leddy JJ, Sandhu H, Sodhi V, Baker JG, Willer B. Rehabilitation of Concussion and Post-concussion Syndrome. *Orthop Surg*. 2012;4(2).

21. Patil S, Steklov N, Bugbee WD, Goldberg T, Colwell CW, D'Lima DD. Anti-gravity treadmills are effective in reducing knee forces. *J Orthop Res*. 2013;31(5):672-679.

22. McNeill DK, de Heer HD, Bounds RG, Coast JR. Accuracy of Unloading With the Anti-Gravity Treadmill. *Natl Strength Cond Assoc*. 2015;29(3):863-868.

23. Alter G. *AlterG Operation Manual*.; 2015.

24. Berthelsen MP, Husu E, Christensen SB, Prahm KP, Vissing J, Jensen BR. Anti-gravity training improves walking capacity and postural balance in patients with muscular dystrophy. *Neuromuscul Disord*. 2014;24(6):492-498.

25. Henkelmann R, Schneider S, Müller D, Gahr R, Josten C, Böhme J. Outcome of patients after lower limb fracture with partial weight bearing postoperatively treated with or without anti-gravity treadmill (alter G®) during six weeks of rehabilitation - A protocol of a prospective randomized trial. *BMC Musculoskelet Disord*. 2017;18(1):1-6.

26. Saxena A, Granot A. Use of an Anti-gravity Treadmill in the Rehabilitation of the Operated Achilles Tendon: A Pilot Study. *J Foot Ankle Surg*. 2011;50(5):558-561.

27. Massey W. Psychological Effect of Sport Injury on an NCAA Division I Student. *Thesis*. 2019;(June).

28. Memon M, Kay J, Hache P, et al. *Athletes Experience a High Rate of Return to Sport Following Hip Arthroscopy*. Vol 0. Springer Berlin Heidelberg; 2018.

29. Wiese-Bjornstal DM. Psychology and Socioculture Affect Injury Risk, Response, and Recovery in High-Intensity Athletes: A Consensus Statement. *Scand J Med Sci Sport*. 2010;20(SUPPL. 2):103-111.