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Stride One in Gait & Mobility (Re)training:

Improving Recovery After Lower-Limb Fractures

It is estimated that in 2019, 436 million people worldwide were living with fractures and associated problems in functioning that could benefit from rehabilitation[1]. The top three anatomical sites of fracture in terms of number of years lived with disability (YLDs) and age-standardized YLD rates are fracture of the lower limb (patella, tibia or fibula, or ankle); pelvis; and hip[2]. An increase in life expectancy will lead to a concurrent increase in the proportion of elderly individuals in the population, and consequently to a rise in the incidence of hip fractures.

The number of hip fractures is expected to increase to about 4.5 million per year worldwide by 2050. Even with successful surgery, the mortality and the risk of permanent disability and dependence remain high in patients with hip fractures. As a result, medical costs associated with the treatment of these patients are increasing. For these reasons, hip fractures are an increasingly important global public health issue[3]. Hip fractures in older patients are one of the most common injuries; in the USA alone, hip fracture cases represent around 30% of all hospitalized cases[4].

Advancing a patient's weight-bearing status is preferably done as quickly as possible in order to minimize tissue atrophy and disuse osteopenia and maximize functional recovery[5,6]. Despite standard rehabilitation, however, many patients fail to regain their pre-fracture ambulatory or functional status[7]. Few older adults regain their pre-fracture mobility after a hip fracture. Comfortable gait speed in the acute phase is extremely low (< 0.3 m/s) and seems to steadily increase throughout the recovery period, but only reaches the cut point of 1 m/s at 6 months[8]. And while gait speed is a robust measure of general health and function among older adults, it is only one specific measure of walking ability according to experts; for physical mobility, several additional domains should be addressed, including gait volume, pace, cadence, asymmetry, gait phases, and gait variability[9].

References:

1.Cieza A, Causey K, Kamenov K, Wulf Hansons S, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2021:19;396:2006–17

2. GBD 2019 Fracture Collaborators. Global, regional, and national burden of bone fractures in 204 countries and territories, 1990–2019: a systematic analysis from the Global Burden of Disease Study 2019. Lancet Healthy Longev. 2021;2:e580–92.

3. Lee K, Um S, Kim Y.Postoperative Rehabilitation after Hip Fracture: A Literature Review. H&P 2020;32:125-131.

4. Abdalbary SA. Partial weight bearing in hip fracture rehabilitation. Future Sci OA. 2017 Oct 12;4(1):FSO254.

5. Kubiak EN, Beebe MJ, North K, Hitchcock R, Potter MQ. Early weight bearing after lower extremity fractures in adults. J Am Acad Orthop Surg. 2013;21(12):727–739.

[6. Dong W, Lisitano LSJ, Marchand LS, Reider LM, Haller JM. Weight-bearing guidelines for common geriatric upper and lower extremity fractures. Curr Osteoporos Rep. 2023;21:698–709.

7. Binder EF, Brown M, Sinacore DR, Steger-May K, Yarasheski KE, Schechtman KB (2004) Effects of extended outpatient rehabilitation after hip fracture: a randomized controlled trial. JAMA 292(7):837–846.

8. Taraldsen, K., Polhemus, A., Engdal, M. et al. Evaluation of mobility recovery after hip fracture: a scoping review of randomized controlled studies. Osteoporos Int 35, 203–215 (2024).

9. Kluge F, Del Din S, Cereatti A, Gassner H, Hansen C, Helbostad JL et al (2021) Consensus based framework for digital mobility monitoring. PLoS One 16(8):e0256541.

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The role of gait and mobility (re)training

Mobility can still be further improved by interventions starting when rehabilitation periods typically end in most countries[8]. Interventions targeting improvement in mobility after hip fracture cause clinically meaningful improvement in mobility and walking speed **in post-hospital settings**, compared with conventional care and with little or no difference in the number of adverse events. Interventions that include training of gait, balance and functional tasks are particularly effective[10,11,12].

After discharge following hip fracture surgery, a home-based physical therapy program including gait training results in improved mobility; high dose **home-based weight-bearing exercises** for 16 weeks after hip fracture surgery result in significantly better balance (step test on fractured leg), mobility (unaided walking), functional performance (sit to stand test), and walking speed.

Increased activity levels following hip fracture surgery have even been reported from a one-year (home based) exercise program[13]. One study found additional motivational interviewing to result in clinically meaningful improvements in outcomes such as daily number of steps and daily walking time[5].

High-intensity exercise performed in the home is **feasible for elderly patients with hip fracture.** Training can be performed without apparent adverse effects, with high adherence (98%)[15]and without increasing total healthcare costs[12].

References:

10. Fairhall NJ, Dyer SM, Mak JC, Diong J, Kwok WS, Sherrington C. Interventions for improving mobility after hip fracture surgery in adults. Cochrane Database Syst Rev. 2022 Sep 7;9(9):CD001704.
11. Sherrington C, Lord SR, Herbert RD (2004) A randomized controlled trial of weight-bearing versus non-weight-bearing exercise for improving physical ability after usual care for hip fracture. Arch Phys Med Rehabil 85(5):710–716.
12. Taraldsen K, Thingstad P, Dohl O, Follestad T, Helbostad JL, Lamb SE et al (2019) Short and long-term clinical effectiveness and cost-effectiveness of a late-phase community-based balance and gait exercise program following hip fracture. The EVA-Hip Randomised Controlled Trial. PLoS One 14(11):e0224971.
13. Handoll HHG, Sherrington C, Mak JCS. Interventions for improving mobility after hip fracture surgery in adults. Cochrane Database of Systematic Reviews 2011, Issue 3. Art. No.: CD001704.
14. O'Halloran PD, Shields N, Blackstock F, Wintle E, Taylor NF (2016) Motivational interviewing increases physical activity and self-efficacy in people living in the community after hip fracture: a randomized controlled trial. Clin Rehabil 30(11):1108–1119
15. Mangione KK, Craik RL, Tomlinson SS, Palombaro KM (2005) Can elderly patients who have had a hip fracture perform moderate- to high-intensity exercise at home? Phys Ther 85(8):727–739

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The Potential of Real-Time Biofeedback on Weight Bearing Loads

Access issues limit elderly people from participating in facility-based programs[12]. Real-time biofeedback devices that can be used for home-based therapy can overcome obstacles for receiving the rehabilitation care that is needed following fractures in the lower limb e.g. in community dwelling older people.

Using biofeedback from a wireless insole sensor to measure the exerted force on the lower extremity during gait significantly improves the maximum peak load in patients following a proximal femur fracture with prescribed unrestricted weight bearing[16]. This suggests improved compliance and confidence with weight bearing instructions, a precondition for gait and mobility training. In addition, given the system's utility at home and in the community, exercise interventions are expected to have an effect on real-world situations and secondary real-life gait parameters such as daily upright time and the number of upright events[12].

As fracture care continues to evolve, we expect external weight-bearing and gait parameters monitoring devices to play a key role in data collection and monitoring of patient outcomes and compliance. Potential effects of rehabilitation on levels of physical mobility at a more granular level such as gait volume or gait quality are rarely evaluated. Digital mobility outcomes derived from sensor-based activity monitoring are increasingly being used as a means to capture mobility reliably and directly, both in controlled and in real-world settings.

Digital mobility outcomes following hip fracture could potentially be gait speed, gait symmetry, step counts, cadence, step length, upright time, or activity patterns[8]. In general, insole systems with the ability to collect a range of gait data, including force, pressure distribution and step count over weeks to months, are ideally suited for ambulatory monitoring applications. These devices allow a range of gait data to be collected while minimizing intervention by both the patient and health professional[17].

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Stride One is a Class I medical device certified under the Medical Device Directive 93/42/EEC. It conforms to applicable EU safety and performance requirements and bears the CE mark. This certification applies solely to the product's current intended use and classification under MDD. Stride One is intended to support post-operative rehabilitation following lower-limb orthopedic procedures. It is not intended to replace clinical judgment, professional physiotherapy, or prescribed rehabilitation protocols. Use should be advised by a healthcare professional. Clinical decisions should be based on the full clinical context, including patient-specific factors and professional expertise. Patient selection, rehabilitation protocols, and monitoring remain the sole responsibility of the treating healthcare provider. The device is currently undergoing further clinical validation. Ceriter makes no claims regarding treatment outcomes or specific levels of efficacy beyond the scope of its certified use.

References:

16. M. Raaben, S. Redzwan, R. Augustine, T.J. Blokhuis. Real-time biofeedback improves rehabilitation after hip fractures in elderly: an international, multicenter randomised controlled trial (COMFORT).
17. Robinson J, Wang AWT, Stockton DJ. Weight-Bearing Monitoring Devices in Lower Extremity Fractures: A Scoping Review. Orthop Res Rev. 2025;17:257-267