FROM FRACTURE TO FUNCTION

An update on rehabilitation post fragility fracture

Daniel Pinto, PhD, PT
Assistant Professor, Marquette University
Learning objectives

1. Approaches for developing the most comprehensive rehabilitation plan
2. Key parameters and precautions for effective management of patients under rehabilitation and for the prevention of secondary fragility fractures.
3. Suggested research priorities in rehabilitation post fragility fracture
The global approach to rehabilitation following an osteoporotic fragility fracture: A review of the rehabilitation working group of the International Osteoporosis Foundation (IOF) committee of scientific advisors


Osteoporosis International 33, 527–540 (2022)
Rehabilitation Working Group

- R Blank,
- B Buehring,
- R Chapurlat,
- T Chevalley,
- C Cooper,
- E Dennison,
- S Ferrari,
- JA Kanis,
- JF Kaux,
- N Lane,
- OD Messina,
- J Morales Torres,
- B Muzzi Carmargos,
- J Paccou,
- A Papaioannou,
- JY Reginster,
- R Rizzoli,
- S Silverman,
- S Tüzü

Chairs: O Bruyère, D Pinto
Burden of Osteoporosis

- ~30% of all postmenopausal women have osteoporosis.

- Of these, 40% will have an osteoporotic fracture, also known as ‘fragility fracture’.
Fragility Fracture Consequences

- Pain
- Loss of bone mineral density (BMD)
- Loss of muscle mass
- Disability and loss of independence
- Reduced quality of life
- Increased risk of subsequent fracture
- Death
Non-surgical treatment post fragility fracture

- **Pharmaceutical agents**
  - First line of treatment.
  - Fractures can be reduced by approximately 20–60%.

- **Patient-centered multidisciplinary care**
  - Care pathways and Fracture Liaison Services (FLS)
  - Education
  - Exercise
  - Fall prevention
  - Physiotherapy
  - Nutritional care
To be discussed today:

- Care pathway and Fracture Liaison Services (FLS)
- Patient education
- Exercise principles and characteristics
- Fall prevention programs
- Physiotherapy
- Nutritional care
Continuum-Care episode of rehabilitation

Sheehan et al. PTJ. 2019
Care pathways and coordination

- System-level problems exist where acute care providers have no formal connection to providers who manage osteoporosis and other chronic conditions.
- Many practitioners are unaware that a fracture has occurred within the context of low bone mass and the risk for future fracture
Models include ortho-geriatric units and fracture liaison services (FLS).
  - Often limited to coordinating of inpatient services
  - Have improved the acute care management for older adults

Well-organized national and international campaigns have created robust fracture liaison services, such as Capture the Fracture
  - Case identification
  - Pharmaceutical management to strengthen bones
  - Falls risk identification and education

https://www.capturethefracture.org
To be discussed today:

- Care pathway and Fracture Liaison Services (FLS)
- Patient education
- Exercise
- Fall prevention programs
- Physiotherapy
- Nutritional care
Three overall themes:
  - Knowledge of osteoporosis
  - Medication
  - Diet and exercise

Multifaceted osteoporosis group education can increase
  - Patients' knowledge of osteoporosis
  - Health-related quality of life
  - Physical activity
  - Psychosocial functioning
  - Patient adherence
Specific information needs include the following:

- The nature of osteoporosis/fracture risk
- Medication
- Self-management
- Understanding dual energy x-ray absorptiometry and follow-up
To be discussed today:

- Care pathway and Fracture Liaison Services (FLS)
- Patient education
- Exercise principles and characteristics
- Fall prevention programs
- Physiotherapy
- Nutritional care
Loading characteristics

- Dynamic versus static
- High intensity (build to 80-85% Rep max, high velocity)
- Diversify loading patterns
- Rest (1-2 minutes between sets)
Training Principles

- Specificity – target tissue
- Progressive overload – must be above habitual walking
- Initial values – lower initial BMD shows greater gain
- Diminishing returns – bone loses mechanosensitivity after small loading cycles
- Reversible – If you don’t use it you lose it
<table>
<thead>
<tr>
<th>Training type</th>
<th>Dose</th>
<th>Recommendations</th>
<th>Precautions</th>
</tr>
</thead>
</table>
| Progressive resistance training                  | • ≥2 days/week.  
• ≥ 2 sets of 8–12 repetitions  
• 1–3-minute rest between sets  
• ≥8 exercises targeting major muscle groups and common fracture sites | • Slow progression with emphasis on correct lifting technique | • Consider vulnerable tissue when training, e.g., the rotator cuff with overhead lifting.  
• Use caution with trunk bending or twisting for patients with low spine BMD |
| Weight-bearing impact training*                  | • 4–7 times per week  
• 5-50 jumps per session (Build capacity over time)  
• 5 sets  
• 1-10 repetitions  
• 1–2-minute rest between sets | • Increase jump and step height  
• Change movement direction | • Consider comorbid conditions affected by impact exercises, e.g., patients with incontinence or arthritic joint pain. |
| Functional balance, agility, and coordination training. | • 30 minutes, 4 times/week  
• Examples include weight shifting, single leg balance, turning and stepping on and over objects. Can manipulate vision, speed, direction, multi-limb movements and cognitive tasks. | • Must be progressive, challenging and supervised | • Start with static and progress to dynamic balance for patients with impaired balance or with high risk of fracture. |
Nine trials, n = 749, 68 male participants

No evidence to support exercise for incident fractures, falls or adverse events

Moderate-quality evidence for improving physical performance
Adherence and optimal load

Exercise for improving outcomes after osteoporotic vertebral fracture

Monitoring Editor: Jenna C Gibbs, Norma J MacIntyre, Matteo Ponzano, Jeffrey Alan Templeton, Lehana Thabane, Alexandra Papaioannou, Lora M Giangregorio, and Cochrane Musculoskeletal Group

- **Short term:** 4-12 weeks, acceptable but definitions varied. At lowest levels reported 80% of sample attended >80% of visits.
- **Long term:**
  - 6 months 58% to 62%
  - 12 months 46% to 80% (attended at least 80% of sessions)
Adverse events and caution

- Three trials reported four adverse events related to the exercise intervention (costal cartilage fracture, rib fracture, knee pain, irritation to tape)
- Activities that involve rapid, repetitive, weighted, or end-range twisting or flexion of the spine, or that have high fall risk should be avoided
- The benefits from higher impact exercise may be outweighed by the risks of further injury
Original Study

Effect of Lower-Limb Progressive Resistance Exercise After Hip Fracture Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Studies

Sang Yoon Lee MD, PhD, Byung-Ho Yoon MD, PhD, Jaewon Beom MD, PhD, Yong-Chan Ha MD, PhD, Jae-Young Lim MD, PhD

<table>
<thead>
<tr>
<th>Study name</th>
<th>Outcome</th>
<th>Time point</th>
<th>Std diff in means</th>
<th>Upper limit</th>
<th>Lower limit</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylliaas 2012</td>
<td>Combined</td>
<td>12 weeks</td>
<td>0.767</td>
<td>1.190</td>
<td>0.344</td>
<td>0.000</td>
</tr>
<tr>
<td>Singh 2012</td>
<td>Combined</td>
<td>12 months</td>
<td>0.072</td>
<td>0.424</td>
<td>-0.280</td>
<td>0.687</td>
</tr>
<tr>
<td>Edgren 2012</td>
<td>Combined</td>
<td>12 weeks</td>
<td>0.234</td>
<td>0.834</td>
<td>-0.366</td>
<td>0.445</td>
</tr>
<tr>
<td>Sylliaas 2011</td>
<td>Combined</td>
<td>12 weeks</td>
<td>0.606</td>
<td>0.957</td>
<td>0.256</td>
<td>0.001</td>
</tr>
<tr>
<td>Mangione 2010</td>
<td>Combined</td>
<td>Combined</td>
<td>0.415</td>
<td>1.196</td>
<td>-0.366</td>
<td>0.298</td>
</tr>
<tr>
<td>Portegijs 2008</td>
<td>Combined</td>
<td>12 weeks</td>
<td>0.612</td>
<td>1.252</td>
<td>-0.028</td>
<td>0.061</td>
</tr>
<tr>
<td>Mangione 2005</td>
<td>Combined</td>
<td>12 weeks</td>
<td>0.208</td>
<td>1.068</td>
<td>-0.653</td>
<td>0.636</td>
</tr>
<tr>
<td>Peterson 2004</td>
<td>Combined</td>
<td>1 year</td>
<td>0.257</td>
<td>0.732</td>
<td>-0.219</td>
<td>0.290</td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 8.805, df = 7 (P = .267); I^2 = 20.5\%$
Test for overall effect: $z = 0.408 (P < .001)$
Balance training can enhance hip fracture patients’ independence in activities of daily living
A meta-analysis of randomized controlled trials

Xin Xin Chen, MM; Wenhui Yang, MM; Xiao Wang, MM*

![Table](image)

<table>
<thead>
<tr>
<th>Study ID</th>
<th>SMD (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder 2004</td>
<td>2.90 (2.31, 3.50)</td>
<td>10.07</td>
</tr>
<tr>
<td>Hauer 2002</td>
<td>3.27 (2.11, 4.42)</td>
<td>7.76</td>
</tr>
<tr>
<td>Latham 2014</td>
<td>2.06 (1.74, 2.38)</td>
<td>10.91</td>
</tr>
<tr>
<td>Monticone 2018</td>
<td>1.54 (0.92, 2.16)</td>
<td>9.98</td>
</tr>
<tr>
<td>Moseley 2009</td>
<td>3.74 (3.23, 4.26)</td>
<td>10.35</td>
</tr>
<tr>
<td>Peterson 2004</td>
<td>1.38 (0.86, 1.91)</td>
<td>10.32</td>
</tr>
<tr>
<td>Sherrington 1997</td>
<td>1.70 (0.97, 2.43)</td>
<td>9.57</td>
</tr>
<tr>
<td>Sherrington 2004</td>
<td>2.59 (1.99, 3.19)</td>
<td>10.06</td>
</tr>
<tr>
<td>Zheng 2010</td>
<td>0.85 (0.48, 1.23)</td>
<td>10.77</td>
</tr>
<tr>
<td>Lin 2019</td>
<td>2.29 (1.74, 2.85)</td>
<td>10.21</td>
</tr>
<tr>
<td>Overall (I²-squared = 91.5%, p = 0.000)</td>
<td>2.20 (1.63, 2.78)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

NOTE: Weights are from random effects analysis

Figure 4. Forest figure used to compare physical health between the balance training and control groups.
Structured exercise improves mobility after hip fracture: a meta-analysis with meta-regression

Joanna Diong, Natalie Allen, Catherine Sherrington

- 13 trials (n=1903)
- Structured exercises improve mobility after hip fracture.
- Interventions showing greatest effectiveness
  - Progressive resistance
  - Conducted in community or community/ hospital mix versus in hospital alone.
To be discussed today:

- Exercise principles and characteristics
  - Vertebreal fracture
  - Hip fracture
- Fall prevention programs
- Physiotherapy
- Nutritional care
- Patient education
- Care pathway and Fracture Liaison Services (FLS)
108 RCTs with 23,407 participants

Exercise programs for falls
  - Primarily involve balance and functional exercises
  - Reduce the rate of falls and number of people who fall in the community.
  - Uncertain effects for non-fall outcomes.
  - Report predominantly non-serious adverse events.

Tai Chi has low certainty for preventing falls

Resistance exercise alone, dance, or walking has an uncertain effect on the rate of falls.
62 trials, n=19,935 older people in the community

Multifactorial interventions

- Usually include exercise, education, environment or assistive technologies, medication review and psychological interventions.
- May reduce the rate of falls and risk of falling versus usual care or attention control.
- Little or no effect on other fall-related outcomes.
To be discussed today:

- Care pathway and Fracture Liaison Services (FLS)
- Patient education
- Exercise principles and characteristics
- Fall prevention programs
- Physiotherapy
- Nutritional care
Physiotherapists employ a variety of strategies post fragility fracture in addition to exercise including:

- Functional mobilization
- Transfer training
- Safety training
- Patient education
- Postural taping
- Manual therapy
- Use of assistive devices
In-hospital mortality was significantly higher for the delayed physiotherapy group, 6.8 vs. 3.2% OR 2.2, 95% CI 1.06–4.42, p=0.034
HIP4Hips (High Intensity Physiotherapy for Hip fractures in the acute hospital setting): a randomised controlled trial

Lara A Kimmell, Susan M Llew, James M Sayer, Anne E Holland

5 Adjusted Kaplan–Meier analysis of the probability of discharge, after adjusting for sex, anaesthetic type, carer at home, and stairs at home*

*The probability of discharge in the intervention group was greater than for control patients at all time points (P<0.001).
▪ 5 included studies
▪ Home physiotherapy
  o Better than no physiotherapy
  o Similar to outpatient physiotherapy for improving HRQoL
▪ Performance-based outcomes marginally better with outpatient physiotherapy versus home physiotherapy.
▪ High risk of bias.
To be discussed today:

- Exercise principles and characteristics
  - Vertebral fracture
  - Hip fracture
- Fall prevention programs
- Physiotherapy
- Nutritional care
- Patient education
- Care pathway and Fracture Liaison Services (FLS)
Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group

Jürgen Bauer, Gianni Biolo, Tommy Cederholm, Matteo Cesari, Alfonso J Cruz-Jentoft, John E Morley, Stuart Phillips, Cornel Sieber, Peter Stehle, Daniel Teta, Renuka Visvanathan, Elena Volpi, Yves Boirie

- 1.0-1.2 grams/kg body weight per day
  - Maintain and regain lean body mass and function
- > 1.2 grams /kg body weight per day
  - Older adults who are exercising
- 1.2-1.5 grams /kg body weight per day
  - Older adults with chronic disease
Impact of malnutrition on 12-month mortality following acute hip fracture

Jack J. Bell,* Ranjeev C. Pulle,* Alisa M. Crouch,* Suzanne S. Kuys,† Rebecca L. Ferrier* and Sarah L. Whitehouse*‡

Table 3  Independent predictors of 12-month mortality

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Odds ratio (95% confidence interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admitted from residential aged care facility</td>
<td>2.6 (1.3–5.3)</td>
<td>0.005</td>
</tr>
<tr>
<td>Charlson Comorbidity Index 5+</td>
<td>1.4 (0.6–2.9)</td>
<td>0.430</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>2.4 (1.3–4.7)</td>
<td>0.007</td>
</tr>
<tr>
<td>Delirium</td>
<td>1.0 (0.5–2.1)</td>
<td>0.901</td>
</tr>
<tr>
<td>Time to mobilize &gt;48 h</td>
<td>1.7 (0.9–3.4)</td>
<td>0.136</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>11.0 (1.5–78.7)</td>
<td>0.017</td>
</tr>
<tr>
<td>Cardiovascular complication</td>
<td>1.6 (0.8–3.2)</td>
<td>0.151</td>
</tr>
</tbody>
</table>
The role of perioperative oral nutritional supplementation in elderly patients after hip surgery
Oral multinutrient supplements started before or soon after surgery
  o May prevent complications within the first 12 months after hip fracture – low quality evidence
  o No clear effect on mortality.

Adequately sized randomised trials are required
Recommendations for future research

- Exercise supported by behavioral strategies that focus on adherence and reflect patient preferences.

- Assess integration of rehabilitation services
  - Relationship between malnutrition, fracture healing, rehabilitation, and future fracture risk
Summary

- Rehabilitation services are inter-dependent, but the episode of rehabilitation remains poorly defined.
- Rehabilitation research has a growing evidence base much of which supports the use of rehabilitation services.
- Studies adhering to physiologic principles show greater effectiveness.
Thank you!

Daniel Pinto, PhD, PT | d.pinto@marquette.edu