Hip Replacement:
A Total View within the ICF

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Content

Part I – Global Introduction

1. Topics - Total Hip Replacement and Hip Fracture

- Hip replacements are done for:
  - osteoarthritis (70%)
  - femoral neck fractures accounting for 10%
  - avascular necrosis and rheumatoid arthritis, combined, leading to 3% of the procedures
- Hip fracture
  - Hip fracture is a leading cause of profound morbidity in individuals aged 65 years and older
  - Worldwide, the number of people with hip fracture is expected to rise significantly due to the aging population and other factors.

Rizzo, 2019; McDonough et al, 2021

Part I – Global Introduction

2. A Broad Perspective – Enhanced Recovery after Surgery

Enhanced Recovery after surgery (ERAS) Protocols in Orthopedic Patients

- Key Points

- ERAS represents a leading example of evidence-based, multidisciplinary, multimodal perioperative care.
- ERAS pathways include standardized elements with demonstrated benefits in respect to recovery, tailored to the individual surgical subtype.
- Within orthopedic surgery, ERAS has been most widely applied to elective total hip and knee arthroplasty, with consequent reductions in length of hospital stay and complications.
- ERAS has the potential to improve the quality of care for patients undergoing orthopedic surgery.

Soffin, 2020

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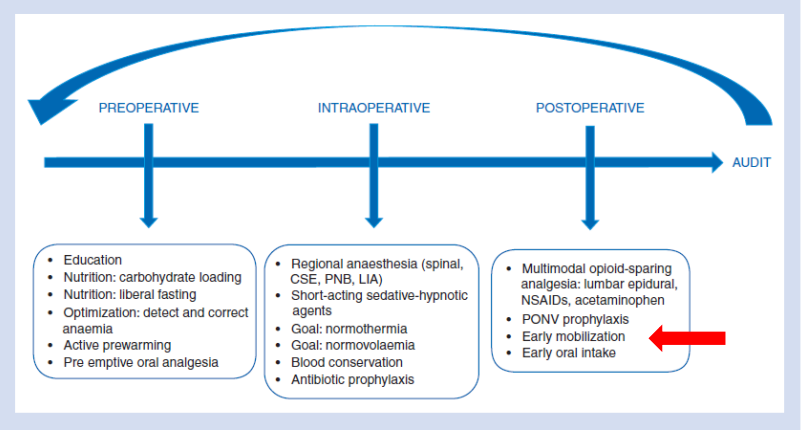
Part I – Global Introduction

2. A Broad Perspective – Enhanced Recovery after Surgery

Enhanced Recovery after surgery (ERAS) Protocols in Orthopedic Patients



A recommended protocol for ERAS for total joint arthroplasty. This diagram highlights the multimodal, multidiscliplinary nature of ERAS protocols. Audit is required and is a key driver of continuous evaluation and refining of the components of care. CSE, combined spinal–epidural; ERAS, enhanced recovery after surgery; LIA, local infiltration anaesthesia; NSAID, non-steroidal anti-inflammatory; PNB, peripheral nerve block; PONV, postoperative nausea and vomiting. (Soffin, 2016)

Part I – Global Introduction

3. A Broad Perspective – WHO Call-to Action

Role of Rehabilitation

- The World Health Organization has recently highlighted a substantial unmet need for rehabilitation worldwide, with a 2017 Call-to-Action to increase the role of rehabilitation in health care as an essential component of integrated health services.
- It was acknowledged that there is a profound unmet need for rehabilitation.

Dyer, et al.,2021

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Part I – Global Introduction

3. A Broad Perspective – WHO Call-to Action

ICF Framework

- The World Health Organization (WHO) International Classification of Functioning, Disability and Health (ICF) framework provides a standardised framework for the classification and description of health, functioning and disability.
- It moves away from the idea that disability is simply the consequence of disease or ageing towards an approach that acknowledges factors created by the social environment and it attempts to explicitly identify barriers and facilitators to social inclusion.
- Functioning and disability are seen as multidimensional concepts.

Dyer, et al.,2021

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Part I – Global Introduction

4. ICF Framework

Basisbegrippen

- De ICF bevat beschrijvers (los van oorzaak) van het menselijk functioneren ~ beschrijvend model
- De ICF bevat een ordening van verschijnselen met gelijke kenmerken (tot componenten)
- Beschrijving vanuit drie perspectieven:
  - de mens als organisme
    - *functies & anatomische eigenschappen*
  - het menselijk handelen
    - *activiteiten*
  - deelname aan de samenleving
    - *participatie*

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Part I – Global Introduction

4. ICF Framework

ICF-schema (1)

- Het menselijk functioneren (functioneringsproblemen) vanuit drie perspectieven

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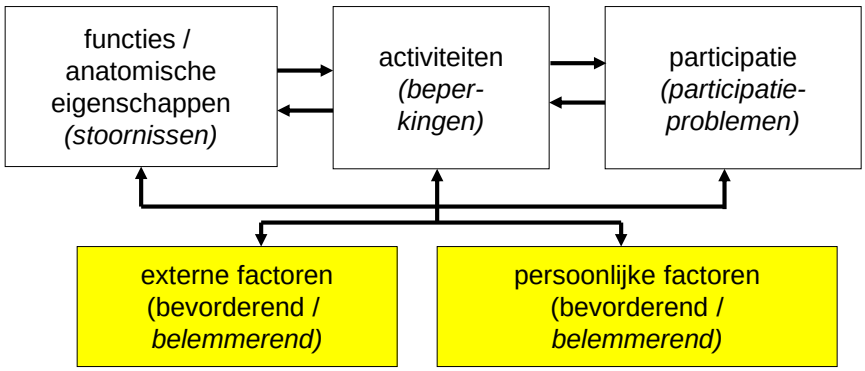
Part I – Global Introduction

4. ICF Framework

ICF-schema (2)

- De externe en persoonlijke factoren en het menselijk functioneren



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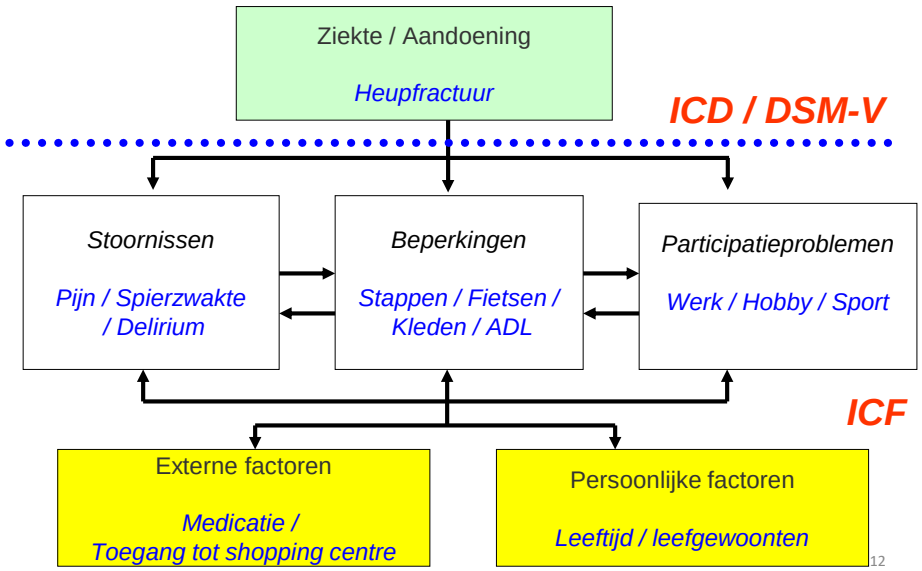
4. ICF Framework



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Part I – Global Introduction

4. ICF Framework

Structuur van de ICF

De ICF bevat vier classificaties:

1. Classificatie van anatomische eigenschappen
2. Classificatie van functies
3. Classificatie van activiteiten en participatie
4. Classificatie van externe factoren

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Part I – Global Introduction

4. ICF Framework

Classificatie van anatomische eigenschappen

Anatomische eigenschappen
1 Anatomische eigenschappen van zenuwstelsel
2 Anatomische eigenschappen van oog, oor en verwante structuren
3 Anatomische eigenschappen van structuren betrokken bij stem en spraak
4 Anatomische eigenschappen van bloedvatenstelsel, afweersysteem en ademhalingsstelsel
5 Anatomische eigenschappen van spijsverteringsstelsel, metabool stelsel en hormoonstelsel
6 Anatomische eigenschappen van urogenitaal stelsel
7 Anatomische eigenschappen van structuren verwant aan beweging
8 Anatomische eigenschappen van huid en verwante structuren

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Part I – Global Introduction

4. ICF Framework

Classificatie van functies

Functies
1 Mentale functies
2 Sensorische functies en pijn
3 Stem en spraak
4 Functies van hart en bloedvatenstelsel, hematologisch systeem, afweersysteem en ademhalingsstelsel
5 Functies van spijsverteringsstelsel, metabool stelsel en hormoonstelsel
6 Functies van urogenitaal stelsel en reproductieve functies
7 Functies van bewegingssysteem en aan beweging verwante functies
8 Functies van huid en verwante structuren

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Part I – Global Introduction

4. ICF Framework

Classificatie van activiteiten en participatie

Activiteiten en Participatie
1. Leren en toepassen van kennis
2. Algemene taken en eisen
3. Communicatie
4. Mobiliteit
5. Zelfverzorging
6. Huishouden
7. Tussenmenselijke interacties en relaties
8. Belangrijke levensgebieden
9. Maatschappelijk, sociaal en burgerlijk leven

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Part I – Global Introduction

4. ICF Framework

Classificatie van externe factoren

Externe factoren
1 Producten en technologie
2 Natuurlijke omgeving en door de mens aangebrachte veranderingen daarin
3 Ondersteuning en relaties
4 Attitudes
5 Diensten, systemen en beleid

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Part I – Global Introduction

4. ICF Framework

Persoonlijke factoren

- Er is geen classificatie van de persoonlijke factoren
- deze factoren betreffen de individuele achtergrond van het leven van een individu en bestaan uit kenmerken van het individu die **geen** deel uitmaken van zijn functionele gezondheidstoestand
- Deze kunnen omvatten: leeftijd, ras, geslacht, opleiding, ervaringen, persoonlijkheid en karakter, bekwaamheden, aandoeningen, lichamelijke conditie in het algemeen, levensstijl, levensgewoonten, copingstijl, opvoeding, redzaamheid, zelfbeeld, sociale achtergrond, beroep en ervaringen uit het heden en verleden, …

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2. A Broad Perspective – Enhanced Recovery after Surgery (ERAS)
3. A Broad Perspective – WHO Call-to-Action
4. ICF Framework

Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction
2. Rehabilitation Protocol
3. Physical Therapy - Diagnosis
4. Physical Therapy – Treatment Plan

Part III – Hip Fracture

1. Introduction
2. Rehabilitation Protocol
3. Physical Therapy - Diagnosis
4. Physical Therapy – Treatment Plan

Part IV – Practical Applications

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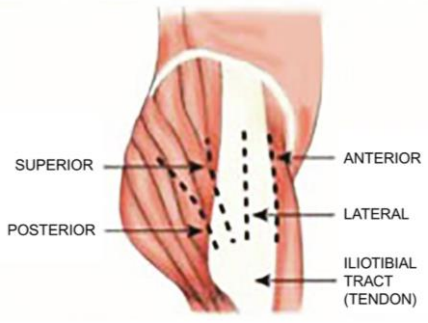
Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features



Surgical approach for total hip arthroplasty (THA)

Avers, Wong, 2020

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

Approach	Description	Rerhabilitation Considerations
Anterior (Smith-Peterson)	More technically demanding, requires special surgical table. Risk to lateral femoral cutaneous nerve. Leaves posterior capsule and muscles intact, thus no hip precautions, except maybe to restrict hip extension to neutral. Incision is made between the rectus femoris and tensor fascia latae.	Active and isolated hip flexion can be extremely painful, thus causing activities such as sit-to-supine transition to be very difficult. Overall less pain and faster progression in function and use of assistive device as compared with posterior approach. These patients can manage at home on their own.

Avers, Wong, 2020

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

Approach	Description	Rerhabilitation Considerations
Posterior	Traditional approach that provides the best visualization, minimal risk of nerve damage. Used in presence of osteoporosis, obesity, and significant bone deformity. Generally splits the gluteus maximus and excises the tendons of the piriformis, superior and inferior gemelli. Spares the gluteus medius.	No flexion over 90 degrees. No internal rotation. No adduction past midline for 3–6 weeks. Generally difficult to return home immediately because of precautions and amount of surgical dressing.

Avers, Wong, 2020

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

Approach	Description	Rerhabilitation Considerations
Lateral Approach	Low chance of posterior dislocation. More abductor insufficiency (4% to 20% vs. 0 to 16% with posterior approach) because hip abductors are incised.	Patient may limp for 3 or more months secondary to gluteus medius weakness. May need assistive device for 3 or more months postoperatively. Risk of permanent limp.
Superior	Advertised as outpatient procedure or 1-night stay. Avoids incising IT band, but does incise the piriformis tendon. Blood loss is minimal (no transfusions). Dislocations rare.	No precautions. Early return to function. Minimal hospital

Avers, Wong, 2020

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

Facts and Challenges

- Several challenges lie ahead to improve recovery after hip arthroplasty.
  - For example, according to patient-reported outcomes (PROMs), the overall result is generally positive, although discrepancies are seen when PROMs are compared to performance-based function.
  - Also, postoperative activity levels are disappointingly low in many patients, and around 20% of patients are socially isolated following surgery.
  - Additionally, about 5 to 20% of all patients report chronic pain after THA.

Bandholm, et al., 2018

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

Facts and Challenges

- Several challenges lie ahead to improve recovery after hip arthroplasty.
  - Studies focusing on quality of life as an endpoint report general satisfaction of patients and surgeons in the short term. However, clinical series describe persistence of pain, deficit in range of motion or in strength and functional limitations, including speed of gait and postural stability up to 1 year post operation in a small percentage of patients.
  - Other authors have shown weakness of the hip muscles up to 2 years from surgery, even if gait pattern is normal. This weakness seems to influence static and dynamic balance and could be a major risk factor for falls in the elderly population.
  - Some authors suggest that exercise in the first phases of rehabilitation are not sufficient for patients to regain full recovery of muscle function and postural stability and that they should be continued for the whole first year.

Colibazzi, et al., 2020

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

Facts and Challenges

- Today, even if rehabilitation is considered an important factor in postoperative recovery, it is not clear what type of exercises and what timing is necessary to improve outcome in the short and medium term, or to enhance independence and quality of life for patients.
- Since the length of hospital stay and the overall risk of complications have been reduced with the concept of fast-track surgery or enhanced recovery programs, the main focus of perioperative care should now be on how to accelerate post-discharge recovery and physical rehabilitation.
- Since the guidelines and protocols are not based on evidence but mostly on clinical expertise, we have conducted a systematic review of the existing literature to collate the best evidence and to create a rehabilitative protocol based on this.

Colibazzi, et al., 2020 Bandholm, et al., 2018

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Part II – Total Hip Replacement (Osteoarthritis)

2. Rehabilitation Protocol

Evidence-Based Rehabilitation Recommendtions based on Guidelines and Evidence-Based Information

- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
- Evidence based rehabilitation after hip arthroplasty – systematic review (Colibazzi, et al., 2020)

Colibazzi, et al., 2020 KNGF, 2018

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Part II – Total Hip Replacement (Osteoarthritis)

3. Physical Therapy - Diagnosis

Guidelines and Evidence-Based Rehabilitation

- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
  - Schematisch overzicht van probleemgebieden en beïnvloedende factoren bij artrose van heup aan de hand van de International Classification of Functioning, Disability and Health (ICF) Core Sets for osteoarthritis
    - verkorte ICF core sets, aangevuld met klinisch relevante factoren op basis van expert opinion.

KNGF, 2018

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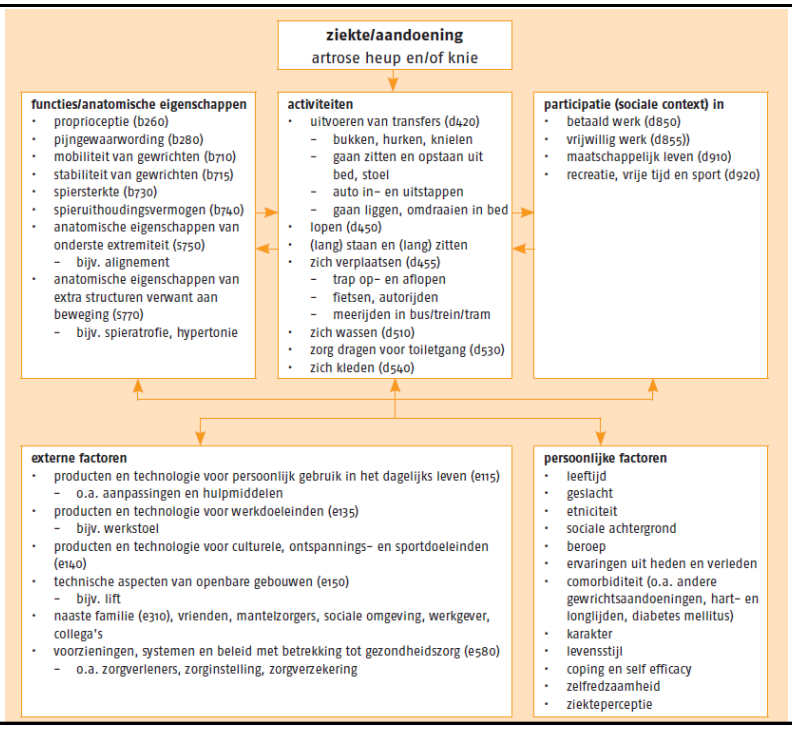

Part II – Total Hip Replacement (Osteoarthritis)

3. Physical Therapy - Diagnosis

Guidelines and Evidence-Based Rehabilitation

- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
  - Meetinstrumenten

KNGF, 2018

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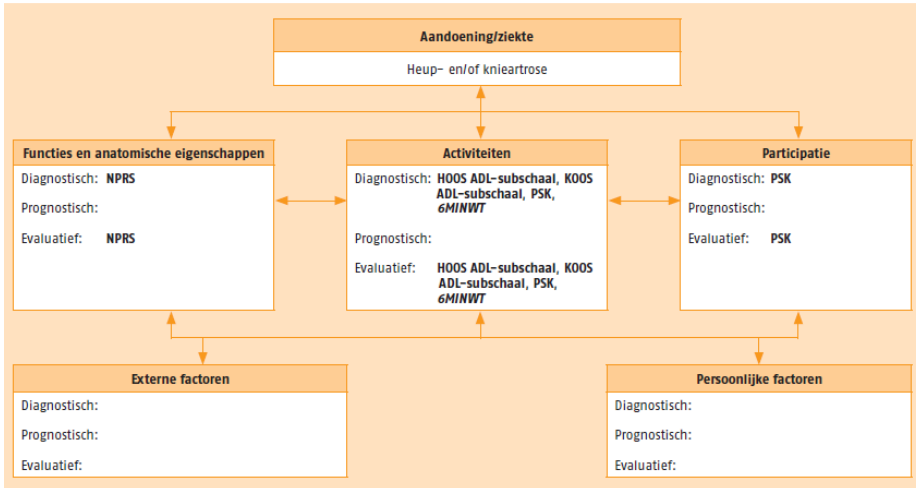
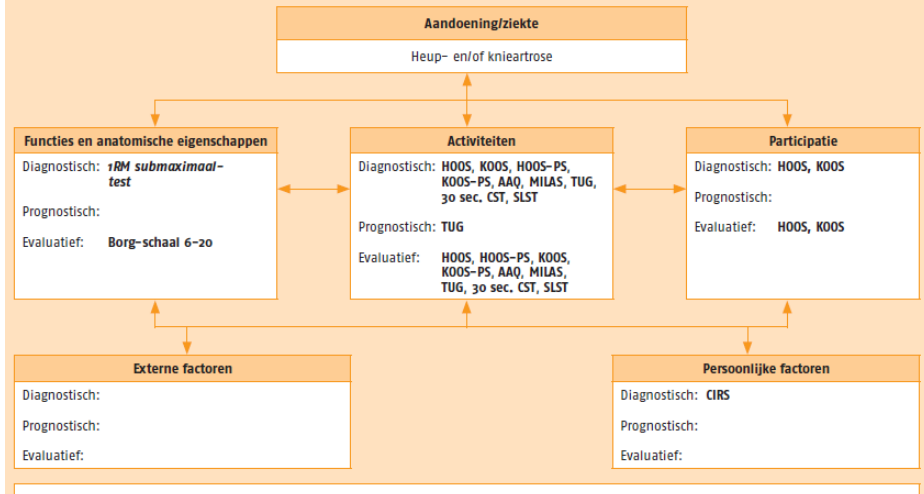


Toelichting 6MINWT = Zes Minuten Wandeltest; HOOS ADL-subschaal = *Hip Injury and Osteoarthritis Outcome Score* – Subschaal 'Functioneren in het dagelijks leven'; KOOS ADL-subschaal = *Knee Injury Osteoarthritis Outcome Score* – Subschaal 'Functioneren in het dagelijks leven'; NPRS = *Numeric Pain Rating Scale*; PSK= Patiënt Specifieke Klachten. *Cursief* = performancetest/functietest; niet cursief = vragenlijst/observatielijst. **NB** Voor het in kaart brengen van externe en persoonlijke factoren zijn geen voldoende betrouwbare en valide meetinstrumenten beschikbaar als aanbevolen meetinstrument.

Figuur 1a. Overzicht van de aanbevolen meetinstrumenten.



Toelichting 30 sec. CST = 30 sec *Chair-Stand-Test*; AAQ = *Animated Activity Questionnaire*; CIRS = *Cumulative Illness Rating Scale* voor het vastleggen van comorbiditeit; HOOS-PS = *Hip Injury and Osteoarthritis Outcome Score – Physical function Shortform*; KOOS-PS = *Knee Injury and Osteoarthritis Outcome Score – Physical function Shortform*; SLST = *Single Leg Stance Test*; MILAS = *Modified IOWA Level of Assistance Score*; TUG = Timed Up & Go test. *Cursief* = performancetest/functietest; niet cursief = vragenlijst/observatielijst. **NB** Voor het in kaart brengen van externe factoren zijn in deze richtlijn geen geschikte meetinstrumenten gevonden.

Figuur 1b. Overzicht van de optionele meetinstrumenten.

Part II – Total Hip Replacement (Osteoarthritis)

4. Physical Therapy – Treatment Plan

Guidelines and Evidence-Based Rehabilitation

- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
  - Postoperatieve fase na een gewrichtsvervangende operatie

KNGF, 2018

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Part II – Total Hip Replacement (Osteoarthritis)

KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)

Postoperatieve fase na een gewrichtsvervangende operatie

Volg de algemene FITT-factoren, maar pas deze als volgt aan:

- **Postoperatieve, klinische fase:**
  - Richt de oefentherapie op het zelfstandig en veilig uitvoeren van transfers, zoals:
    - opstaan uit bed,
    - gaan opstaan en zitten vanaf een stoel,
    - toiletbezoek, lopen (met loophulpmiddel),
    - en indien nodig traplopen (met loophulpmiddel)

KNGF, 2018

Part II – Total Hip Replacement (Osteoarthritis)

KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)

Postoperatieve fase na een gewrichtsvervangende operatie

Volg de algemene FITT-factoren, maar pas deze als volgt aan:

- **Postoperatieve, postklinische fase:**
  - Richt de oefentherapie op:
    - functionele training (transfers, lopen en traplopen, gebruik van loophulpmiddel);
    - balanstraining (statische en dynamische balans);
  - Hanteer de (minimale) door de behandelend orthopedisch chirurg voorgeschreven leefregels ten aanzien van gewrichtsbelasting en -mobiliteit.
  - Stem de FITT-factoren af op de individuele patiënt, waarbij rekening gehouden wordt met de aanwezigheid van risicofactoren voor een vertraagd herstel, het wondherstel, eventuele hechtingen in de eerste twee weken na operatie, en de signalen die kunnen wijzen op een verminderde belastbaarheid van het gewricht (toenemende pijnklachten, niet afnemende zwelling).

KNGF, 2018

Part II – Total Hip Replacement (Osteoarthritis)

KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)

Postoperatieve fase na een gewrichtsvervangende operatie

Volg de algemene FITT-factoren, maar pas deze als volgt aan:

- **Postoperatieve, postklinische fase:**
  - Houd bij de frequentie en tijdsduur van de oefentherapie er rekening mee dat het postoperatief beloop sterk varieert tussen individuele patiënten.
  - Bouw het gebruik van een loophulpmiddel na zes weken af, of eerder indien mogelijk en/of afhankelijk van het type operatie
  - Neem contact op met de behandelend orthopedisch chirurg en/of de huisarts, indien er sprake lijkt te zijn van stagnatie in het herstelproces en/of (ernstige) complicaties van de operatie

KNGF, 2018

Part II – Total Hip Replacement (Osteoarthritis)

4. Physical Therapy – Treatment Plan

Guidelines and Evidence-Based Rehabilitation

- Evidence based rehabilitation after hip arthroplasty (Colibazzi, et al, 2020)
  - Indications for rehabilitation

Colibazzi et al, 2020

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Part II – Total Hip Replacement (Osteoarthritis)

Evidence based rehabilitation after hip arthroplasty (Colibazzi, et al, 2020)

Indications for rehabilitation

- **Preoperative**
  - A multidisciplinary team is necessary to optimise preparation for surgery; it may be effective for anxiety and length of stay, especially in subjects with complex assistance needs.
  - meeting with both surgeon and physiotherapist
    - information about hospital stay, type of surgery, potentially dangerous movements in the acute postoperative phase (flexion >90°, internal rotation and adduction over middle line), standards for hospital discharge and activities for daily living (occupational therapist consultation), including sexual activity.
  - A short period of physiotherapy preoperatively with the following goals:
    - Reducing pain
    - Stretching contracted musculature
    - Muscle strengthening (especially quadriceps and abductors)
    - Cardiovascular training
    - Training in walking with crutches.

Colibazzi et al, 2020

Part II – Total Hip Replacement (Osteoarthritis)

Evidence based rehabilitation after hip arthroplasty (Colibazzi, et al, 2020)

Indications for rehabilitation

- **Postoperative**
  - **Days 0–2.**
    - Goals: controlling pain, thromboembolic prophylaxis, ROM recovery, postural verticalisation.
    - Bed exercise
      - dorsal and plantar foot flexion
      - quadriceps, gluteus medius and adductor isometric contractions
      - passive mobilisation in the allowed range of motion
      - postural transition from sitting to standing
      - walking with crutches or walker, as early as possible.

Colibazzi et al, 2020

Part II – Total Hip Replacement (Osteoarthritis)

Evidence based rehabilitation after hip arthroplasty (Colibazzi, et al, 2020)

Indications for rehabilitation

- **Postoperative**
  - **Days 3–7.**
    - Goals: maintain standing position, gain confidence in the use of crutches and in postural transitions (supine to sitting, sitting to standing).
      - continue with previous exercises
      - introduce concentric contractions (quadriceps, adductor and abductor)
      - walking with crutches, reciprocal way
  - **2–4 weeks.**
    - Goals: increasing allowed ROM and muscular tone, controlling standing position, walking pattern without deficit.
      - continue with previous exercises
      - abductor contraction in standing position
      - squat in standing position (<90°)
      - elevation on the toes
      - bridge exercise
      - training on treadmill from the 4th week, earlier if possible
      - training in walking with one crutch (contralateral)

Colibazzi et al, 2020

Part II – Total Hip Replacement (Osteoarthritis)

Evidence based rehabilitation after hip arthroplasty (Colibazzi, et al, 2020)

Indications for rehabilitation

- **Postoperative**
  - **5–7 weeks**
    - Goals: absence of pain, regain pre-op lifestyle.
      - continue with previous exercises
      - free walking in protected situation
      - introduce functional exercises like sit to standing, go up the stairs, climb over obstacles
      - balance exercises on unstable boards, walking with changing of speed and direction.
  - **From 8th week**
    - continue with previous exercises
    - increasing ROM and strength
    - go on with supervised rehabilitation.

Colibazzi et al, 2020

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Part III – Hip Fracture

1. Introduction

Facts and Challenges

- Hip fractures are common fragility fractures usually caused by low-energy trauma, such as falls, primarily in older people with osteoporosis.
- Hip fractures result in high morbidity rates and seriously impair mobility and the ability to perform daily activities.
- Nearly one-half of women with hip, pelvic, or lower limb fracture had not regained prefracture mobility at 1 year after the injury.
  - Individuals report difficulty with bending (hip and vertebral fractures), walking down stairs (hip, ankle, and vertebral fractures), and reaching (vertebral and humeral fractures). These mobility issues can have a negative impact on balance and activity levels.

Min, et al., 2021 Avers, Wong., 2020

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Part III – Hip Fracture

1. Introduction

Facts and Challenges

- Chronic pain after a fracture and in the later stages of recovery is also a frequent complaint. Rates of chronic pain among older adults with fracture is high, estimated at 43% in vertebral fractures and 42% in hip fractures.
  - This pain has a negative impact on return to normal activities, may restrict social participation, and reinforces inactivity
- The mortality rate within one year after the occurrence of a hip fracture is reported to be 18%–31%.
- In the long term, only half of the patients were able to walk without assistance and approximately one-fifth required care services.
- Patients who have had a hip fracture are 2.5 times as likely to have a subsequent hip fracture caused by a fall when compared with age-matched peers.

Min, et al., 2021 Avers, Wong., 2020

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Part III – Hip Fracture

1. Introduction

Facts and Challenges

- With hip fractures, the life expectancy of people aged >80 years was shortened by 1.8 years, and the life expectancy of those with hip fractures decreased by 25% compared to the age-matched people without hip fractures.
- When a hip fracture occurs in women aged ≥70 years, the excess mortality rate is 9 per 100 patients.
- In a study of hip fracture surgery (HFS) (n=2,208), intensive rehabilitation after surgery significantly reduced the mortality rate at 6 months.
- One study showed that 50% of postoperative deaths could be avoided.

Min, et al., 2021

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Part III – Hip Fracture

1. Introduction

Challenges

Fragility Fracture Network (FFN) - Global Call to Action (2018)

- A call for implementation of a systematic approach to fragility fracture care with the goal of restoring function and preventing subsequent fractures without further delay.
- There is an urgent need to improve:
  - Acute multidisciplinary care for the person who suffers a hip, clinical vertebral and other major fragility fractures
  - Rapid secondary prevention after first occurrence of all fragility fractures, including those in younger people as well as those in older persons, to prevent future fractures
  - Ongoing post-acute care of people whose ability to function is impaired by hip and major fragility fractures

Dreihofer et al., 2018

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Part III – Hip Fracture

1. Introduction

Hip fractures: classification

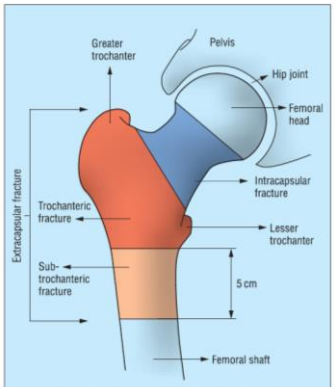

FIGURE 1. Classification of hip fractures. Fractures in the blue area are intracapsular and those in the red and orange areas are extracapsular. Reproduced with permission from Parker M, Johansen A. Hip fracture. BMJ. 2006;333:27-30. https://doi.org/10.1136/bmj.333.7557.27 Copyright ©2006 BMJ Publishing Group Ltd.

McDonough, et al., 2021

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Part III – Hip Fracture

1. Introduction

Hip fractures: surgical management

Palm, 2021

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Part III – Hip Fracture

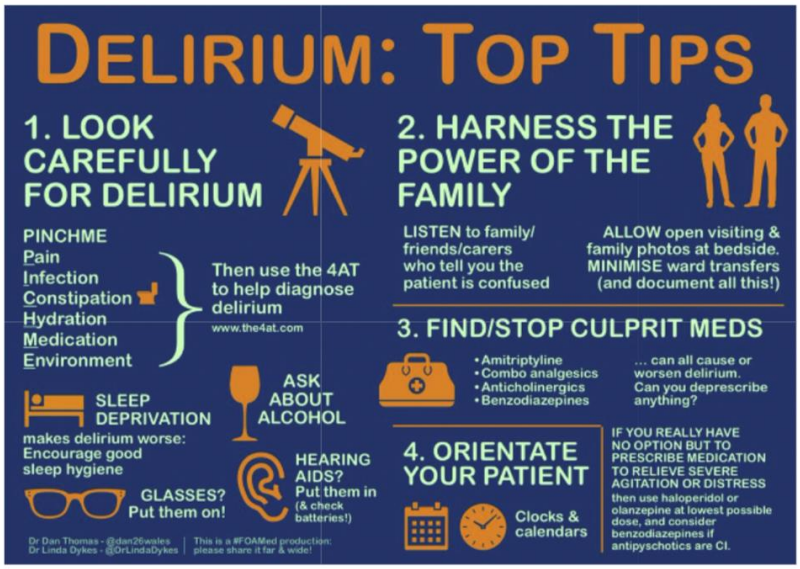
1. Introduction

Postoperative management to prevent complications requires a multidisciplinary approach

A minimum set of standardised protocols that should be implemented in the orthogeriatric setting include the following:

- Prophylaxis of venous thromboembolism
- Antibiotic prophylaxis
- Urinary catheter utilisation
- Pain control
- Skincare and pressure-relieving mattresses
- Constipation and stool impaction prevention
- Delirium prevention
- Post-operative haemoglobin monitoring and management of anaemia
- Malnutrition detection and correction/nutritional support
- Monitoring of vital physiological parameters
- Supplemental oxygen as appropriate
- **Early mobilisation**

Pioli et al., 2021



Tips for Managing delirium in the hospital

Part III – Hip Fracture

2. Rehabilitation Protocol

Evidence-Based Rehabilitation Recommendtions based on Guidelines and Evidence-Based Information

- McDonough CM, Harris-Hayes M, Kristensen MT, et al. Physical therapy management of older adults with hip fracture. J Orthop Sports Phys Ther. 2021;51:CPG1-CPG81.
- K. Min, J. Beom, and B. R. Kim, et al. "Clinical practice guideline for postoperative rehabilitation in older patients with hip fractures," Annals of Rehabilitation Medicine, vol. 45, no. 3, pp. 225–259, 2021.
- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
- Rehabilitation Following Hip Fracture. Dyer, et al. (2021)
- Rehabilitation After Geriatric Hip Fractures. Sperring, et al. (2021)

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Part III – Hip Fracture

3. Physical Therapy - Diagnosis

Guidelines and Evidence-Based Rehabilitation

- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
  - Meetinstrumenten
    - Zie Meetinstrumenten 'Total Hip Replacement'
- McDonough CM, Harris-Hayes M, Kristensen MT, et al. Physical therapy management of older adults with hip fracture. J Orthop Sports Phys Ther. 2021;51:CPG1-CPG81.
  - Examination – Recommendations
    - Gait speed
    - Timed-up and Go
    - Falls Efficacy Scale-International
    - Strength Hip extensors an abductors
    - 30 sec. sit-to-stand
    - 6MWT
    - ~ BESTest ~

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Part III – Hip Fracture

4. Physical Therapy – Treatment Plan

Guidelines and Evidence-Based Rehabilitation

- KNFG-richtlijn "Artrose Heup-Knie" (KNGF, 2018)
  - Postoperatieve fase na een gewrichtsvervangende operatie

- McDonough CM, Harris-Hayes M, Kristensen MT, et al. Physical therapy management of older adults with hip fracture. J Orthop Sports Phys Ther. 2021;51:CPG1-CPG81.
- K. Min, J. Beom, and B. R. Kim, et al. "Clinical practice guideline for postoperative rehabilitation in older patients with hip fractures," Annals of Rehabilitation Medicine, vol. 45, no. 3, pp. 225–259, 2021.
- Rehabilitation Following Hip Fracture. Dyer, et al. (2021)
- Rehabilitation After Geriatric Hip Fractures. Sperring, et al. (2021)

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Table 10.1 Key studies in rehabilitation after geriatric hip fracture

Study	Year	Comment
Beckmann et al. [8]	2020	Exercise intervention started in the early phase of rehabilitation improved physical function, with no clear superior exercise type or setting
Auais et al. [52]	2020	Greater social support increases patients' sense of self-efficacy, which is important to maintain as low self-efficacy can limit functioning and hinder rehabilitation
Pol et al. [51]	2019	Patients appreciated support and coaching, as well as contact with other rehabilitants during their inpatient stay and maintaining those contacts during recovery
Nordstrom et al. [29]	2018	Rehabilitation involving interdisciplinary geriatric teams improved mobility and physical function when compared to standard care
Nishioka et al. [45]	2018	Improved nutritional status was associated with better performance on ADLs among malnourished hip fracture patients, and weight loss was a strong predictor of decreased functional recovery
Diong et al. [33]	2016	Exercise intervention within 1 year of injury led to small yet significant improvements in overall mobility
Niitsu et al. [45]	2016	Hip fracture patients receiving whey protein supplementation during the early postoperative period had greater bilateral muscle strength and better scores on ADLs
Edgren et al. [25]	2015	Patients receiving home-based rehabilitation may have a greater reduction in disability when compared to those patients who received just physical therapy education at the bedside
Boddaert et al. [31]	2014	Discharge within 48 h to a geriatric unit which focused on comorbidities and rehabilitation improved mortality and morbidity at 6 months
Li et al. [41]	2013	64% of hip fracture patients suffered from malnutrition, and those malnourished performed worse on ADLs when compared to those non-malnourished

Abbreviations: *ADLs* activities of daily living

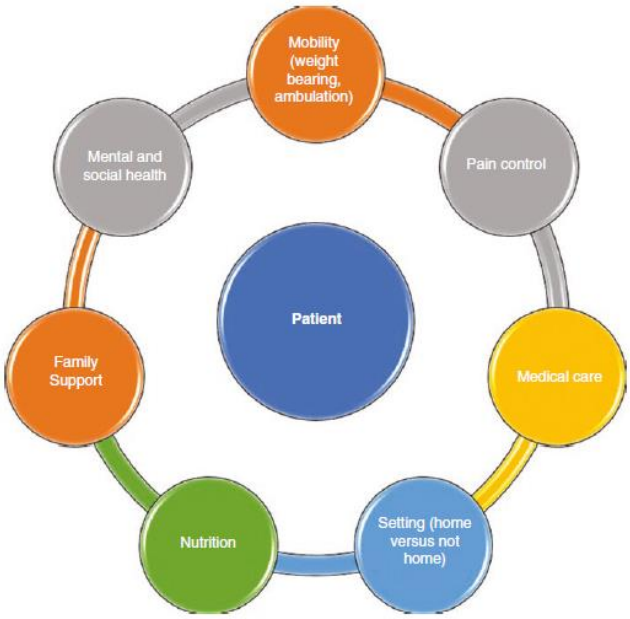


Fig. 10.1 A model of factors that determine patient recovery after geriatric hip fracture

Stage of Hip Fracture	Acute Rehabilitation (Hospital)	Postacute Rehabilitation	Enduring Stage	
Approximate duration	~ 7–10 days	7 days–3 months	3–6 months	6 months–1 year
Primary interventions	• Early weight-bearing • Bed mobility • Lower extremity/quadriceps strengthening • Pain modulation	• Stepping and improving quality of movement to reduce fear of falling • Improve confidence with activity • Improve muscle strength through progressive high-intensity resistance training • Balance Training • Mood/self-efficacy (goal setting, self-monitoring)	• Progressive strengthening tailored toward persisting deficits (e.g., full loading, gluteal weakness) • Advanced balance training	• Support for independent exercise routine • Problem-solving any residual symptoms • Community-based physical activity
Goals of intervention	• Independent with: • bed mobility • sit to stand • walking with assistive device • Cognitive recovery (2–4 months)		• Prefracture walking ability: 6 months	• 6–9 months: gait and balance recovered • 10–14 months lower limb function recovered

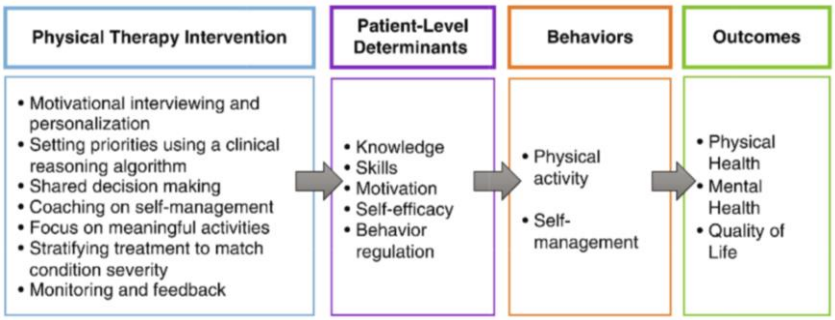
Naar Avers, Wong, 2020

Part III – Hip Fracture

4. Physical Therapy – Treatment Plan

Guidelines and Evidence-Based Rehabilitation

- **Health Behaviour Change**



Logic model of change in physical activity behavior. (Avers, Wong, 2021)

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Part III – Hip Fracture

4. Physical Therapy – Treatment Plan

Evidence based rehabilitation after hip fracture

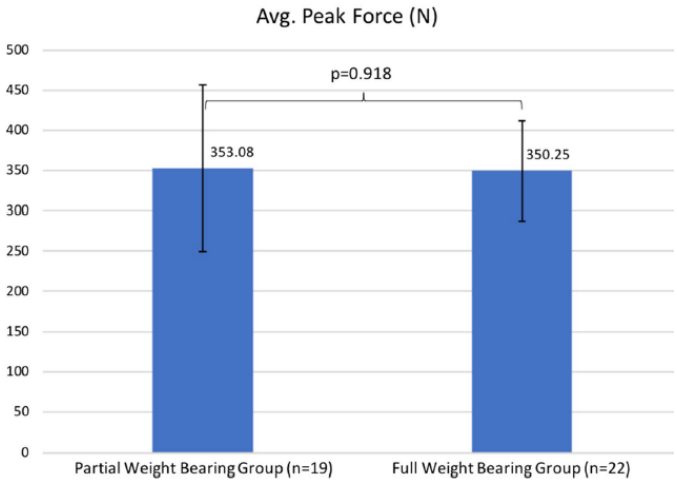
Indications for rehabilitation – Specific topics

- **Weight-Bearing Considerations**
  - The amount of weight bearing permissible during early ambulation and transfers is always determined by the surgeon for each patient on an individual basis.
  - Factors that influence the decision are the patient's age and bone quality, the fracture location and pattern, the type of fixation used to stabilize the fracture site, and the degree of intraoperative stability achieved.
  - Weight-bearing restrictions in elderly hip fracture patients contributed to a loss of mobility, while no significant differences in loading of the affected extremity were observed.
  - Therefore, postoperative weight-bearing restrictions in elderly hip fracture patients should be avoided, to achieve early mobilization at full weight bearing.

Kisner, 2017 Pfeufer et al, 20219

Part III – Hip Fracture

Fig. 4 The load on the affected limb in newton for the partial weight-bearing group at the left and the full weight-bearing group at the right



Part III – Hip Fracture

4. Physical Therapy – Treatment Plan

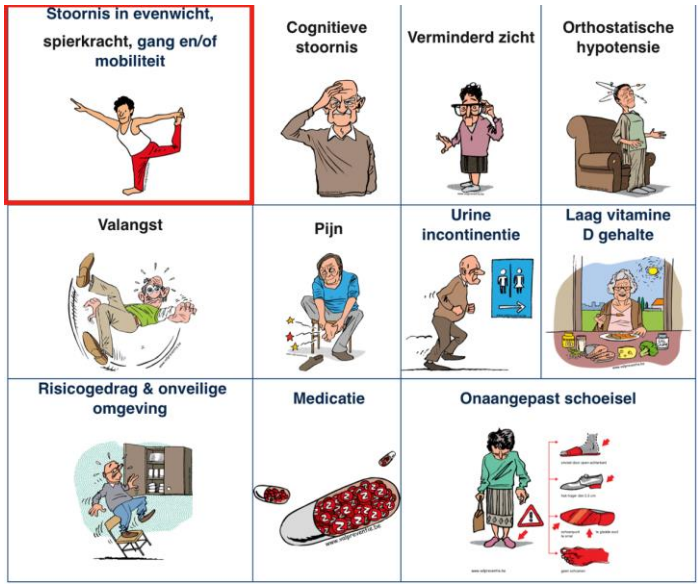
Evidence based rehabilitation after hip fracture

Indications for rehabilitation – Specific topics

- **Fall Prevention**
  - Interprofessional Management – Prevention of Falls
    - Physical therapists must assess and document patient risk factors for falls and contribute to interprofessional management. Physical therapists should use published recommendations to guide fall-risk management in patients with hip fracture to assess and manage fall risk. weight bearing.
    - **Evaluation of Postural Control**

McDonough et al., 2021

Part III – Hip Fracture



Posturale Controle: Systemen, Mechanismen en Klinimetrie

- Current clinical balance assessment tools do not aim to help therapists identify the underlying postural control systems responsible for poor functional balance.
- By identifying the disordered systems underlying balance control, therapists can direct specific types of intervention for different types of balance problems.
  - The **BESTest** is unique in allowing clinicians to determine the type of balance problems to direct specific treatments for their patients.
  - The BESTest is the most comprehensive clinical balance tool available.

Horak, 2009, p. 484

Posturale Controle: Systemen, Mechanismen en Klinimetrie

Summary of the BESTest Items Under Each System Category

TABLE 11.5 Summary of BESTest Items and Subsystem Categories

The 14 items forming the mini-BESTest for dynamic balance are in bold. Only the worst performance in items 11 (Stand on one leg) and 18 (Lateral stepping) have to be taken into account for the score. Moreover, the performance in item 27 (Cognitive Get up and Go) must be compared with that in the baseline item 26.

I. Biomechanical Constraints	II. Stability Limits	III. Anticipatory Transitions
1. Base of support	6 a. Lateral lean L	**9. Sit-to-stand**
2. Alignment	b. Lateral lean R	**10. Rise to toes**
3. Ankle strength	c. Sitting verticality L	**11. Stand on one leg**
4. Hip strength	d. Sitting verticality R	**(both right and left)**
5. Sit on floor and stand up	7. Reach forward	12. Alternate stair touch
	8 a. Reach L	13. Standing arm raise
	b. Reach R	

(*continued*)

Posturale Controle: Systemen, Mechanismen en Klinimetrie

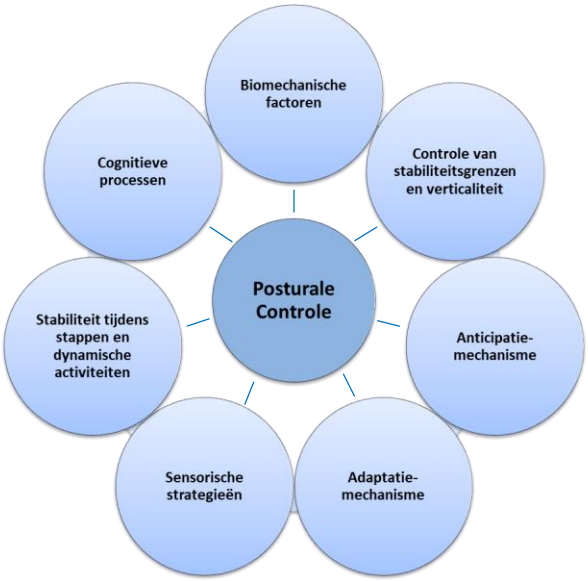
Summary of the BESTest Items Under Each System Category

TABLE 11.5 Summary of BESTest Items and Subsystem Categories (*Continued*)

IV. Postural Responses	V. Sensory Orientation	VI. Dynamic Gait
14. In-place forward	**19 a. Stance EO**	21. Gait natural
15. In-place backward	**(firm surface)**	**22. Change speed**
16. Stepping forward	b. Stance EC	**23. Head turns**
17. Stepping backward	(firm surface)	**24. Pivot turns**
18. Lateral stepping	c. Foam EO	**25. Obstacles**
(both right and left)	**d. Foam EC**	26. Get up and go
	20. Incline EC	**27. Cognitive get up and go**

EC, eyes closed; EO, eyes open; L, left; R, right.
Reprinted from Franchignoni F, Horak F, Godi M, et al. Using psychometric techniques to improve the Balance Evaluation System's Test: the mini-BESTest. J Rehabil Med 2010;42:323–331.

Posturale Controle: Systemen, Mechanismen en Klinimetrie

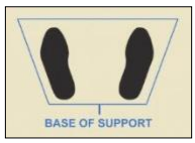


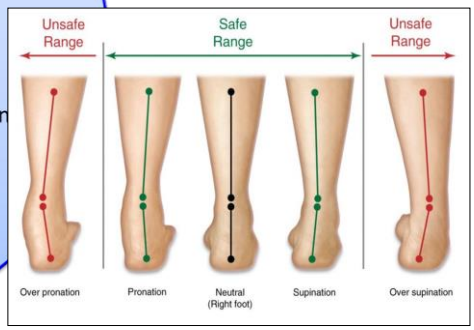
Posturale controle: systemen en mechanismen als basis voor de BESTest

Posturale Controle: Systemen, Mechanismen en Klinimetrie

Biomechanische factoren

- Kenmerken
  - Steunbasis en CoM-alignment
  - Spierkracht
  - Gewrichtsbeweeglijkheid
- Klinische tests – Behandelingsdoelen
  - Steunbasis en CoM-alignment
  - Spierkracht enkel en heup
  - Van zit op de vloer naar stand





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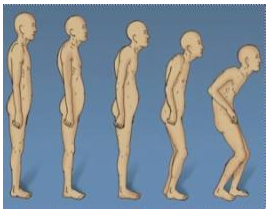
Posturale Controle: Systemen, Mechanismen en Klinimetrie

Biomechanische factoren

- Kenmerken
  - Steunbasis en CoM-alignment
  - Spierkracht
  - Gewrichtsbeweeglijkheid
- Klinische tests – Behandelingsdoelen
  - Steunbasis en CoM-alignment
  - Spierkracht enkel en heup
  - Van zit op de vloer naar stand



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Posturale Controle: Systemen, Mechanismen en Klinimetrie

Controle van stabiliteitsgrenzen en verticaliteit

- Kenmerken
  - Interne representatie van de stabiliteitsgrenzen
  - Perceptie van posturale verticaliteit
- Klinische tests – Behandelingsdoelen
  - Lateraal leunen in zit en re-alignment
  - Functional reach (voorw/zijw)

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Posturale Controle: Systemen, Mechanismen en Klinimetrie

Anticipatiemechanisme

- Kenmerken
  - Pro-actieve CoM-verplaatsing
- Klinische tests – Behandelingsdoelen
  - Van zit naar stand
  - Unipodale stand
  - Tenenstand
  - Alternerende step
  - Anteflexie armen

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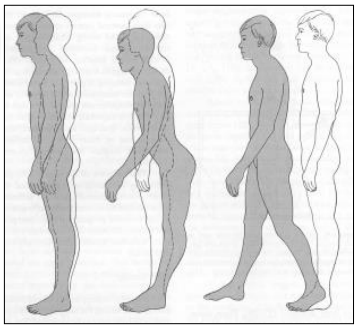
Posturale Controle: Systemen, Mechanismen en Klinimetrie

Adaptatiemechanisme

- Kenmerken
  - Re-actieve posturale controle
- Klinische tests – Behandelingsdoelen
  - Externe verstoring (push & release) (voorw/achterw)
    - Enkelstrategie
    - Heupstrategie
    - Stapstrategie



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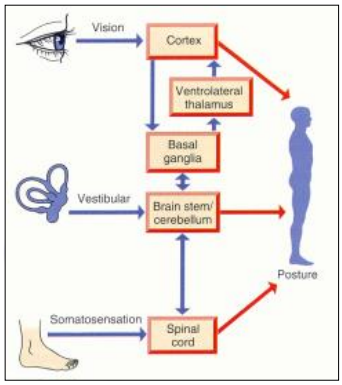
Posturale Controle: Systemen, Mechanismen en Klinimetrie

Sensorische strategieën

- Kenmerken
  - Visuele, vestibulaire en somatosensorische integratie en 're-weightening'
- Klinische tests – Behandelingsdoelen
  - CTSIB
  - Stand op inclinatiebankje



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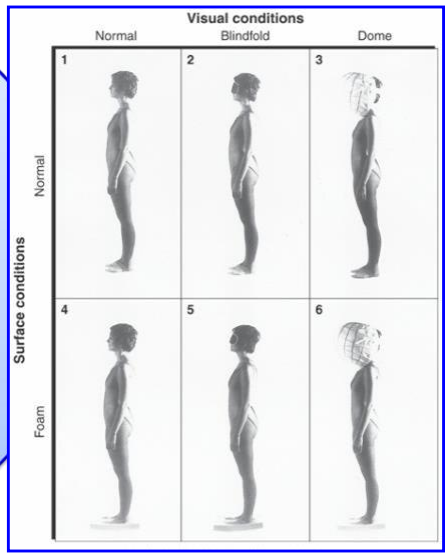
Posturale Controle: Systemen, Mechanismen en Klinimetrie

Sensorische strategieën

- Kenmerken
  - Visuele, vestibulaire en somatosensorische integratie en 're-weightening'
- Klinische tests – Behandelingsdoelen
  - CTSIB
  - Stand op inclinatiebankje



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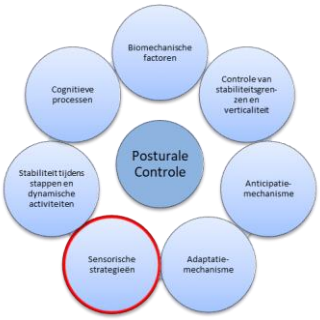
Posturale Controle: Systemen, Mechanismen en Klinimetrie

Sensorische strategieën

- Kenmerken
  - Visuele, vestibulaire en somatosensorische integratie en 're-weightening'
- Klinische tests – Behandelingsdoelen
  - CTSIB
  - Stand op inclinatiebankje



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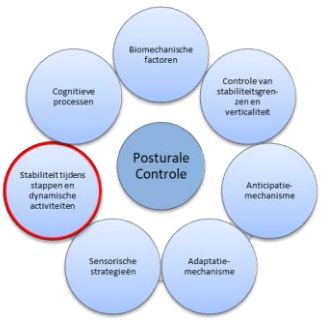
Posturale Controle: Systemen, Mechanismen en Klinimetrie

Stabiliteit tijdens stappen en dynamische activiteiten

- Kenmerken
  - Continu veranderende positie van het CoM
- Klinische tests – Behandelingsdoelen
  - Evenwicht tijdens het stappen
    - Vlakke ondergrond
    - Snelheidsveranderingen
    - Hoofdrotaties, pivoteren
    - Hindernissenparcours
    - Timed up and Go



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Posturale Controle: Systemen, Mechanismen en Klinimetrie

Cognitieve processen

- Kenmerken
  - Dubbeltaken bemoeilijken de posturale controle
- Klinische tests – Behandelingsdoelen
  - Timed 'Get up and Go' met een dubbeltaak

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Posturale Controle: Systemen, Mechanismen en Klinimetrie

Interventions for training postural control

TABLE 8.3 Balance Assessments and Interventions

Category of Balance Assessment	Clinical Tests/Measures*	Interventions if Deficits Present
Static	Observations of patient maintaining different postures; Romberg Test[127]; sharpened (tandem) Romberg[127]; Single-Leg Stance Test[173]; Stork Stand Test[84]	Vary postures Vary support surface Incorporate external loads
Dynamic	Observations of patient standing or sitting on unstable surface or performing postural transitions and functional activities; Five-times-sit-to-stand test (5 × STS)[34]	Moving support surfaces Move head, trunk, arms, legs Transitional and locomotor activities
Anticipatory (feedforward)	Observations of patient catching ball, opening doors, lifting objects of different weights; Functional Reach Test[39]; Multidirectional Reach Test[128]; Star Excursion Balance Test[132]; Y-Balance Test[152]	Reaching Catching Kicking Lifting Obstacle course

Posturale Controle: Systemen, Mechanismen en Klinimetrie

Interventions for training postural control

Reactive (feedback)	Observation of patient's responses to pushes (small or large, slow or rapid, anticipated and unanticipated); Pull Test[116]; Push and Release Test (PRT)[81]; Postural Stress Test[183]	Standing sway Ankle strategy Hip strategy Stepping strategy Perturbations
Sensory organization	Clinical Test of Sensory Integration on Balance Test (CTSIB)[157] or modified CTSIB, Balance Error Scoring System (BESS)[58]	Reduce visual inputs Reduce somatosensory cues
Balance during functional activities	Berg Balance Scale (BBS)[11]; Timed Up and Go Test (TUG)[138]; Tinetti Performance-Oriented Mobility Assessment (POMA)[165]; Balance Evaluation Systems Test (BESTest) or mini-BESTest[72]; Four Square Step Test (4SST)[35]; Dynamic Gait Index (DGI)[159]; Functional Gait Assessment (FGA)[186]; Community Balance and Mobility Scale[73]; High Level Mobility Assessment (HiMat)[179]; Dizziness Handicap Inventory (DHI)[82]	Functional activities Dual or multitask activities (e.g., walking with secondary cognitive or motor task)
Safety during gait, locomotion, or balance	Observations; home assessments; Falls Efficacy Scale[166]; Activities-Specific Balance Confidence (ABC) Scale[140]	Balance within stability limits, environmental modifications, assistive devices, external support

*Tests are listed in relative order of least to most difficult to perform.

Posturale Controle: Systemen, Mechanismen en Klinimetrie

TABLE 8.2 Outcome Measures for Fall Risk Assessment

Outcome Measure	Perfect Score	Cut-off Score (Sensitivity, Specificity)*
Berg Balance Test	56	<46 (25%, 87% for predicting any fall and 42%, 87% for multiple falls)[115]
Tinetti Performance-Oriented Mobility Assessment	28 (Balance subscale 16, Gait subscale 12)	<20 for elderly (64%/66%)**[42] and individuals with Parkinson's disease (76%, 66%)[86]
Timed Up-and-Go Test	N/A (timed test)	>13.5 seconds (87%, 87%)[156]
Four-Square Step Test	N/A (timed test)	>15 seconds (89%, 85%)[35]
Dynamic Gait Index	24	<20 (67%, 86%)[185]
Functional Gait Assessment	30	<23 (100%, 72%)[185]
Five-Times-Sit-to-Stand Test	N/A (timed test)	>15 seconds (55%, 65%)[18]
ABC Scale	100%	<67% (84%, 88%)[92]

*Sensitivity and specificity values are given for community-dwelling elderly.
**Sensitivity and specificity values are for elderly in long-term self-care and nursing care facilities.

Content

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Part IV – Practical Applications

1. **Exercise Program**
2. **Deloading Exercises**
   - **Heel lifts**
   - **Knee/Hip extension**
3. **Kinetic Chain Exercises**
   - **Static hip and knee control during trunk rotation**
   - **Dynamic hip and knee control**
   - **Push-off with resistance**
4. **High load hip and knee control**
5. **Training Postural Control related to subsystems**

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Part IV – Practical Applications

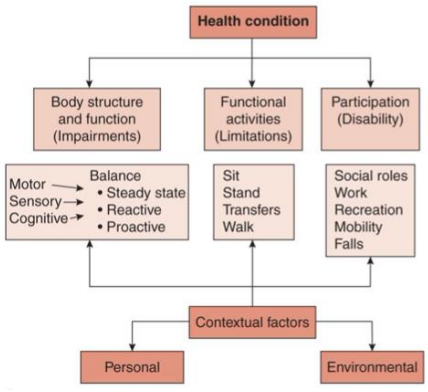
1. Exercise Program

Oefenprogramma op maat

- structurele aanpak: opwarming, kern, cooling down
- op maat van de oudere
- FITT-Formule
- preventief of curatief?
- vb. Otago-oefenprogramma = preventief
- project bewegen op verwijzing

Part IV – Practical Applications

Oefenprogramma op maat



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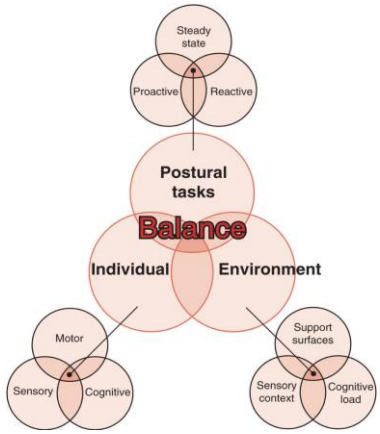


Systeemmodel

Taakgeoriënteerde benadering van posturale controle

Part IV – Practical Applications

1. Exercise Program

Oefenprogramma op maat

- Doelstellingen/Taken (~ motorische strategieën)
  - Steady-state posturale controle
  - Proactieve posturale controle
  - Reactieve posturale controle
- Oefenwetten (principes)
  - FITT(S)
    - Frequentie, intensiteit, tijd, type (specificiteit)

Part IV – Practical Applications

1. Exercise Program

Oefenprogramma op maat

- Oefenvariabelen
  - Motorische strategieën (steady-state, proactief, reactieve taken)
  - Sensorische strategieën (visuele, somatosensorische, vestibulaire input)
  - Cognitieve strategieën (complexiteit van de taak, dubbel-taken, multipele taken)
  - Steunbasis
  - Ondergrond
  - Snelheid van de beweging
  - …

Part IV – Practical Applications

Kracht	Evenwicht/proprioceptie	Coördinatie
Uithouding	Conditie	Automobilisatie/stretchen
Snelheid Reactiesnelheid	dubbeltaken	Preventie

→ →→ Functionele oefeningen

Part IV – Practical Applications

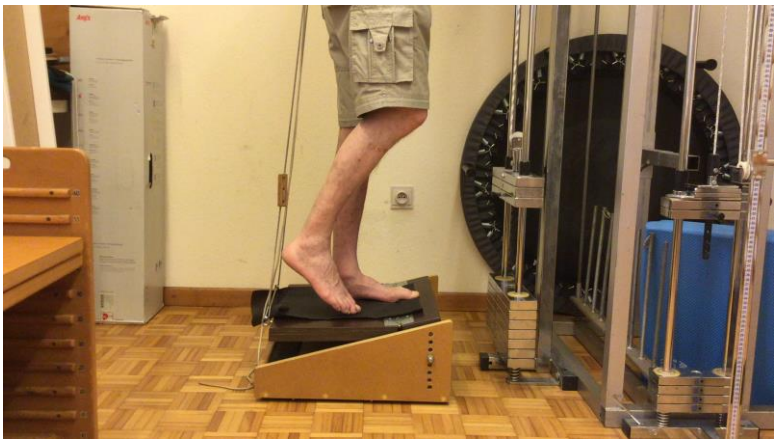
Keypoint parameters voor combinatietraining [24]

trainingstype	frequentie	volume	intensiteit	volgorde
krachttraining	beginnend met 1 sessie/week evoluerend naar 2 à 3 sessies/week gedurende 8 weken	beginnend met 2 tot 3 sets van 15 tot 20 herhalingen voor elke oefening	beginnend met 40–50 % van 1RM evoluerend naar 70–80 % van 1RM oftewel beginnend bij 18–20RM evoluerend naar 6–8RM	vóór de uithoudingstraining
uithoudingstraining	beginnend met 1 sessie/week evoluerend naar 2 à 3 sessies/week gedurende 8 weken	beginnend met 20–30 min evoluerend naar 40–60 min	beginnend met 50–60 % van VO_{2max} evoluerend naar 80 % VO_{2max}	na de krachttraining

Part IV – Practical Applications

2. Deloading Exercises

- Heel lifts
- Knee/Hip extension



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Part IV – Practical Applications

2. Deloading Exercises

- Heel lifts
- Knee/Hip extension

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Part IV – Practical Applications

2. Deloading Exercises

- **Heel lifts**
- **Knee/Hip extension**

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Part IV – Practical Applications

2. Deloading Exercises

- **Heel lifts**
  - **Closed kinetic chain**
  - **Inclination**
  - **M. soleus**

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Part IV – Practical Applications

2. Deloading Exercises

- **Heel lifts**
  - **Closed kinetic chain**
  - **Inclination board**

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Part IV – Practical Applications

3. Kinetic Chain Exercises

- **Static hip and knee control during trunk rotation**
- **Dynamic hip and knee control**
- **Push-off with resistance**

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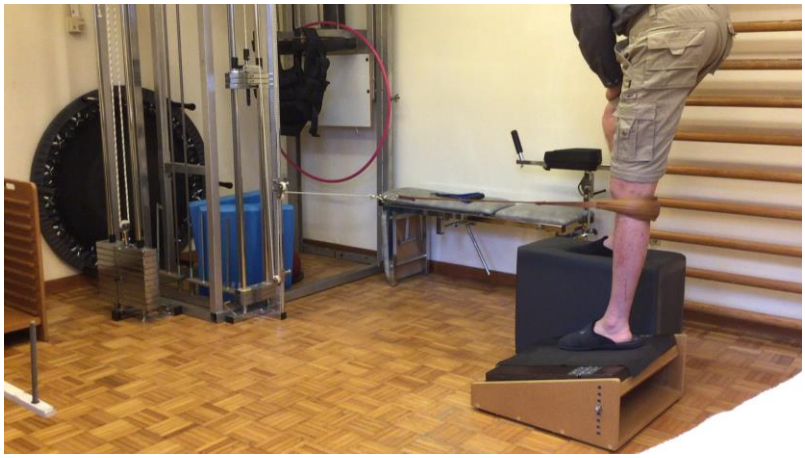
Part IV – Practical Applications

4. High load hip and knee control



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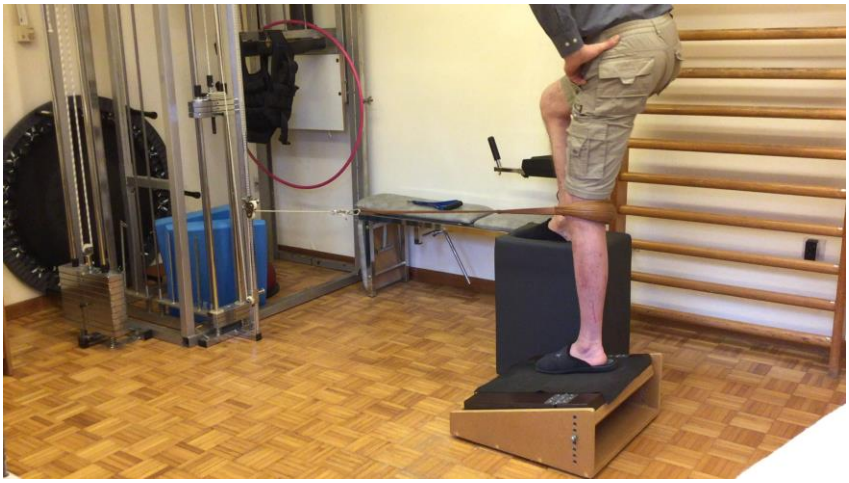
Part IV – Practical Applications

4. High load hip and knee control



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Part IV – Practical Applications

5. Training Postural Control related to subsystems

See Interventions for training postural control

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Part IV – Practical Applications

5. Training Postural Control related to subsystems

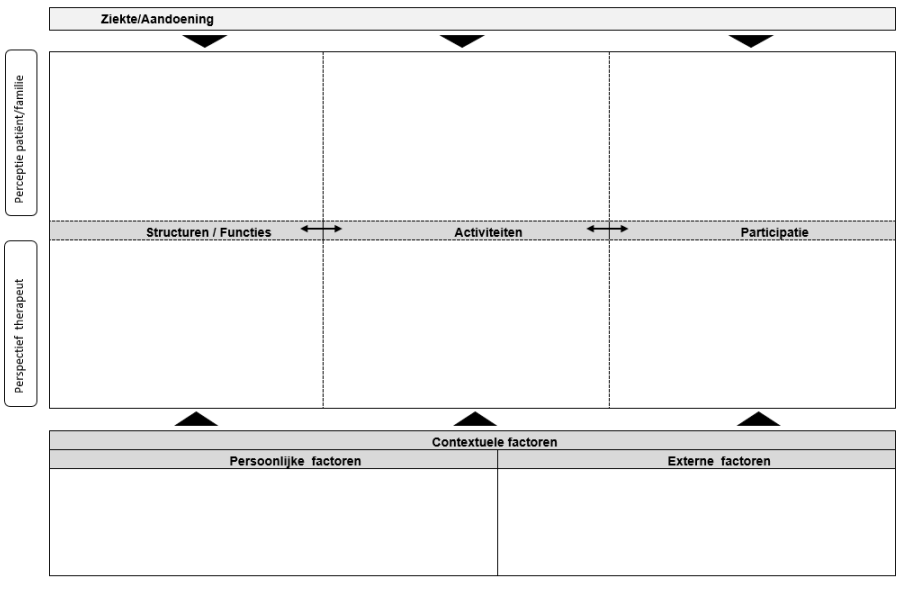
See Interventions for training postural control

EO

EC

96

Casuïstiek


Ziekte/Aandoening
Perceptie patiënt/familie
Structuren / Functies
Activiteiten
Participatie
Perspectief therapeut
Contextuele factoren
Persoonlijke factoren
Externe factoren
Kinesitherapeutisch FunctioneringsAnalyse-formulier
©2013 Valentin Schroyen voor Pro-Q-Kine

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Addenda

Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

ONLINE TABLE 20.1 Features of Traditional (Conventional) Surgical Approaches for THA and Potential Impact on Postoperative Function

Surgical Approach	Involvement of Hip Muscles and Other Soft Tissues	Impact on Postoperative Function
Posterior or Posterolateral[37,42,59,71,81,106,107]		
	▪ Gluteus maximus divided in line with its fibers with a posterior approach ▪ Interval between the gluteus maximus and medius divided in a posterolateral approach ▪ Short external rotators and piriformis released and repaired ▪ Gluteus maximus tendon possibly released from femur; repaired at conclusion ▪ Posterior capsule incised and repaired ▪ Gluteus medius and TFL left intact	▪ Possible earlier recovery of a normal gait pattern because gluteus medius and TFL left intact ▪ Highest risk of dislocation or subluxation of prosthetic hip

Guccione, 2020

Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

ONLINE TABLE 20.1 Features of Traditional (Conventional) Surgical Approaches for THA and Potential Impact on Postoperative Function

Surgical Approach	Involvement of Hip Muscles and Other Soft Tissues	Impact on Postoperative Function
Direct Lateral[37,59]		
	▪ Longitudinal division of the TFL ▪ Release of up to one-half of the proximal insertion of the gluteus medius and minimus; reattached prior to closure ▪ Longitudinal splitting of the vastus lateralis ▪ Capsulotomy and repair	▪ Weakness of the hip abductors ▪ Possible pelvic obliquity ▪ Delayed recovery of symmetrical gait

Guccione, 2020

Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

ONLINE TABLE 20.1 Features of Traditional (Conventional) Surgical Approaches for THA and Potential Impact on Postoperative Function

Surgical Approach	Involvement of Hip Muscles and Other Soft Tissues	Impact on Postoperative Function
Anterolateral[37,59,71,88,96]		
	▪ Incision centered over the greater trochanter and lateral to the TFL ▪ Anterior one-third of the gluteus medius and minimus and sometimes the vastus lateralis released; reattached prior to closure ▪ External rotators usually remain intact ▪ Anterior capsulotomy and repair	▪ Weakness of the hip abductors ▪ Delayed recovery of gait symmetry ▪ Lower incidence of hip dislocation than posterior approach

Guccione, 2020

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Part II – Total Hip Replacement (Osteoarthritis)

1. Introduction

THA : Operative Approaches - Key Features

ONLINE TABLE 20.1 Features of Traditional (Conventional) Surgical Approaches for THA and Potential Impact on Postoperative Function

Surgical Approach	Involvement of Hip Muscles and Other Soft Tissues	Impact on Postoperative Function
Direct Anterior[37,59,88]		
	▪ Incision made anterior and distal to the ASIS, slightly anterior to the greater trochanter, and medial to the TFL ▪ No muscles incised or detached, but rectus femoris and sartorius retracted medially to access the joint ▪ Anterior capsulotomy and repair	▪ Weight bearing as tolerated immediately after surgery ▪ More rapid recovery of hip muscle strength and normal gait pattern compared with anterolateral approach

Guccione, 2020

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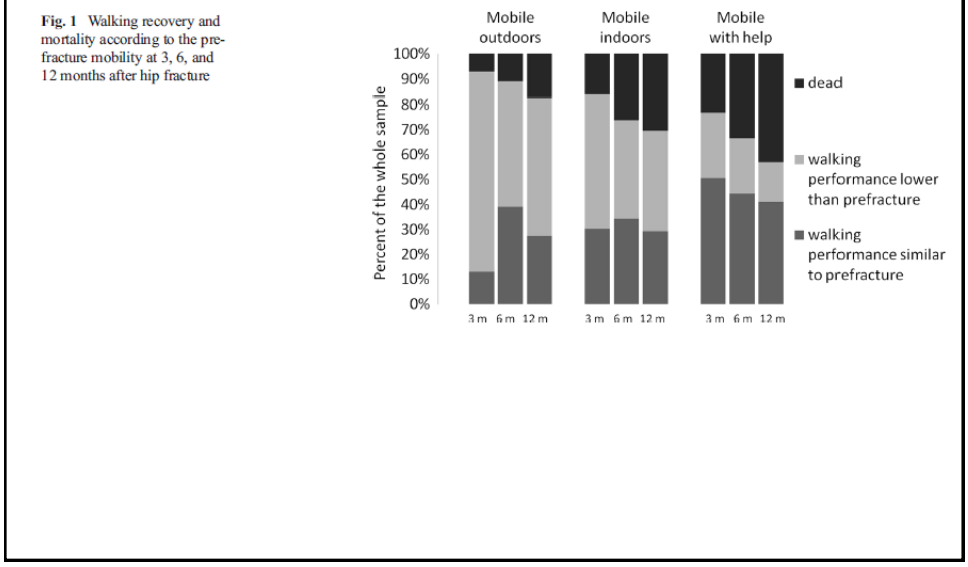

Fig. 1 Walking recovery and mortality according to the pre-fracture mobility at 3, 6, and 12 months after hip fracture

Posturale Controle: Systemen, Mechanismen en Klinimetrie

Summary of the BESTest Items Under Each System Category

I. Biomechanical Constraints	II. Stability Limits/Verticality	III. Anticipatory Postural Adjustments	IV. Postural Responses	V. Sensory Orientation	VI. Stability in Gait
1. Base of support	6. Sitting verticality (left and right) and lateral lean (left and right)	9. Sit to stand	14. In-place response, forward	19. Sensory integration for balance (modified CTSIB) Stance on firm surface, EO Stance on firm surface,EC Stance on foam, EO Stance on foam, EC	21. Gait, level surface
2. CoM alignment	7. Functional reach forward	10. Rise to toes	15. In-place response, backward		22. Change in gait speed
3. Ankle strength and ROM	8. Functional reach lateral (left and right)	11. Stand on one leg (left and right)	16. Compensatory stepping correction, forward		23. Walk with head turns, horizontal
4. Hip/trunk lateral strength		12. Alternate stair touching	17. Compensatory stepping correction, backward	20. Incline, EC	24. Walk with pivot turns
5. Sit on floor and stand up		13. Standing arm raise	18. Compensatory stepping correction, lateral (left and right)		25. Step over obstacles
					26. Timed "Get Up & Go" Test
					27. Timed "Get Up & Go" Test with dual task

[a] CoM=center of mass, ROM=range of motion, CTSIB=Clinical Test of Sensory Integration for Balance, EO=eyes open, EC=eyes closed.