

Muscle strength measurements in polio survivors

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Program

- 1 Muscle strength in polio survivors**
 - 2 Methods for measuring muscle strength (non-instrumented and instrumented)**
 - 3 Reliability of strength measurements**
 - 4 Implications for clinical practice and research**
 - 5 Conclusions and recommendations**
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1. Muscle strength in polio survivors

Muscle weakness

- Main residual impairment after recovery from acute polio
- New weakness: hallmark symptom of postpolio syndrome
- Gradual decline in muscle strength \approx 1 - 2% per year
- Impact of muscle weakness on every day activities and participation

1. Muscle strength in polio survivors

Why measuring muscle strength?

- In clinical practice (individual patients)
 - For diagnostic purposes (weakness, extent of paresis)
 - Monitoring disease course (progression of weakness)
 - Evaluating effect of intervention

as part of a functional assessment of activities!
- In research (groups of patients):
 - To investigate strength decline over time and identify prognostic factors
 - Effectiveness of interventions

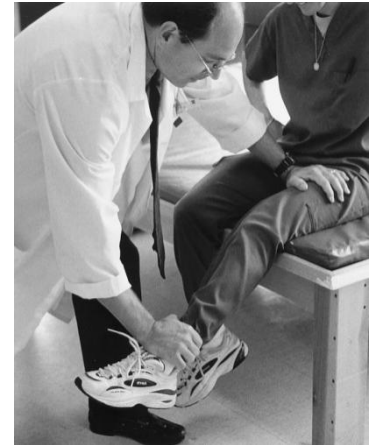
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2. Methods for measuring muscle strength

Non-instrumented methods

- Qualitative measures of strength
 - Ordinal grading systems
- Most frequently used: grading of the MRC
- Validity:
 - concurrent validity: moderate to good ($r = 0.48-0.90$).
 - Sensitivity to detect weakness: limited (Beasley, 1956; 1961) to excellent (Perry et al 2004)



2. Methods for measuring muscle strength

Instrumented methods

- Instrumented methods: quantitative measures of strength
 - Strength expressed in Newton, kilogram, or Nm.
 - Instruments:
 - hand-held dynamometers,
 - hand-grip dynamometers,
 - fixed force gauges
 - fixed dynamometers



2. Methods for measuring muscle strength

Hand held dynamometers

- Good feasibility:
 - portable, limited expense, easy to use in clinical practice.
- Validity:
 - concurrent validity (compared with fixed dynamometry):
 - Good (Systematic review Stark et al. 2011)
 - HHD underestimates strength of strong lower limb muscles (e.g. knee extensor strength, Martin et al, 2006; Nollet & Beelen 1999)
 - Sensitivity to detect weakness:
 - Limited in large muscle groups (dependent on tester strength):
Measurement range up to 200-250N



2. Methods for measuring muscle strength

Fixed dynamometers (e.g. Biodex, KinCom, Cybex)

- Gold standard for strength testing
- Static and dynamic testing (isometric, isokinetic, isotonic).
- Disadvantage: expensive equipment



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3. Reliability of strength measurements

- Test-retest reliability

- Several indices of reliability reported:
 - Relative reliability (distinction of patients):
 - *How well can patients be distinguished from each other?*
 - Indices: Pearson's R, ICC
 - Dependent on variability within the population sample
 - Absolute reliability (measurement variability, agreement):
 - *How close are the scores with repeated testing?*
 - Indices: Standard Error of the measurement, Smallest Real Difference, Bland-Altman Limits of Agreement
- For clinical practice (evaluation of individual patients) indices of absolute reliability are important.

3. Reliability of strength measurements

- Manual muscle testing
 - No studies on reliability of MMT in polio survivors
 - In other patient groups with muscle weakness:
 - inter-rater reliability (agreement): moderate to good
 - Sensitivity to detect changes within an individual: limited

3. Reliability of strength measurements

- Hand-held dynamometer

Only 1 study in polio survivors (Nollet & Beelen 1999)

- 6 lower limb muscle groups, “break”-tests
- Relative reliability: good
 - ICC: range 0.90 to 0.98
- Absolute reliability: poor
 - Limits of Agreement (ratio): wide .76-1.52 (knee extensor) to .58 – 1.92 (ankle dorsal flexion)
 - Smallest detectable difference (individual): 24 to 92%

3. Reliability of strength measurements

- Fixed dynamometer

3 studies in polio survivors* (knee extensor/flexor)

- Relative reliability^{1,2,3}: good

 - ICC: range .80 to .99

- Absolute reliability^{2,3}: moderate

 - LOA: .75 – 1.29²

 - SEM%: 4-14%^{2,3}

 - SRD:11-39%³

* ¹Kilfoil & St Pierre 1993; ²Horemans et al 2004; ³Flansbjerg & Lexell 2010

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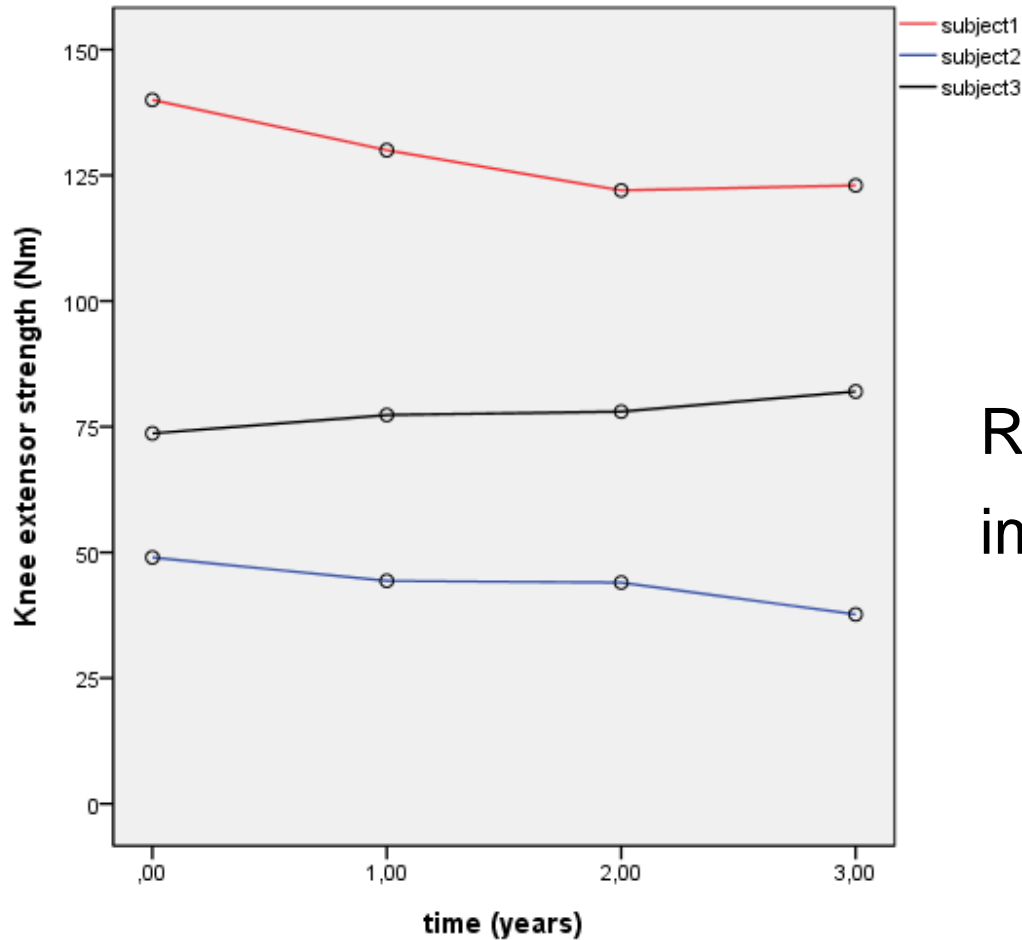
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4. Implications for clinical practice

Monitoring strength in individual patients

- MMT: limited sensitivity to change
 - Changes in strength: not suitable
 - Extent of paresis: suitable but needs further validation
- HHD: limited measurement range, large measurement variability
 - changes in strength: not suitable
- Fixed dynamometry: moderate to large measurement variability
 - Changes in strength: intervention effects?

4. Implications for clinical practice



Repeated measurements
improve reliability

4. Implications for research

Monitoring strength in groups of patients

- Fixed dynamometry: $SD_{\text{difference}}$: 10 - 15%
- Effect of intervention:
 - Sample size needed to detect a 10% difference in strength change with $SD_{\text{dif}}=15\%$ (90% power, $\alpha=0.05$): $N = 96$ (48 per group)
- Strength decline over time:
 - Horemans et al (2004): $n= 65$, changes of more than 4.5% can be detected
 - Long term (>4 years) follow up needed!

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5 Conclusions and recommendations

Key points for clinical practice

- Manual muscle testing (MRC) can be used to assess severity of polio residuals but lacks sensitivity for monitoring strength over time.
- Quantitative assessment of muscle strength should be performed with fixed dynamometry.
- Measurement variability ('smallest real difference') in muscle strength should be considered in the interpretation of individual changes in strength.

5 Conclusions and key points

Key points for research

- Reliability of fixed dynamometry is sufficient to evaluate changes in muscle strength in groups of polio survivors.
- Studies on reliability of strength measurements in polio survivors should include indices for measurement variability and minimally important differences in muscle strength.



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