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Title: Application of Bedside Lower Extremity Rehabilitation Robots in Stroke Rehabilitation: A Randomized Controlled Trial

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Author Questionnaire

1. Microscopy: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

2. Software: Does the part of your protocol being filmed include step-by-step descriptions of software usage? **Yes**

Videographer: Please record the computer screen for the shots labeled as SCREEN

3. Filming location: Will the filming need to take place in multiple locations? **No**

4. Testimonials (optional): Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **No**

Current Protocol Length

Number of Steps: 12

Number of Shots: 30 (8 SC)

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

INTRODUCTION:

~~What is the scope of your research? What questions are you trying to answer?~~

- 1.1. **Binjie Qi**: This research focuses on bedside lower limb rehab robots for stroke to assess efficacy and comfort.

- 1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

CONCLUSION:

~~What research gap are you addressing with your protocol?~~

- 1.2. **Binjie Qi**: This protocol addresses workload and consistency issues in traditional stroke rehabilitation through the use of bedside robots.

- 1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

~~What questions will future research focus on?~~

- 1.3. **Binjie Qi**: Our future research will focus on larger multicenter trials, matched training duration and biomechanical assessments.

- 1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Videographer: Obtain headshots for all authors available at the filming location.

Ethics Title Card

This research has been approved by the Ethics Committee at the First Affiliated Hospital of Zhejiang University

Protocol

2. Intervention Protocol for Control and Robot-Assisted Therapy Group

Demonstrators: Binjie Qi, Yingying Liu

2.1. To begin, let the patient with first-onset stroke and lower limb dysfunction from the control manual therapy group perform passive range-of-motion exercises, including hip and knee flexion-extension for 2 weeks [1-TXT] and ankle dorsiflexion for 20 minutes per day while maintaining joint angles within safe limits [2].

2.1.1. Talent guiding the patient's hip and knee through controlled flexion-extension movements. **TXT: Safe limits: Hip $\leq 90^\circ$; Knee $\leq 120^\circ$**

2.1.2. Patient performing ankle dorsiflexion.

2.2. For the 3rd and 4th week, guide active resistance training using elastic bands providing 20 to 30 newton resistance [1]. Instruct the patient to perform hip abduction-adduction, knee extension-flexion, and ankle dorsiflexion-plantarflexion for 20 minutes per day [2]. Ensure the patient maintains a stable sitting position and avoids compensatory trunk movements [3].

2.2.1. Talent positioning elastic bands and demonstrating resistance exercises with the patient.

2.2.2. Talent supervising the patient performing lower-limb movements against the elastic band resistance.

2.2.3. Side view of the patient sitting upright while the talent observes for trunk stability.

2.3. For the robot-assisted therapy group, set up the device [1] and review all the settings including the speed, torque limit and motion range limits [2-TXT]. ~~Set the torque limit to 30 newton-meters for the hip and knee and 15 newton-meters for the ankle [3]. Adjust the range of motion limits to hip 0 to 90 degrees, knee 0 to 120 degrees, and for ankle choose minus 10 degrees to plus 20 degrees [4].~~

2.3.1. Show the device positioned.

2.3.2. LAB MEDIA: Built-in Parameter_Animation_2.3.

TXT: Torque limits: Hip and knee: 30 Nm; Ankle: 15 Nm

Range of motion: Hip: 0° to 90° ; Knee: 0° to 120° ; Ankle: -10° to $+20^\circ$

- 2.3.3. ~~SCREEN: Show the device menu where the speed parameter is selected and adjusted to 15 degrees per second or 20 degrees a per second. *Videographer: Please record the computer screen for the shots labeled as SCREEN*~~
- 2.3.4. ~~SCREEN: Display the torque limit fields as the talent enters 30 newton meter for hip and knee and 15 newton meter for ankle.~~
- 2.3.5. ~~SCREEN: Show the range of motion settings being modified to the specified degree limits.~~

NOTE: Not filmed

- 2.4. ~~Now, secure the patient in the supine position with a 30-degree head elevation [1]. Initiate passive mode on the device [2] and monitor electromyography activity to detect spasms, where readings greater than 50 microvolts per 100 milliseconds trigger an automatic pause [3].~~
 - 2.4.1. ~~Talent positioning the patient supine and adjusting the head support to 30 degrees.~~
 - 2.4.2. ~~Show the talent selecting and activating the passive mode on the device interface.~~
 - 2.4.3. ~~SCREEN: Display the electromyography monitoring panel with emphasis on the automatic pause trigger threshold.~~
- 2.5. ~~Combine 20 minute therapist led active training with 20 minute robot assisted passive training [1]. Calibrate the force sensors before each training session and recalibrate them if drift becomes greater than 5 percent [2].~~
 - 2.5.1. ~~Talent conducting therapist led active exercises with the patient.~~
 - 2.5.2. ~~SCREEN: Show the force sensor calibration page~~

3. Brace Installation and Training Execution for the Robot-Assisted Therapy

- 3.1. *Position the patient with first-onset stroke and lower limb dysfunction assigned to the therapy group in a supine, lateral, or prone position as needed [1].*
 - 3.1.1. Talent positioning the patient into the required position on the treatment table.
- 3.2. *Using visual inspection, examine the patient's lower limb to confirm it is suitable for bracing [1].*
 - 3.2.1. Talent closely inspecting the lower limb for any issues that may interfere with

brace placement.

- 3.3. Inform the patient about the training procedures [1] before installing the brace on the patient's lower limb [2].
 - 3.3.1. Talent explaining the upcoming training steps to the patient.
 - 3.3.2. Talent positioning the brace along the lower limb in preparation for installation.
- 3.4. Align the brace connectors marked with an upward arrow with the joint axes [1] and tighten the straps to a two-finger tightness that corresponds to 5 to 7 newton tension, ensuring no skin pinching or excessive pressure [2]. Ensure proper alignment and comfort after installation [3].
 - 3.4.1. Talent aligning the brace connectors with the joint axes.
 - 3.4.2. Close-up of the talent tightening each strap to achieve two-finger tightness.
 - 3.4.3. ~~Talent placing pressure film under the straps and checking for pressure values.~~
NOTE: Not filmed, VO merged
 - 3.4.4. Talent adjusting the brace and alignment with the patient.
- 3.5. In the passive mode, select **Pre-programmed Trajectory 1** to perform flexion-extension cycles with ten repetitions per set [1]. For patients in phase 1 of the observation group during weeks 1 to 2, conduct 20 minutes of passive mode training daily [2]. If any joint misalignment occurs, reposition the brace and restart the procedure [3].
 - 3.5.1. SCREEN: Show the device interface where **Pre-programmed Trajectory 1** is selected for flexion-extension cycles.
 - 3.5.2. Talent setting a timer for 20-minutes.
 - 3.5.3. Talent pausing the procedure and readjusting the brace alignment.
- 3.6. Set the assistance level to 50 percent of the patient's maximum voluntary contraction. For patients in phase 2 of the observation group during weeks 3 to 4, combine 20 minutes of assistive mode training with 20 minutes of therapist-led active training daily [1-TXT].
 - 3.6.1. ~~SCREEN: Show the assistance level field being set to 50 percent of the maximum voluntary contraction.~~ **NOTE: Not filmed, VO merged and moved as on screen text**
 - 3.6.2. Talent assisting the patient in therapist-led active exercises. **TXT: Reassess the maximum voluntary contraction weekly**

3.6.3. ~~Talent measuring the patient's maximum voluntary contraction using a handheld dynamometer.~~

3.7. Finally, stop the session and export the session logs [1].

3.7.1. SCREEN: Press the "Stop" button to end the training. **NOTE: The shot was changed, can be slated as 3.7.1 or 3.7.2**

Results

4. Results

- 4.1. Before training, general comfort questionnaire scores were not significantly different between the groups [1], but after the first phase, the observation group scored significantly higher than the control group [2], and the difference further increased after the second phase [3].
 - 4.1.1. LAB MEDIA: Table 3. *Video editor: Highlight the columns "Before treatment" for both "Control" and "Observation" groups*
 - 4.1.2. LAB MEDIA: Table 3. *Video editor: Highlight the column "After first-stage treatment" for and "Observation" groups*
 - 4.1.3. LAB MEDIA: Table 3. *Video editor: Highlight the column "After second-stage treatment" for and "Observation" groups*
- 4.2. Only the observation group showed a statistically significant increase in comfort level after the second phase of training [1].
 - 4.2.1. LAB MEDIA: Table 3. *Video editor: Highlight the " $\Delta GCQ (T2-T0)$ " value " 3.80 ± 2.63 " for the "Observation" group*
- 4.3. After the second phase of training, the observation group showed significantly higher lower limb motor recovery scores than the control group [1].
 - 4.3.1. LAB MEDIA: Table 4. *Video editor: Highlight the cell under "After second-stage treatment" for "Observation" group*
- 4.4. Modified Barthel index scores increased significantly in both groups after training [1], with the observation group scoring significantly higher than the control group [2].
 - 4.4.1. LAB MEDIA: Table 6. *Video editor: Highlight the column "After second-stage treatment" for both "Control" and "Observation" groups*
 - 4.4.2. LAB MEDIA: Table 6. *Video editor: Highlight the cell "After second-stage treatment" value " 20.05 ± 2.56 " for "Observation"*

1. Abduction

Pronunciation link: <https://www.merriam-webster.com/dictionary/abduction>

- IPA: /æb'dʌkfən/, /əb'dʌkfən/
Phonetic Spelling: ab·duk·shuhn / uhb·duk·shuhn ([merriam-webster.com](https://www.merriam-webster.com))
2. Adduction
Pronunciation link: <https://www.merriam-webster.com/dictionary/adduction>
IPA: /ə'dʌkfən/, /a'dʌkfən/
Phonetic Spelling: uh·duk·shuhn / ah·duk·shuhn ([merriam-webster.com](https://www.merriam-webster.com))
 3. Calibrate
Pronunciation link: <https://www.merriam-webster.com/dictionary/calibrate>
IPA: /'kæl.əˌbreɪt/
Phonetic Spelling: kal·uh·brayt ([merriam-webster.com](https://www.merriam-webster.com))
 4. Dynamometer
Pronunciation link: <https://www.merriam-webster.com/dictionary/dynamometer>
IPA: /ˌdaɪ.nə'mɑː.mə.tər/
Phonetic Spelling: dye·nuh·mah·muh·ter ([merriam-webster.com](https://www.merriam-webster.com))
 5. Electromyography
Pronunciation link: <https://www.merriam-webster.com/dictionary/electromyography>
IPA: /ɪˌlek.troʊ.mai'ɑː.grə.fi/
Phonetic Spelling: ih·lek·troh·my·aa·gruh·fee ([merriam-webster.com](https://www.merriam-webster.com))
 6. Flexion
Pronunciation link: <https://www.merriam-webster.com/dictionary/flexion>
IPA: /'flekʃən/
Phonetic Spelling: flek·shuhn ([merriam-webster.com](https://www.merriam-webster.com))
 7. Spasm
Pronunciation link: <https://www.merriam-webster.com/dictionary/spasm>
IPA: /'spæz.əm/
Phonetic Spelling: spaz·uhm ([merriam-webster.com](https://www.merriam-webster.com))
 8. Supine
Pronunciation link: <https://www.merriam-webster.com/dictionary/supine>
IPA: /sə'paɪn/, /'suː.paɪn/
Phonetic Spelling: suh·pyne / soo·pyne ([merriam-webster.com](https://www.merriam-webster.com))
 9. Torque
Pronunciation link: <https://www.merriam-webster.com/dictionary/torque>
IPA: /tɔrk/
Phonetic Spelling: tork ([merriam-webster.com](https://www.merriam-webster.com))
 10. Trajectory
Pronunciation link: <https://www.merriam-webster.com/dictionary/trajectory>
IPA: /trə'dʒek.tə.ri/, /trə'dʒek.tri/
Phonetic Spelling: truh·jek·tuh·ree / truh·jek·tree