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Robot-Assisted Gait Training for Quadruple Amputee : cases report

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Background

Quadruple amputation, the major amputation of all four limbs, is rare. Bilateral lower extremities amputees need to hold parallel bars or use bilateral crutches for initial gait training. However, quadruple amputee patients have difficulty in gait training because they cannot hold such tools due to upper extremities amputation. We performed robot-assisted gait training (RAGT) using Morning Walk® (Curexo, Seoul) on a quadruple amputee and would report the effectiveness of RAGT in improving their gait ability.

Case 1

A 72-year-old woman had necrosis of bilateral hands and feet after inotropic treatment due to septic shock. She underwent hand amputation and bilateral transtibial amputation. We prescribed the prostheses for transtibial amputation with a patella tendon bearing (PTB) socket, shuttle lock suspension, and energy-storing feet. She could not hold a parallel bar or cane, so she had difficulty in gait training. On December 28, 2022, we started RAGT in ground walk mode for gait training(Figure 1). In the first session of RAGT in ground walk mode, we set the cadence with 25 steps/min. Subsequently, we increased the cadence to 45 steps/min (Figure 2). After 26 sessions of the ground mode, we started stair ascending mode with a cadence set at 40 steps/min and progressively increased to 50 steps/min (Figure 3). Before starting RAGT, she could only stand for a few seconds. After two weeks, she progressed to perform an 80-meter gait using an elbow support walker, and after five months, she could walk under supervision.

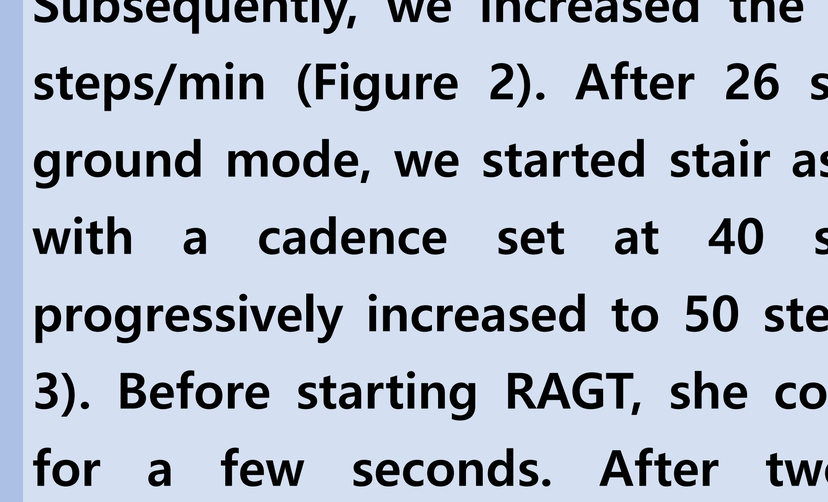

Figure 1. RAGT with Morning Walk® of case 1.

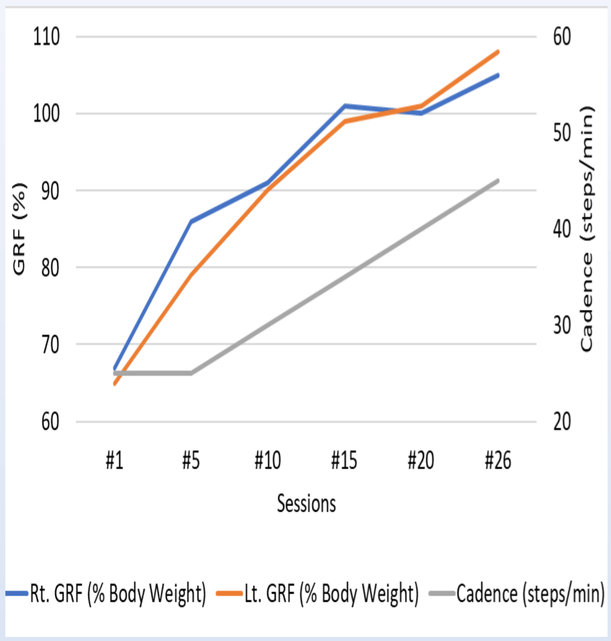

Figure 2. Mean ground reaction force and cadence of case 1 in the ground walking mode.

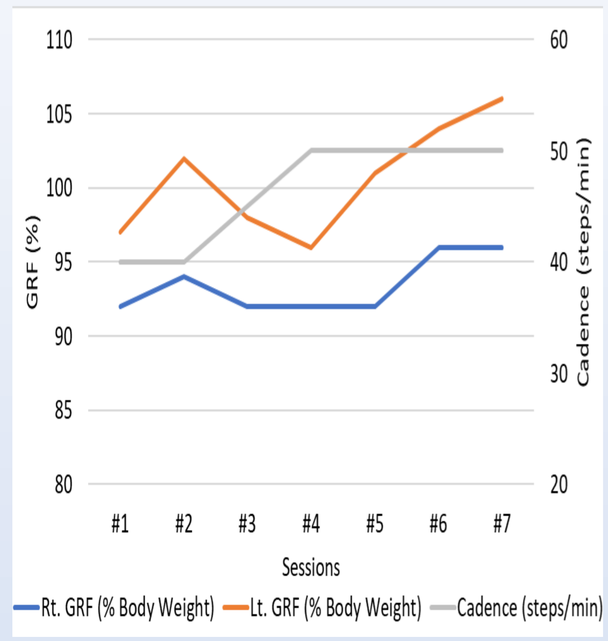

Figure 3. Mean ground reaction force and cadence of case 1 in the stair ascending mode.

Case 2

A 51-year-old woman had necrosis of bilateral hands and feet after inotropic treatment due to hypoglycemic shock. She underwent bilateral transtibial amputation at the mid-calf level and right transradial amputation above 5cm from the wrist. We prescribed the prostheses for transtibial amputation with a PTB socket, shuttle lock suspension, and energy-storing feet. For right transradial amputation, we prescribed a Muenster-type cosmetic hand. On September 1, 2023, we started RAGT in ground walk mode for gait training. In the first session of RAGT in ground walk mode, we set the cadence as 30 steps/min and progressively increased it to 50 steps/min (Figure 4). She could perform the stair ascending and descending with supervision for only two sessions of stair ascending mode. Therefore, we decided to stop the stair mode of RAGT. Before starting RAGT, she could only stand alone. After two weeks, she progressed to perform gait using a Lofstrand crutch, and after three weeks, she could walk under supervision.

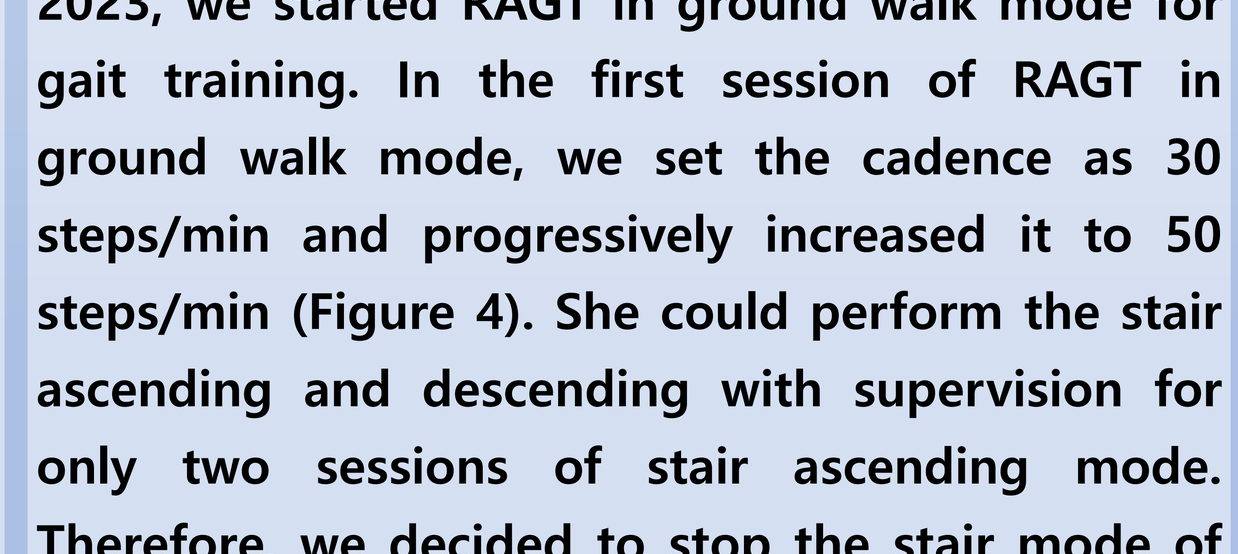

Figure 4. Mean ground reaction force and cadence of case 2 in the ground walking mode.

Conclusion

Quadruple amputations are rare, and research on RAGT for quadruple amputees has not been reported yet. Despite the absence of functional upper extremities prostheses, the RAGT for the lower limbs yielded positive outcomes, suggesting the potential benefits of this approach in improving gait function for quadruple amputees.