Robotika in navidezna resničnosti v rehabilitaciji – tri desetletja uporabe in izkušenj

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Uvod: V 80. letih 20. stoletja so se pojavili prvi robotski pristopi k rehabilitaciji pacientov po možganski kapi. Izjemen razvoj je sledil v 90. letih s prvim klinično uporabljenim robotom MIT-Manus (1). Hkrati z razvojem rehabilitacijskih robotov so se razvijale metode navidezne resničnosti, ki so dopolnjevale robotsko podprto vadbo, omogočale pa tudi senzorno podprto vadbo brez robotov. Hitremu razvoju pa ni sledila uporaba novih tehnologij v klinični praksi. Največja ovira za uvajanje in uporabo robotsko podprte rehabilitacije ter navidezne resničnosti je bilo pomanjkanje dokazov o učinkovitosti vadbe. **Metode**: Tri desetletja intenzivnega razvoja, preizkušanja in izpopolnjevanja tehnologij so omogočila varno, pacientom prilagojeno in učinkovito vadbo, ki je po rezultatih lahko primerljiva z intenzivno standardno terapijo. V desetletjih uporabe robotov in navidezne resničnosti so bile izvedene številne klinične raziskave za objektivno vrednotenje učinkov vadbe. **Rezultati**: Robotsko podprta vadba zgornjih udov lahko izboljša izide rehabilitacije v primerjavi z običajno, ne pa z intenzivno terapijo (2, 3). Elektromehanska in robotska vadba lahko tudi izboljša dejavnosti vsakodnevnega življenja pri ljudeh po možganski kapi ter funkcijo in mišično jakost okvarjenega zgornjega uda. Pri tem ni pričakovati resnih neželenih učinkov, kot so poškodbe in bolečine, kot posledico robotske vadbe (4). Dokazano je, da lahko elektromehansko podprta vadba v kombinaciji s fizioterapijo poveča izboljšanje samostojne hoje pri pacientih po možganski kapi v primerjavi s samo fizioterapijo. Pacienti v prvih treh mesecih po kapi in tisti, ki ne morejo hoditi, imajo lahko največjo korist od tovrstne vadbe (5). Uporaba navidezne resničnosti v splošnem ni učinkovitejša od standardnih terapevtskih pristopov pri izboljšanju funkcije zgornjih udov, vendar pa je lahko učinkovita pri izboljšanju funkcije zgornjega uda in vsakodnevnih dejavnostih, ko se uporablja kot dopolnilo k običajni vadbi (za povečanje obsega vadbe). Čas od nastopa možganske kapi, stopnja okvare in vadbena naprava ne vplivajo bistveno na izid rehabilitacije. Priporočljivi so daljši čas trajanja vadbe in prilagojene naloge v navidezni resničnosti (6). **Zaključki**: Ob pravilni uporabi in ustrezni intenzivnosti vadbe lahko robotsko podprta rehabilitacija in/ali vadba s pomočjo navidezne resničnosti izboljšata motorične funkcije zgornjih oziroma spodnjih udov pri ljudeh po možganski kapi. Izboljšanje je primerljivo rehabilitaciji s standardno terapijo. Uporaba sodobnih tehnologij se priporoča kot dopolnitev standardne terapije za povečanje obsega in intenzivnosti vadbe.

Ključne besede: rehabilitacijska robotika, navidezna resničnost, gibanje

Robotics and virtual reality in rehabilitation – three decades of use and experience

Background: In the 1980s, the first robotic concepts appeared for the purpose of rehabilitation of patients after stroke. Extreme development followed in the 90s with the first clinically-used robot MIT-Manus (1). Simultaneously with the development of rehabilitation robots, virtual reality methods were developed, complementing the robot-supported exercises, and also enabling sensor-based training without robots. However, rapid technological development was not followed by the use of new technologies in clinical practice. The greatest obstacle to the deployment and use of robot-supported rehabilitation and virtual reality was the lack of evidence of the therapy effectiveness. **Methods**: Three decades of intensive development, testing and advancing of technologies today enable safe, patient-specific, and effective rehabilitation, which can be comparable to intensive conventional therapy. In three decades of using robots and virtual reality, numerous clinical studies have been performed to objectively quantify the effects of technology-supported therapy. **Results**: Upper limb robot-assisted therapy may improve rehabilitation outcomes as compared with usual care but not with intensive therapy (2, 3). Electromechanical and robot-assisted arm training can improve activities of daily living in people after stroke, and function and muscle strength of the affected arm. No serious adverse events, such as injuries and pain, as result of robot-assisted should be expected (4). Evidence was found that electromechanical-assisted gait training combined with physiotherapy when compared with physiotherapy alone may improve recovery of independent walking in people after stroke. Specifically, patients in the first three months after stroke and those who are not able to walk appear to benefit most from this type of intervention (5). The use of virtual reality is not more beneficial than conventional therapy approaches in improving upper limb function. However, it may be beneficial in improving upper limb function and activities of daily living when used as an adjunct to usual care (to increase overall therapy time). Time since onset of stroke, severity of impairment, and the type of device do not strongly influence the outcome. However, higher training dose may be preferable as are customized virtual reality programs (6). **Conclusions**: With proper use of technology and adequate training intensity, robot- and/or virtual reality-supported rehabilitation can help to improve motor functions of upper or lower limbs in people after stroke. The improvement is comparable to conventional therapy. The use of modern technologies is recommended as a complement to conventional therapy to increase training duration and intensity.

Key words: rehabilitation robotics, virtual reality, motor rehabilitation

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