Literature Review: Cerebral Palsy and Wheelchair Tennis Adaptations

Mia Beveridge

Touro University Nevada

Occupational Profile

June was 5 years old when she was diagnosed with Cerebral palsy. Cerebral palsy (CP) is a neurological condition sometimes resulting in orthopedic consequences, affecting muscle tone, reflexes, coordination, balance, and ability to walk (Types and Forms of Cerebral Palsy, n.d.).There are severe to mild cases. June has a form of spastic cerebral palsy, characterized by difficulty moving and walking due to tight, stiff muscles (spasticity) in her legs. Cerebral palsy affects both legs and affects her right hand. June's hand is occasionally cramped or fatigued because of 30% paresis in her right hand. June has a rare case of mixed cerebral palsy that causes paresis of the hand. She has worn leg braces since she was a toddler and used a walker to help her walk short distances when she was younger. Now, she relies on a wheelchair for longer distances and physical activity. June does not have any hearing or visual impairments but she has some speech impairments. Her difficulties are purely physical; she communicates well, is a good student and has many friends. June lives with her mother, father, and younger sister in Las Vegas, Nevada, and attends the University of Nevada, Las Vegas. She is now 21 years old. June uses a manual wheelchair to get around most places but also has a power wheelchair. June has always dreamed of playing wheelchair tennis and going to the Paralympics.

Diagnosis

June has spastic plegia (paralysis) Cerebral palsy

Topographical Distributions

June's cerebral palsy is topographically classified as diaplegia; this is generally understood to affect the lower extremities, causing paralysis, but in rare cases other parts of the upper extremities can be affected (Types and Forms of Cerebral Palsy, n.d.).

Motor Function classification

There are two classifications for cerebral palsy: spastic and non-spastic. Spastic classification falls under pyramidal cerebral palsy and non-spastic classification falls under extrapyramidal. June has spastic cerebral palsy, which increases muscle tone. Spastic cerebral palsy is caused by an upper motor neuron lesion to the brain and affects the pyramidal tract; impairments in all four limbs, pharynx, tongue, and mouth are all possible and can result in speech impairments. Cerebral palsy can also cause joint deformities because of muscle contractions **(**Types and Forms of Cerebral Palsy, n.d.).

Severity level

With regard to cerebral palsy, severity levels such as mild, moderate and severe do not delineate set criteria. To determine severity levels medical professionals use the Gross Motor

Function Classification System, GMFCS, scores instead (Types and Forms of Cerebral Palsy, n.d.).

Literature Review

Tennis Racquet

In a study called, "An adjustable tennis bat and grip system for tetraplegics," researchers demonstrated that a glove adaptation for a tennis bat in table tennis was effective. Researchers made this adaptation primarily for a population with tetraplegia and paraplegia. (Taktak, 1997). This includes spinal cord injuries of C6 and C7 and any lesion below this area of the spinal cord. In this study, the main population had function in the triceps, deltoids, and biceps, but had paresis in the fingers and thumb. In the research review, researchers indicate that, conventionally, bandages were wrapped around the hand and the handle of the table tennis bat grip (Taktak, 1997). The researchers observed in their literature review that the conventional method of wrapping the fingers and hand to the bat was not functional because wrapping a bandage around the hand can cut off the circulation and cause rubbing throughout the game of table tennis. They also note that this method is time consuming and takes away from the time spent engaging in table tennis (Taktak, 1997).

In a related study, researchers demonstrated an adaptation with a leather glove that included Velcro fasteners; this apparatus was shown to be effective (Slatter & Gibb, 1979). In another study, "An adjustable tennis bat and grip system for tetraplegics," researchers decided on the use of a neoprene glove which was attached to the tennis bat with Velcro straps (Taktak, 1997).

When considering an appropriate adaptation for June, I did not think all aspects of the neoprene glove used would be the best solution. June's paresis is similar to that of the participants in that study, and the use of a glove attached with Velcro straps to help improve hand stability is an appropriate adaptation for June. I decided to use a leather glove, as it provides more stability than a neoprene glove. Tennis requires a more stable glove because of the heavier racquet; neoprene may tear during a match.

Wheelchair

The article, "Towards evidence-based classification in wheelchair sport: impact of seating position on wheelchair acceleration," researchers note that athletes use deeper seating positions to increase sitting stability; for example, those who have high spinal cord injuries. (Vanlandewijck, Verellen & Tweedy, 2011). According to Vanlandewijck (2011), "It is important to note that the main reason wheelchair athletes adopt seating positions and strapping that restrict active range of motion is that they have impaired trunk function" (p. 1096). Researchers discussed the fact that wheelchair athletes commonly use a 45-degree seating angle and waist straps to improve trunk stability for wheelchair tennis and other wheelchair sports. The researchers note that there was no statistically significant difference in performance between the 90-degree and 45-degree seating angles, with regard to maximum sprinting speed (Vanlandewijck et al., 2011). They concluded that there is a need for further research on the impact of reduced muscle power in clients with spinal cord injury (SCI) or CP. They further stated that research is needed to determine how coordination impacts wheelchair sports, specifically for those who have CP (Vanlandewijck et al., 2011). June has slight balance issues; she needs a waist strap to help her with balance and coordination.

Importance of Sport Participation

In another article, "Promoting the Participation of Children with Disabilities in Sports, Reaction and Physical Activities," researchers stated that participation in sports is important for those who have disabilities (Murphy & Carbone, 2008). Benefits of participation in sports include: building self-confidence, social support, decreased rates of obesity, increased muscle strength, increased range of motion, increased flexibility, increased cardiorespiratory levels, a place to learn new things, confidence from mastering an activity, socialization, and the discovery of new passions. Those who have disabilities have lower levels of muscle strength, higher levels of obesity and decreased cardiorespiratory levels (Murphy & Carbone, 2008). It is important for children to be involved in sports as early as possible, even if they have a disability.

Other Appropriate Diagnoses and Ages

This adaptation may be appropriate for someone who has a spinal cord injury level of C7 and C8. Someone who has a C7 spinal cord injury has limited ability to grasp and release objects and they also have complete paralysis of the trunk and the lower extremities (Radomski & Trombly, 2008). Both the racquet and the wheelchair adaptations may be appropriate for those who have tetraplegia, and people who have limited grasp release and dexterity issues secondary to partial paralysis of the intrinsic muscles of the hand. People with SCI should use a seating position of at least 45 degrees to increase sitting stability. The wheelchair adaptations, such as the fanny pack to hold the balls, the bag that straps in front of them, and the straps to help with trunk and stability deficits may also be appropriate for this population.

People who have suffered a cerebral vascular accident (CVA) may be able to use the racquet and glove adaptation if they have decreased hand function. Most CVA clients have either

paresis or hemiparalysis (Radomski & Trombly, 2008). Those who have weakness in one hand, but do not experience full paralysis are good candidates for this adaptive device. Those who have weakness in an entire left or right side may require additional adaptations to promote trunk support, such as straps on the shoulders, or high-incline seating.

Osteoarthritis is known as a loss of articular cartilage around the joints which causes stiffness and pain. Repetitive impact to specific joints is detrimental to individuals who have osteoarthritis (Radomski & Trombly, 2008). This adaptation does not prevent repetitive impact to joints and would not be appropriate for those who have osteoarthritis

This adaptation is not appropriate for those who have been diagnosed with carpal tunnel syndrome (CTS) because forearm rotation, wrist motion, sustained pinch and force grip should all be avoided to prevent further injury (Radomski & Trombly, 2008). This adaptation does not prevent these types of movement and would not be suitable for those with CTS. This adaptation does not sufficiently support the wrist.

This adaptation is appropriate for children and adults of all ages, provided that they have sufficient trunk function, mild hand weakness, and do not suffer from either osteoarthritis or CTS.

Cost Analysis

Item Name	Cost	S&H	Vendor Name
Completed Device			
Head Adult Aluminium Racquet: 108" Oversized Head	$9.86	$0.00	Walmart
Velstretch (waist)	$5.74	$0.00	Walmart
Sew-On Hook and loop Fasteners	$0.89	$0.00	Walmart
Velcro Patch (2" by 4")	$2.97	$0.00	Walmart
Tennis Bag (Wilson)	$14.97	$0.00	Walmart
Glove	$8.64	$0.00	Harbor Freight Tools
Fanny Pack	$0.25	$0.00	Salvation Army
Belt	$1.00	$0.00	Salvation Army
TOTAL COST OF COMPLETED DEVICE	**$44.32**		

Price Comparison

Racquet Comparison			
Head Ti: Instinct Supreme Tennis Racquet	$29.99	$0.00	Amazon
Head Ti: Instinct Supreme Tennis Racquet	$16.86	$0.00	Walmart
Head Ti: Instinct Supreme Tennis Racquet	$15.98	$0.00	Target
Velcro Patches Comparison			
Velcro Patches (Sticky-Back, 4 x 2, Black)	$6.90	$0.00	Amazon
Velcro 4 in. X 2 in. Industrial StrengthStrips 2 Pack	$2.97	$0.00	Home Depot
VELCRO® Brand Heavy-Duty Hold-Down Strips, Black,	$2.99	$0.00	Office Depot
Velcro Strap Comparison (Waist)			
Velcro Velstretch Strap 1 X 27-Inch, 2 Pack, Black (90441)	$4.90	$4.49	Amazon
Velcro 3 ft. X 2 in. Velstrap Straps	$5.96	$0.00	Home Depot
Velcro Strap Comparison (Hand)			
Sew-On (Hook and Loop Fastener)	$4.48	$0.00	Amazon
Sew- On (Hook and Loop Fastener)	$6.95	$0.00	Office Depot
Glove Comparison			
Wilson Racquet Ball Glove	$9.97	$0.00	Dick's Sporting Goods
Wilson Hope Racquet Ball Glove	$11.99	$0.00	Tennis Warehouse
Bionic PTR Tennis Gloves - 1 Pair	$29.99	$0.00	Walmart
Wheelchair Positioning Strap Comparison			
Sammons Preston Adjustable 2 Piece Belt with Side Release Buckle	$25.20	$0.00	Patterson Medical
Posey Quick Release Self- Releasing Belts	$33.14	$0.00	Rehabmart
Wheelchair Leg Strap	$24.00	$0.00	Amazon
Fanny Pack Comparison			
Yens® Fantasybag 3-Zipper Fanny Pack-Teal, FN-03	$8.25	$0.00	Amazon

Purpose of Adaptations for the Wheelchair

Waist and Leg Straps

June has problems controlling balance. When using a tennis wheelchair, it is recommended that athletes use a waist belt and straps for the legs to prevent bucketing in the wheelchair due to balance issues. A waist strap is used for safety to prevent falling out of the chair during play; wheelchair tennis requires many quick changes of direction, and it is easy to fall out of the chair. Waist straps provide support to compensate for slight balance issues. Positioning straps or belts are all commercially available and may be factory options on a tennis wheelchair. The leg straps promote stability due to the spasticity in the legs.

Bag

June will put the strap from the tennis bag around her shoulders and have the bag rest in front of her. She is then able to push the tennis wheelchair with her hands; this allows her to use and remove the bag without twisting to remove the tennis racquet from the back of the chair. Originally, I had planned to attach the tennis racquet on the back of the wheelchair, but after some thought, I decided it would be better if June did not have to twist her torso to reach the bag. She can use the tennis strap on the tennis bag to keep the tennis bag in front of her while wheeling her wheelchair on the tennis court. She can then set it down on the bench, and leave it there while she plays tennis.

Tennis Balls

A fanny pack can be used to hold the tennis balls while playing tennis (see Figure 1). The fanny pack will be worn in the front of the body to hold tennis balls. This will allow easy access to balls during play in case of a re-serve.

Figure 1—Tennis balls inside the fanny pack

Tennis Racquet

June has 30% paresis of the hand and has trouble holding a racquet. She needs more support for her hand to be able to hold the racquet handle. June is unable to hold the tennis racquet without assistance due to the paresis of the hand. I have chosen to adapt the racquet by having June wear a glove to help alleviate some of the problems of impaired circulation, prevent pressure sores, and support her hand by attaching the glove to the racquet with Velcro straps. June will be able to increase functional use of her hand while playing tennis because of this adaptation and will be able to use the tennis racquet with a firm yet moveable grip. The ability to adjust the grip is important, as it is necessary in order to complete a backhand stroke. I've applied self-adhesive Velcro to the back of the hand around the knuckles and used two non-adhesive Velcro straps to wrap around the hand in a crescent shape two times: one Velcro strap starting on the pinky and wrapping around the fingers coming around the back of the hand, and another Velcro strap coming around the pick side and ending on the dorsal aspect of the thenar

side (see Figure 2). The straps cross at one point on the back of the hand near the knuckles. This wrapping will allow for slight movement if a different grip is desired for use in a forehand stroke than the grip used for a backhand stroke; the grip is still stable enough for June to be able to hold the racquet handle in place without assistance.

Figure 2—Completed glove and racquet. Note the straps crossing on the dorsal side of the hand.

The initial version of the racquet adaptation was unsuccessful because June was unable to move her hand to change grip positions. The first version of the racquet adaptation consisted of self-adhesive Velcro patch (hook side) attached to the racquet handle, and self-adhesive Velcro (loop side) affixed to the glove palm, covering the area over the metacarpals and fingers on the palmar side (see Figure 3). This grip did not give June the ability to change grip positions for switching between forehand and backhand strokes. I later altered this version to use Velcro pads on only the dorsal side of the hand in order to allow for freer hand positioning. Instead of attaching the glove directly to the racquet with the Velcro pads on the glove's palmar side, I used a pad on the glove's dorsal side and two straps to secure the hand around the racquet.

Figure 3—Previous attempt, with Velcro on the palmar side of the glove

References

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