CHAPTER 10
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ASSISTIVE TRANSFER DEVICE FOR ADAPTIVE ADVENTURE SPORTS

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INTRODUCTION

Adaptive adventure sports were developed for individuals with disabilities to enhance everyday life, challenge the participants, help build self-confidence, and enable learning through experience. One of the main challenges for the athletes to participate in adventure sports is transferring between two different elevations. Although numerous transfer devices are available today, many of these devices are extremely expensive, large, unsafe, or do not fulfill the needs of the participants. We designed a universal transfer device that addresses these issues as well as being portable, increasing safety during transfer, and ease of use for athletes or athletic organizations.

SUMMARY OF IMPACT

The device is able to raise and lower anywhere between 6 inches and 24 inches off the ground, allowing the user to position the device seat so it is level with their wheelchair or sporting equipment. By doing so, they are only required to transfer laterally between two devices. Overall, the device improves upon existing transfer devices, increases the independence of the user, and increases participation in adventure sports while maintaining a safe and comfortable transfer process. The device meets all performance requirements through supporting a load of 300 lbs. and allowing a total height change of 18 in. During clinical testing, the device received an average overall rating of 4.19 out of 5 on the Likert Scale.

TECHNICAL DESCRIPTION

The device consists of three main components: The base, the seat, and a manual hydraulic jack. The jack is mounted on the base frame, and the seat is mounted (through a drop-forward design) to the jack ram. The jack is actuated by a lever on the user's right side in which they pull up repeatedly to raise the seat

Fig. 10.1. Sled hockey (adaptive adventure sport).

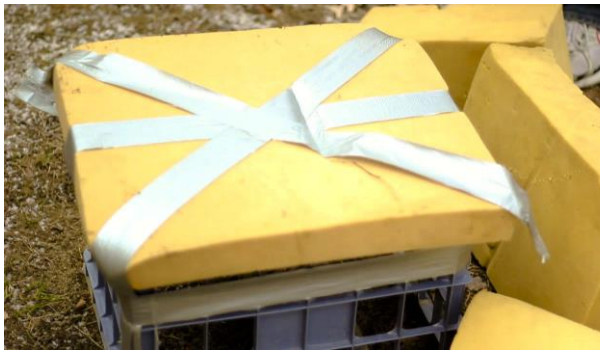

Fig. 10.2. Current transfer device consists of a milk crate with foam padding which acts as intermediate step.

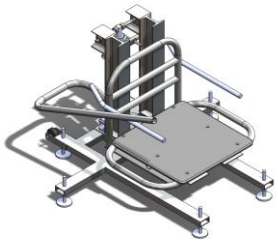

Fig. 10.3. Final device design.

to the height needed. The seat is then lowered, with the assistance of a volunteer, by a release valve connected to the back of the jack. The device is portable by separation of the seat component from the base and jack assembly (to be carried), or by tilting the device onto rear mounted casters (to be dollied). The device also consists of 6 adjustable feet which allow for leveling of the device on uneven terrain. The total direct component cost of the device is $625 and the total cost for the entire project is $1,117.

Fig. 10.4.Wheelchair and transfer device setup.

OFF-ROAD WHEELCHAIR FOR MANUAL WHEELCHAIR USERS

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Client Coordinators: Theresa F. Berner, Dr. Carmen P. DiGiovine
Community Interest: Flying Horse Farms
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INTRODUCTION

Manual wheelchair users experience one of the highest levels of limitation of their daily activities due to the limit of the environments they are successfully able to explore. Because both functional and physical restrictions are present when using wheelchairs, it is often more difficult to propel and maneuver on various outdoor terrains, such as dirt, gravel, snow, and sand. Self-propelling is difficult for some users on flat, level surfaces as well, and although wheelchairs provide mobility for users with disabilities to ensure a better quality of life, their performance is limited on various terrains.

On uneven and outdoor surfaces, stability is lost and a greater effort is required to propel the chair. Changes or additions to the wheelchair are needed to allow for easier and safer transportation on varied surfaces. To obtain a better understanding about how to modify wheelchairs to be used more in off-road environments, clinical information about the user's posture, propulsive patterns, and the limitations of existing wheelchair designs were taken into consideration.

We observed problems with similar devices and determined objectives and constraints for our new assistive device. In addition, we determined quantifiable metrics which will help us to determine how well the device meets the design objectives and whether the team was able to incorporate the objectives and constraints.

SUMMARY OF IMPACT

Wheelchairs provide individuals with disabilities greater mobility, the ability to participate in activities, better health and improved quality of life. However, manual wheelchair users can experience difficulty propelling and maneuvering on various outdoor terrains, such as dirt, gravel, snow, and sand. Due to increasing evidence that closeness to a natural environment and participating in outdoor activities are healthy, manual wheelchair users should have the same opportunity to interact in the outdoor

Fig. 10.5. Final design of device.

Fig. 10.6. Final device attached to wheelchair.

environment as others. After brainstorming our ideas as a team, we narrowed our possible solutions and created a design matrix to evaluate which design would be best, as scored on the evaluation criteria established as most important for the design. We reached our final decision of a three pneumatic wheels design by weighing the costs, weight, and ease of attachment of the device to the wheel chair, along with the location of where the existing casters on the wheelchair would fit into a mounted device. The device our group developed will allow manual wheelchair users to access terrain not achievable in their current everyday chair. This will increase opportunities for them to explore nature, interact with peers at camps and provide a resource for exploring their environments.

TECHNICAL DESCRIPTION

The entire off-road wheelchair attachment is comprised of steel. The attachment weighs approximately 12 pounds. All of the pieces of the device are welded together so no assembly is needed by the user.

The main advantage of our design is that it is truly a universal attachment for any manual wheelchair. In order to remain truly universal, the box of the frame must be wide enough to accommodate the widest front caster placement on wheelchairs corresponding to our constraints. Correspondingly, we have designed our boxed frame to be 25 inches wide, as shown in Figure 10.7. The boxed frame is used to "trap" the caster between the rails. Again, with universality in mind, we have designed the boxed frame rails to 3 inches apart (center to center). This allows the attachment to accept wheelchair casters with diameters between 3 and 5 inches. Another consideration regarding critical dimensions is the clearance between the front wheel and any part of the wheelchair overhanging the front casters. Accordingly, the wheel is located 14.5 inches in front of the boxed frame front rail. In addition, the support rail is 8 inches in front of the boxed frame front rail. Based on our research, this dimension should provide enough clearance for many footrests on manual wheelchairs. The last dimension worth mentioning, is the ground clearance of the frame. The design allows a maximum ride height of just over 2 inches. The ride height is affected by many factors including tire pressure, load on the attachment, and also the location of the load on the attachment. We have tentatively determined that optimum ride height is between 1 and 2 inches. This is based on an optimal 15 degree angle.

The final cost of the attachment is $332.03.

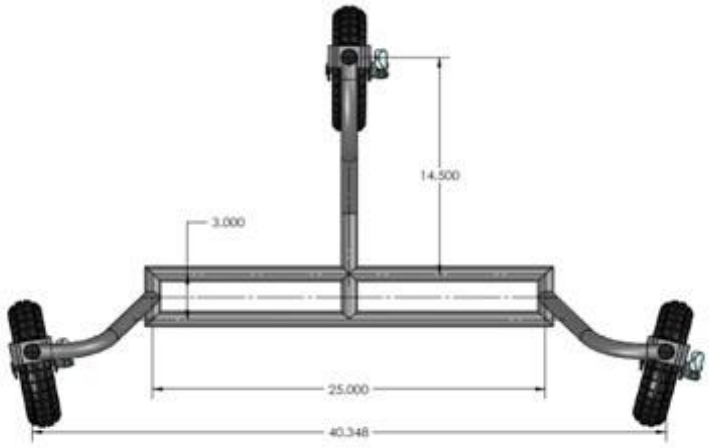

Fig. 10.7. CAD of Attachment with Dimensions.

EVALUATION WHEELCHAIR

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Community interest: Martha Morehouse Medical Pavilion
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INTRODUCTION

A properly fitting wheelchair is essential for a comfortable and active lifestyle, as well as to prevent health complications that often arise from ill-fitting wheelchairs. Unfortunately, the current wheelchair seating and mobility assessment process has many opportunities for error, lacks consistency, and does not always provide the client with the best fit possible.

This current process uses tools that often require some estimation and doesn't allow the clinician to see the client in the device until the final order is already made. The purpose of our project is to create an evaluation manual wheelchair that can be used during clinical evaluations to quickly and efficiently provide a properly fitting wheelchair for manual wheelchair users to trial.

The final design of our evaluation wheelchair is an all-inclusive, highly adjustable chair that is easy to use and provides the patient with the ability to "test drive" their fitted chair in a simulated clinical environment. The design will allow adjustments to the following features: seat depth, seat width, axle location, caster position, back angle, back height, brake position, seat height, wheel camber, and footrest position.

The combination of these adjustments on a single wheelchair offers clinicians and clients a tool that allows a way to test a wheelchair and make adjustments before purchasing; improving the overall fit of the final wheelchair and thus the clients' quality of life.

SUMMARY OF IMPACT

Individuals being evaluated and fitted for manual wheelchairs most often are not given the opportunity to "test drive" a manual wheelchair before the purchase of their everyday wheelchair. Our evaluation wheelchair provides benefit to patients, clinicians, hospitals and clinics, and wheelchair suppliers and manufacturers. Patients are ensured a better wheelchair fit, clinicians benefit in that they are able to more precisely place a wheelchair order for the patient, hospitals and clinics will save time and money with a more efficient wheelchair evaluation process, and wheelchair suppliers and manufactures will be able to better meet the needs of the clients with

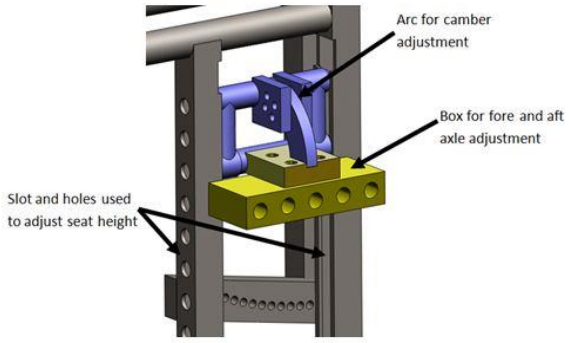

Fig. 10.8. Seat Height, Axle Location, and Camber Adjustments.

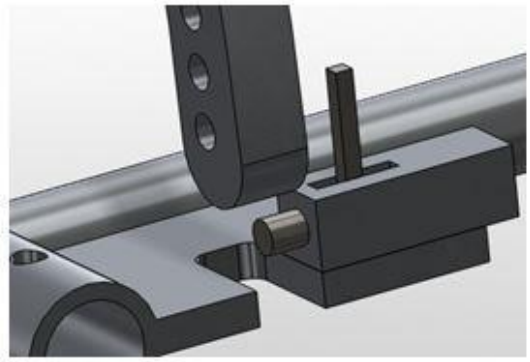

Fig. 10.9. Seat Angle Adjustment.

the purchasing of more properly fitting manual wheelchairs.

TECHNICAL DESCRIPTION

The seat back height for the wheelchair will be adjusted with two parallel telescoping tubes using spring-loaded pins and holes. The fore and aft axle adjustment is a solid aluminum box with five holes that go completely through, allowing the fore and aft position of the wheel to be adjusted with a quick release wheel axle. The seat height adjustment is achieved by removing two shoulder bolts and sliding the axle location box within a guide rail. The camber is adjusted through the use of an arc that passes between two plates, and is locked with a quick release pin as shown in Figure 10.8.

The width of the wheelchair is adjusted using five separate telescoping tubes which are held in place with two quick release pins. The seat depth is adjusted using two parallel telescoping tubes with removable quick release pins.

The seat back angle is adjusted with spring loaded pins on each side of the wheelchair. Two steel bars have thirteen holes spaced two degrees apart. The angle can be adjusted by pulling on a steel cable to unlock the pins from the holes on each side of the wheelchair. The angle for the seat is adjusted using spring loaded pins and steel arcs with holes as shown in Figure 10.9. The angle can be adjusted by pulling on a steel cable connected between the pins on both sides of the wheelchair and then moving the seat to the correct angle.

Our design is the first wheelchair with the ability to adjust every feature to the proper fit for the majority of the population using manual wheelchairs. Furthermore, it does so in a way that is simple and intuitive and saves all parties of the wheelchair evaluation and fitting process time and money. We believe this design is the solution to consistently providing a properly fitting manual wheelchair to individuals with functional mobility limitations.

The approximate cost of all materials was $1600.

Fig. 10.10. Evaluation Wheelchair.

MOBILE ARM SUPPORT

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INTRODUCTION

Every day functions such as eating, drinking, dressing, grooming, and brushing teeth require muscle strength in the upper extremities. Individuals with diagnoses that result in proximal weakness to the trunk and shoulders may experience difficulty in tasks which involve lifting of the arm. Mobile arm supports exist to assist with these tasks, but a survey of existing mobile arm supports reveals that problems exist with the portability, versatility, and affordability of today's options.

A need exists for a mobile arm support that provides high functionality of motion and adjustability while staying at a relatively low cost, because it is difficult to obtain insurance coverage for mobile arm supports. We have developed a new mobile arm support by breaking the problem down into four sub-functions: 1) wheelchair attachment, 2) arm interface, 3) vertical motion, and 4) horizontal motion.

We created the sub-functions based on what we deemed to be critical design components and functions. We brainstormed, rated, and refined design concepts in each of the four sub-functions to come up with a complete final design. Throughout the design process, we kept simplicity in mind to ensure affordability of the final device.

SUMMARY OF IMPACT

Diagnoses that result in proximal weakness to the trunk and shoulders include cervical spinal cord injury, muscular dystrophy, ALS, and multiple sclerosis. In general, activities of daily living, mobility, and access to communication devices may be impaired due to these limitations. Mobile arm supports are used to assist those with upper extremity weakness in completing these daily functions and to restore independence for these individuals. To test our device with two clients, we developed a test plan to test three key functional tasks: 1) reaching forward, 2) reaching upward, and 3) feeding. To test reaching upward, we asked clients to press a power button to open a door. To test reaching forward, we asked clients to type their name on a computer keyboard. To test feeding, we asked clients to raise a spoon to their mouth and return it to a bowl. Both clients showed improvement in feeding and reaching forward, and one client showed improvement in reaching upward. Both clients also showed a significant decrease in fatigue during the completion of these tasks. Based on these results, the device successfully assisted in each of the designated tasks and has the potential to increase the independence of patients with proximal weakness to the upper extremities.

Fig. 10.11. Arm Positioning in Mobile Arm Support.

TECHNICAL DESCRIPTION

The device is attached to the wheelchair by sliding a mount into a channel that previously exists on the wheelchair and is common for many types of wheelchairs. A horizontal beam is welded to the mount and a vertical rod is welded to the horizontal beam. The rod from the wheelchair attachment is bolted to the mounted vertical rod and runs up the wheelchair nearly vertically. A ball joint rod end

bearing is located on the shaft near the shoulder, and a universal joint is connected to the bearing to allow for both horizontal and vertical motion of the device. Clamp-on shaft collars keep the ball joint rod end in place on the shaft and can be moved to adjust the height of the device.

The frame of the device consists of two circular aluminum rods that run from the shoulder joint to slightly past the elbow and are contoured to match the shape of the arm. The arm interface consists of three components: 1) an elastic elbow support, 2) a plastic elbow positioning piece, and 3) a circular forearm cuff. The elastic elbow support is positioned horizontally between the rods to allow the elbow to rest upon it. The elbow positioning piece sits behind the elbow and ensures that it does not slide back and out of position. The forearm cuff consists of plastic shell with foam padding on the inside, and it opens in half and locks around the user's forearm for use. Figure 10.11 shows the appropriate arm positioning within the device.

Elastic bands generate the force to support the weight of the user's arm. The bands are positioned between the shoulder joint and frame and between the frame and forearm cuff. A tensioning device, consisting of an aluminum shell, spring, and pin, is placed on the frame and allows for adjustment of the force provided by the bands. The pin contains locking ball bearings and a snap ring. The spring allows the ball bearings on the pin to be pulled in and out. The aluminum shell contains internal holes to allow the pin to be pulled out of position, rotated to the desired position, and locked into place. In this way, the elastic bands are clamped onto the tensioning device and tensioned by rotating the pins to the desired positions.

The cost of the parts and materials for the final device was approximately $326.09.

Fig. 10.12. Final Prototype of Mobile Arm Support.

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MIDLINE GAIT SYSTEM FOR INDIVIDUALS WITH ATAXIC SCISSORING GAIT

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INTRODUCTION

Scissor gait is a deviation in which the lower extremities cross midline while walking and is a symptom of a variety of neurologic conditions. With ataxic scissoring, patients lose control of refined movements and have difficulty controlling their limbs in space. As a result, the legs may cross midline due to the individual's impaired neuromuscular control and, if not addressed, may lead to falls or patient injury.

Current physical therapy treatments for ataxic scissor gait include the use of freestanding assistive devices, which are prohibitively expensive, and manual techniques, such as holding a ski pole between the patient's legs, which can be inefficient and prevent the physical therapist from performing more skilled patient cueing. The goal of our project was to design a tool for use in physical therapy sessions that improves upon present treatment methods.

Our design is a system of components that must safely and securely attach to standard two-wheeled rolling walkers, greatly reducing the cost and improving clinical integration of the system. The design prevents an individual from crossing midline during gait training while maintaining the safety of the user and therapist. The components are adjustable and removable from the walker, allowing the system to be tailored to a user's specific needs.

SUMMARY OF IMPACT

The purpose of our design is to provide physical therapists with a safe, effective, and affordable treatment tool for use with ataxic scissoring patients. The design will prevent an individual from crossing midline during gait training while maintaining the safety of the user and therapist. The components are adjustable to the user's specific needs in order to accommodate as many users as possible. Additional

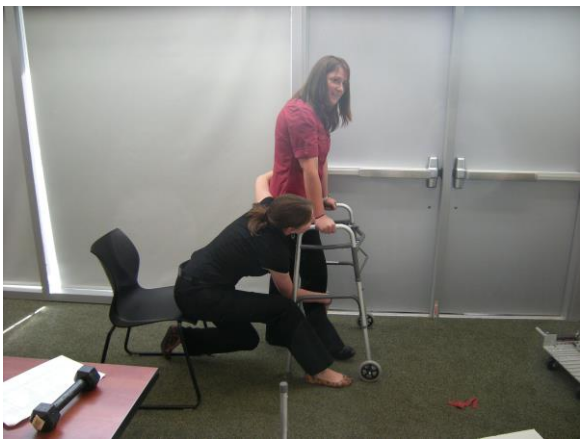

Fig. 10.13. Current treatment methods for patients with ataxic scissor gait

Fig. 10.14. Solid model of Midline Gait System attached to a walker.

research was conducted in order to ensure our attachment subsystems would be compatible with as many user body sizes as possible. We reviewed the human anatomy and biomechanics of the involved body systems, and performed calculations to determine appropriate dimensions for each designed piece. The system can be used as a whole or as separate components, to cater to the individual needs and severity of the user's disability. After clinical testing at both Dodd Hall and the Martha Morehouse Medical Center, therapists responded positively as to the usefulness of the system as a way to treat patients with scissor gait, as well as other pathologies.

TECHNICAL DESCRIPTION

The system design is composed of four attachments to a standard two-wheeled walker, each achieving a specific function. The attachments include a midline blocking bar, a forearm support system, weight receptacles, and a mirror attachment. The midline bar consists of connected components that fulfill depth and height requirements for different users and width adjustments to fit several walkers. In order to increase the attachment stability and safety for the user, the design includes a curve at the end of the solid bar down to the ground, capped with a spherical glider in order to provide adequate support on the ground. The midline bar adjusts in length and height via telescoping bars. The length of the cross bar will be adjusted by a dual spring-loaded system able to compress or expand to fit the walker width.

The forearm support and handle subsystem consists of several components. These components include a semi-circular cushioned armrest, a proprioceptive wedge, a central support pole that holds the armrest, clamps to attach the central support pole to the walker, lateral support bars, and four different types of handles. The four handle types are a straight vertical handle, a straight handle angled at 45°, a horizontal handle, and a tri-pin handle. The inner radius of the armrest is 2.25'', meaning that it is able accommodate a forearm that is a maximum of 14'' in circumference. The length of the armrest is dependent on the length of the forearm of the average user, and more specifically the length of the ulna. The purpose of the wedge is to cue the user if the elbows become overextended and the walker is pushed too far in front of the user. The central bar is adjustable in height by 3" and can rotate transversely 30° inward about its central axis. All four of the handle options for this system have a pin located on the anterior face that allows them to lock into the slot located at the front end of the base plate. The vertical handle, 45° handle, and horizontal handle are covered with ergonomic grips for comfort. The tri-pin handle is designed to support a user's hand if they do not have the physical capacity to grip the other handle options due to neurological or musculoskeletal conditions.

The weight receptacles have a lip which extends from the top of the medial wall to hang over the walker's side cross bar, making attachment possible in a single step. To prevent anterior-posterior and medial-lateral translation of the receptacles during use, there is a supportive bar across the bottom that is curved at the ends, which rests against the legs of the walker. This design allows various types of weights to fit within the receptacle, such as, ankle weights, dumbbells, and other quantifiable weights. The weight receptacles are made out of uniform Aluminum 6061 in 1/8'' thick sheets, and are held together by right angle brackets.

The mirror component is comprised of three main parts: the mirror, the base and the arms. The mirror itself will sit in a frame in order to stabilize and protect it from damage if user were to collide with another object. The mirror is 15"x15"x0.25" to provide the user a full view from their feet. The angle of the mirror is adjustable via pin-holes on the sides of the base, in order to account for users of different heights. The top corners of the mirror will rest in a track and slide easily up and down as the bottom angle is adjusted. The mirror subsystem will have two arms that attach the component to the walker, one on each front leg of the walker, via clamps attached to each end of the arms. The arms are adjustable in width by two 6" long extension rods of 1" diameter located on either end of the front of the base. The total cost of parts and materials for this prototype was approximately $1670.

REDESIGN THE WALKER ASSISTIVE DEVICE

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INTRODUCTION

Walkers are used to provide stability to people with decreased balance and lower extremity strength. The overall goal is to decrease a user's fall risk. Yet, if used improperly, walkers have been shown to increase fall risk in users. Poor posture, destabilizing biomechanical effects, increased attentional demands, interference during balance correction, and increased metabolic and physiological demands are all reasons why current walkers and their misuse can increase fall risk to the user.

Falls are extremely dangerous, especially for older users, who may have other ailments. Current designs do not promote correct posture while in use, which can lead to increased instability and fatigue, which leads to increased fall risk. This new walker was designed primarily to correct weaknesses in the current walker in order to reduce fall risk in walker use.

This redesign makes efforts to correct these issues by using biomechanical feedback to remind the user to use proper posture. Additionally, it uses a mechanical response system to adjust to how the user is using the walker. The goal was to create a walker that decreases fall risk in walker users, is intuitive to use correctly, and is able to be used by a wide range of walker users.

SUMMARY OF IMPACT

9.1 million individuals in the United States currently use an assistive device for ambulation. 1.5 million people use walkers in the United States, and 78 percent are over 65 years of age. There are a number of reasons an elderly individual may require a walker, but they are most commonly used for balance and support. Current walker designs can lead to increased fall risk through user misuse as well as several design flaws. Because current designs do not help correct the issues of poor posture, destabilizing biomechanical effects, increased attentional demands, interference during balance correction, and increased metabolic and physiological demands, these designs can actually be dangerous for users. A walker that helps to correct these issues, while not losing the stability that users need, would help to decrease fall risk thus making ambulating safer for users.

TECHNICAL DESCRIPTION

The new walker design includes several additions and modifications to help to correct the issues listed above. The design is longer, which allows users to walk within the frame, to increase stability by keeping the walker close to them. Also to accommodate more users, the design can be adjusted for width as well as height. The walker has four wheels, but instead of only having brakes in the back, the new design incorporates four wheel brakes. Additionally, the brake activation lever has a shorter, more manageable activation, allowing users to easily engage the brakes.

One addition that was included are biomechanical posture cues; springs covered by soft housings that protrude out across the back opening of the walker. When a user leans forward, a sign of bad posture, the posture cues make contact with the user's legs, giving the user a reminder to stand up straight. Additionally, the design includes a weight-activated system to increase stability for users who use the device for more weight-bearing. As users press down on the frame, spring activated sleds are pressed to the

floor, changing the walker from a four-wheeled design to more stable two-wheel, two-sled design. This addition helps to make the walker more universal.

Approximate cost for all materials was $2000.

Fig. 10.15. Prototype of Final Walker Design

HIP CONTINUOUS PASSIVE MOTION DEVICE

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Community interest: OSU Sports Medicine at Martha Morehouse
Supervising Professor: Dr. David Lee, Department of Biomedical Engineering
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INTRODUCTION

Between 22% and 55% of people who experience hip pain have acetabular labral tears. Surgery is required to repair a torn labrum. Following surgery, a strict rehabilitation program is prescribed for optimal recovery. This assistive device accurately replicates the continuous passive hip circumduction (circular) motion prescribed as a physical therapy intervention. Continuous movement is defined as constant motion of the involved area of the body by an outside source. Passive intervention means that the involved person does not actively contract any muscles.

Currently, physical therapists must perform this intervention without assistance from a device, because no device assists to aid in the intervention. This device assists with performing this prescribed continuous passive motion (CPM). Patients lie supine with their surgical leg in a boot that is attached to an assembly that provides the circumduction movement.

The device was presented to clinicians at the Ohio State University Sports Clinic at Martha Morehouse, for clinical feedback. This assistive device addresses the functional requirements to mimic the therapy currently performed by physical therapists or patient caregivers with a unique and innovative design.

SUMMARY OF IMPACT

During the hip CPM process, someone or something other than the patient moves the surgical hip without any muscle contractions. Currently, patient compliance with the prescribed intervention is difficult because physical therapy visits are expensive and inconvenient to schedule and home exercise programs are physically difficult to complete. Improved patient participation in CPM may decrease healing time and improve functional and clinical outcomes. With roughly 30,000 hip arthroscopic surgeries performed in 2010 in the United States, it is important to improve clinical outcomes to accommodate the growing population of patients undergoing this surgery. This device provides passive circumduction of the hip joint and can be used independently. This device can enable patients to increase compliance and relieve physical stress for both the physical therapist and patient caregiver.

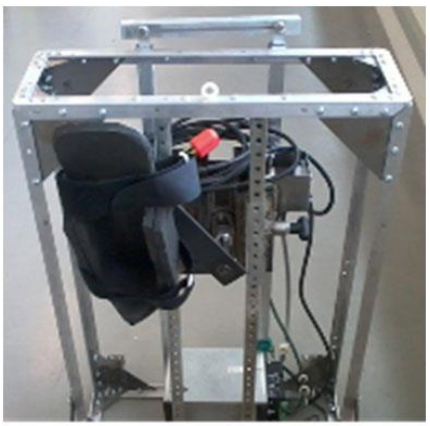

Fig. 10.16. Boot and Motor Attachment

TECHNICAL DESCRIPTION

Our design process consisted of generating ideas for device components that could then be easily assembled. These features remained throughout our design modifications.

The housing was at first a rectangular box with dimensions 24 inches wide by 36 inches high by 8 inches deep. For our design prototype, we deemed that it was simpler to make modifications and adjustments to an open box, rather than to an enclosed one. However, in a more finalized construction, we would enclose all the features housed in the box frame. The frame provides the housing for the motor that sits on an adjustable track,

the step-down gears and output shaft, and the speed controller.

After searching the products offered by many different manufacturers we chose a DC brushless gear motor from Anaheim Automation that comes with a gearbox already attached. This motor, controlled with a MDC150 speed controller, provides an output speed of 53 RPM with a maximum torque of 40 lb. ft. from the gearbox; adequate torque for our needs.

The boot is our patient-to-device interface and transfers the circumduction motion to the patient's leg. At first, we planned to use 3D printing capabilities to create a form-fitting boot out of plastic. The plastic boot would match the shape of a patient's foot for the utmost comfort. Despite the allure of the plastic boot, we decided to change our design to a simple "one size fits all" boot made from sheet metal padded with foam. After testing, we may find that a hybrid of sheet metal and a smaller design from the 3D printer will be suitable.

As the boot travels in the circular motion during the intervention, the leg distance from the device changes. Originally, we wanted to compensate for this change by allowing increased freedom of movement for the motor shaft. However, after unsuccessfully manufacturing a smooth interface for the shaft to travel on, we needed to change our design more drastically. We replaced the moving motor shaft with a rolling cart. Instead of lying stationary on a mat, the patient now moves back and forth with the cart. This motion is now possible as the patient moves back and forth facilitated by the rolling cart. The result of the rolling cart is a much smoother motion than the sliding shaft design.

We added a retractable suitcase style handle and wheels in this design iteration. These additions allowed the patient to maneuver the hip CPM in the same manner as a large carry-on suitcase. Users are able to tow the hip CPM behind them. They can also transport and maneuver it easily within their home. Patients will likely be more comfortable with the hip CPM because it looks like a common item, a suitcase, rather than a piece of medical equipment.

The approximate cost of all materials was $2010.

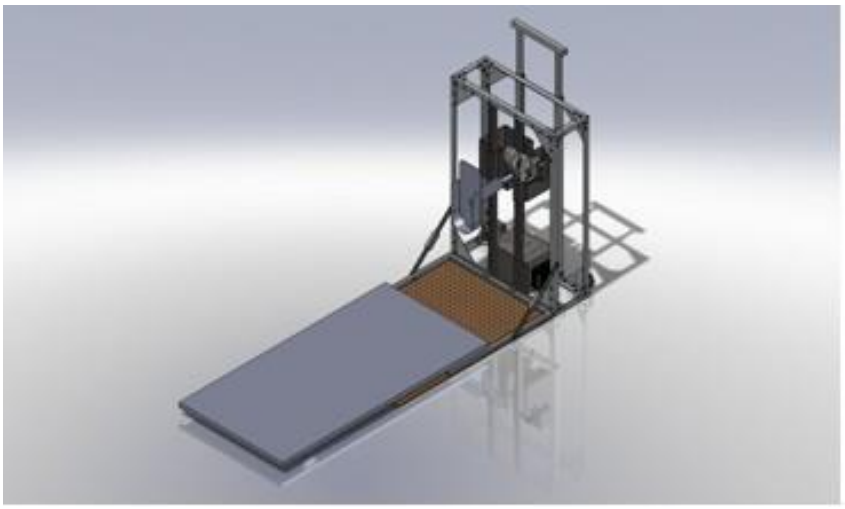

Fig. 10.17. Hip CPM device

SUBOCCIPITAL RELEASE DEVICE

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INTRODUCTION

Suboccipital release technique is commonly performed by physical therapists to relieve cervicogenic headaches, neck pain, and range of motion restrictions. Patients with these conditions routinely visit the clinic to receive this treatment. This can be a financial burden and inconvenience for the patients. Those who chronically suffer from these conditions may benefit from a device that can be used in the convenience of their home, and successfully deliver the suboccipital release treatment. Current devices on the market fail to replicate the effects of suboccipital release therapy. These devices on the market lack any dynamic component.

During suboccipital release therapy therapists adjust finger placement and provide traction or oscillatory motions with their fingers. Therefore, it is essential for dynamic movements when providing suboccipital release. Furthermore, devices on the market do not replicate the placement of the therapist's fingers accurately. The therapist's fingers are arranged in a V-shape orientation with four fingers comprising either end of the V. Finally, devices on the market greatly lack in adjustability to the user. Devices fail to allow the user to change the amount of pressure, location of pressure, and placement of head support.

Our team designed and developed a device to include dynamic movement, V-shape orientation of pressure applicators, and enhanced adjustability. We clinically tested our device with physical therapists and patients. The clinical tests were successful. Patient and physical therapist feedback both showed our device successfully replicated the effects of the manual technique of suboccipital release therapy.

SUMMARY OF IMPACT

Patients with chronic headaches, cervicogenic headaches, neck pain, and range of motion restrictions will greatly benefit from a device that provides suboccipital release in the convenience of their home. This device will help reduce the financial burden of constantly visiting the clinic for the technique. Furthermore, the device will readily provide patients treatment when the patient is feeling pain or discomfort. The physical therapists will also greatly benefit from our device. The technique can be strenuous for the physical therapist and may lead to injuries to the therapist. This device will reduce the frequency physical therapists conduct this technique for patients reducing the risk of injury and fatigue of their fingers. During the clinical trials both therapist and patients viewed the device as a means for the user to more readily receive the technique. Therefore, the patient will not have to regularly visit the clinic and can use the device when needed.

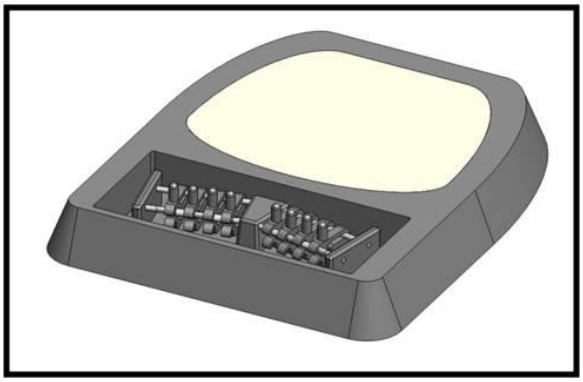

Fig. 10.18. Solid works model of device

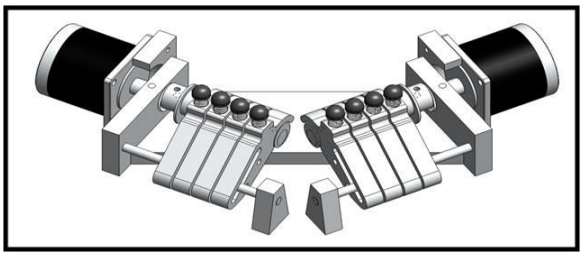

Fig. 10.19. Assembly of device.

TECHNICAL DESCRIPTION

Our device contains five essential components for producing suboccipital release therapy. These include: eight modified pressure applicators, a

dynamic component, a head support, a base with attachments, and a fabric cover.

The 8 pressure applicators are arranged in a V-shaped alignment with 4 pressure applicators on either side. Each set of 4 aluminum applicators are positioned by a camshaft and an aluminum shaft which are both horizontally arranged and attached to supports. These supports also create part of the base. The camshaft supports the front region of the pressure applicator and the aluminum shaft supports the body of the pressure applicator. The modified pressure applicators are shaped with a hook on the frontal portion of the applicator allowing it to attach to the cams on the camshaft. The remainder of the applicator is supported by an aluminum shaft. The diagonal slot of the body of the pressure applicator contacts the aluminum shaft. This space allows the applicator to easily be detached or attached to the cam without removing any components from the device. The applicators move laterally on both the camshaft and aluminum shaft. Washers are inserted between cams on the cam shaft to secure both the pressure applicators and the cams. The pressure applicators are shaped with a protrusion between the hook attachment and body. This protrusion was drilled to hold a small threaded aluminum shaft that can screw or unscrew to adjust the height of the pressure applicator. The head of this threaded shaft contains a ball and socket tip, which interfaces the user. A rubber head is attached to the ball and socket to provide greater comfort when using. Both cam shafts are connected to a stepper motor, which is programmed with Arduino microcontroller and circuit boards to rotate the cam shaft slowly at 10 RPM. The pressure applicators resting on the small cams will be raised and lowered at various heights as the camshaft rotates. This movement provides minor massage to the user similar to that of therapist. Two motors are used for each cam shaft to rotate both sides of the device contain the four pressure applicators. The motors will be housed in the base. The base is also used as attachments for the horizontal shafts and housing for the head support. The base also provides aluminum supports below the washers on the cam shaft to better support the weight of the user. The head support consists of memory foam which will be attached to the base of the device. Button snaps will attach the memory foam to the base at various locations. This will allow the user to adjust the memory foam where needed. A fabric cloth will fasten with snaps to cover the device for cleanliness and comfort to the user. This cloth can be removed, washed, and exchanged.

Final cost of suboccipital release device was $313.21

Fig. 10.20. Suboccipital Release Device