

Prosthesis Design for Bilateral Hip Disarticulation Management

Ing. Mauricio Plaza Torres PhD, Ing. William Aperador. PhD
UNIVERSIDAD MILITAR NUEVA GRANADA

Abstract—Hip disarticulation is an amputation through the hip joint capsule, removing the entire lower extremity, with closure of the remaining musculature over the exposed acetabulum. Tumors of the distal and proximal femur were treated by total femur resection; a hip disarticulation sometimes is performed for massive trauma with crush injuries to the lower extremity. This article discusses the design of a system for rehabilitation of a patient with bilateral hip disarticulations. The prosthetics designed allowed the patient to do natural gait suspended between parallel articulate crutches with the body weight support between the crutches. The care of this patient was a challenge due to bilateral amputations at such a high level and the special needs of a patient mobility.

Keywords— Amputation, prosthesis, mobility, hemipelvectomy

I. INTRODUCTION

Hip disarticulation is the removal of the entire lower extremity through the hip joint. Hip disarticulation amputations are relatively rare [1],[2],[3]. For this reason there is not much research on this area to give a solution specific to self-mobility. They are usually performed when a malignant disease of the pelvis, hip joint or upper thigh cannot be treated by more conservative means. Sometimes they are performed if osteomyelitis of the pelvis or proximal femur or certain massive benign tumors in the pelvic region has not responded to less radical procedures [4],[5].

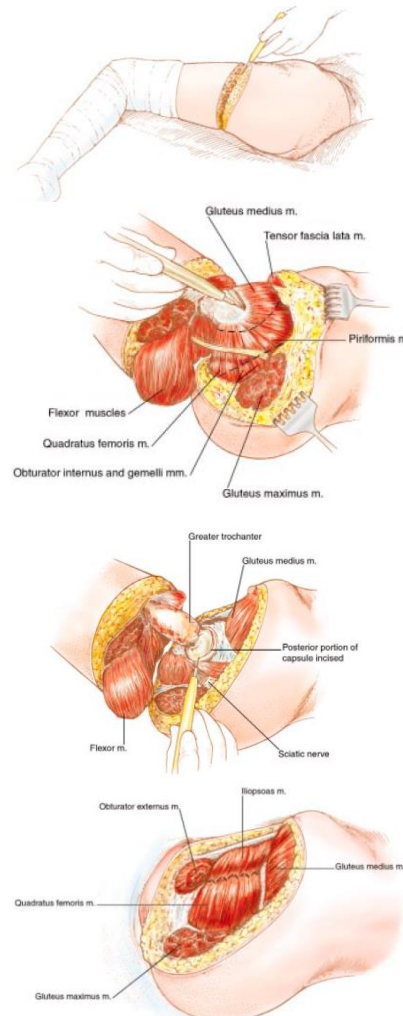


Fig 1. Surgical Procedure

The surgical procedure includes

- ✓ Completion of the skin incision
- ✓ Division of tensor fascia lata, gluteus maximus, and rectus femoris muscles
- ✓ Transection of the muscles inserting into the greater trochanter
- ✓ Release of specimen
- ✓ Approximation of obturator externus and gluteus medius over the joint capsule

- ✓ Approximation of gluteal fascia to the inguinal ligament and pubic ramus
- ✓ Skin closure

Who had bilateral hip disarticulation amputations, including transection of ischia to the level of the horizontal ramus of the pubis was treated prosthetically and rehabilitated. Prosthetic fitting failed because of chronic tissue breakdown over the remaining bony prominences [6],[7],[8]. The prosthesis had to provide mobility by gait training and the design of the mat avoid tissue breakdown. Paraplegics face a number of medical, psychological and emotional issues, which can usually be managed in resource-rich centers with adequate social support. [9],[10],[11].

However, in developing countries, with some resources, living with paraplegia and its associated complications is considerably more difficult especially to self-mobility actions. [12],[13],[14] Hip disarticulation orthosis has some advantages for the paraplegic patient, such as increased independence, a lighter body weight and minimization of local infection. Disadvantages, however, include impaired cosmetic appearance; need some training to acquire stability and good balance and loss of body image (Fig 2).

II. EVALUATION

The prosthetics designed allowed the patient to do natural gait suspended between parallel articulate crutches with the body weight support between the crutches.(Fig 3.) The majority of the weight was distributed to the support system over the bony prominences release a portion of the weight from the forearms.

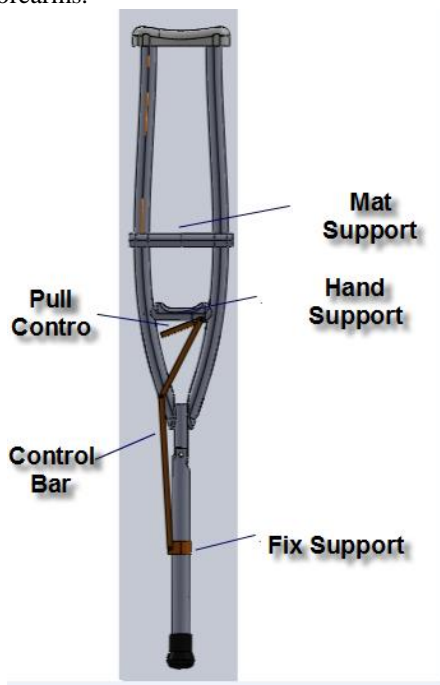


Fig 2. Crutches design

III. DESIGN CONSIDERATION

The support mold was design to distribute weight primarily to the shelf created by the spinal and posterior thorax region. Reliefs were provided over bony prominences via plaster build-ups on the mold.

The mold was to provide a surface which would allow the patient to sit erect without external support. The socket was laminated with polyester resin at 80% rigid, 20% flexible. This system satisfied the walk action by parallel bars or addition of artificial limbs made the entire design functional for transfer and mobility.

The patient was able to ambulate in the parallel bars with a swing through gait.[15],[16] A lay up of four layers of nylon stockinette was made over the socket and again laminated with polyester resin. This patient could not tolerate any distal pressure due to a large ulcer over the sacrum. His amputations were secondary to circulatory problems and diabetes. A minimal amount of extension of the socket was needed as his pelvis was intact and only needed suspension to protect the unhealed area. This patient desires lower limbs for gait provided by parallel bars or artificial limbs for mobility. The socket only provided him with protection for his wounds, sitting balance, and ease in transfer.

IV. FABRICATION AND FITTING

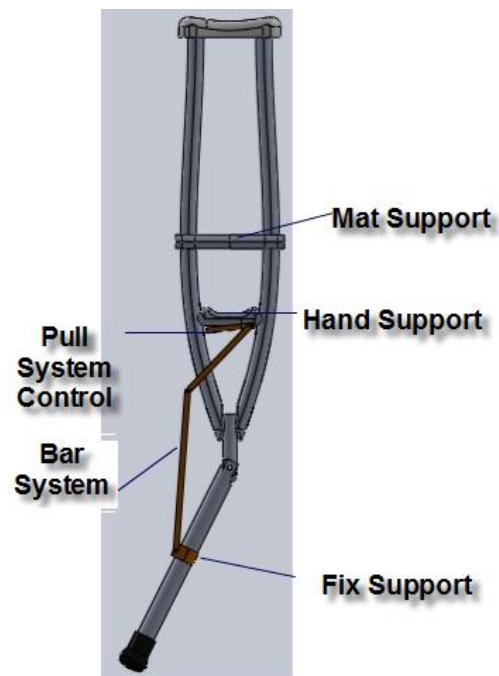


Fig 3. Articulate Crutches System

A plastic pad was formed over the mold for fit in sitting, standing and prone positions. Reliefs were provided to the bony prominences, and two crutches were provided to allow

gait in normal way. Cushions system was located at the axilla level sufficiently to prevent impingement during upper-extremity motion such as flexion and extension of the glen humeral joint and lateral trunk bending. A spring system was placed at the level of the arm to allow adjustments the level of the crutch as the same way of the knees. The spring could adjust the amount of weight both side during the gait. Lower manual system were attached to the metallic bar using for manual locking knees are implemented, While this modular spring system would have provided weight switch, the components and covering would withstand the stress and forces encountered when the patient gait.[17],[18]

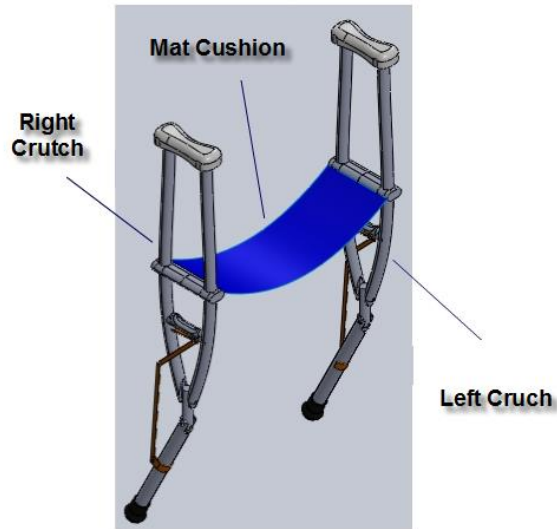


Fig 4. Complete system

Static alignment of the prosthesis was performed on stand position. The hip joints were spaced with a 40 cm dimension between outside edges and positioned to provide full support. The join on the crutch allow flexion-extension, free degree of movement for adduction and two thigh segments to achieve a support the arm and axilla. The prosthesis is 80 cm from hip joints to floor on extended position and knee center system is located at 50 cm.

The prosthesis was laminated with carbon fibers and acrylic resin. The pad affixed of the cushion provided an air chamber to release pressures to the distal residual limb.

The finished prosthesis is seen in Figure 4. Before regular use, training is necessary, is possible gaing in natural way.

The socket was further modified to provide relief to the right and left movement and the transverse process of stand-up process.

V. REHABILITATION

The patient's rehabilitation goals included training for short distances for specific activities of daily living such as stand up

and gait without the use of a wheelchair. In addition, the design helped maintain the extension posture moment at the hips necessary to maintain balance when standing.[19],[20]

The designed system was dynamically assessed in sitting and standing to provide maximum balance and stance stability. The articulate crouch provided additional trunk stability on gait process and sitting balance. Training Exercises may include planar and diagonal sit-ups in supine and upper trunk extension in prone and supine positions. [21],[22],[23],[24]

All activities incorporate compensatory movement patterns to enhance functional gait abilities. [21],[22],[23]

Trunk support through a mat is provided. The system also enhanced lateral trunk motion. The flex sections were design to achieve a level base while long-sitting on the floor.[24],[25] Upright balance activities must be performed while wearing the prosthesis in natural way. Rehabilitation for standing is initiated in parallel bars for musculoskeletal system improve, progressing from bilateral upper-extremity support with the design system to independent standing and gait. [26],[27]

Balance is challenged by movement of arms, and the trunk. Training begins in the parallel bars and progresses to forearm crutches system. He progressed with forearm crutches for distances of up indoors and short distances outside. Pressure points are monitored during the training. [28],[29],[30],[31],[32]

VI. CONCLUSION

Functional goals of the system design were met through the careful fitting and dynamic design of the prosthesis in response to self-mobility for paraplegics patients with Bilateral Hip Disarticulation

The initial effort in this case was to get the patient erect at a normal sitting height and provide gait opportunity. Patient could be supported under his ribs with our hands while another prosthetics balanced his upper trunk.

With the prosthesis the patient is able to live independently for mobility actions. A solid support system is important to recovery from any hip disarticulation problem. The support comes from a design system for mobility to release friends and family from this responsibility.

The decision to proceed with a design of prosthesis for bilateral hip replacement can be a very practical one. Recovery from a bilateral hip replacement can be difficult. From practical point of view at the beginning is very difficult to maneuver, for this reason it is necessary a specific training to control the designed system. The final design system allows patients with bilateral hip replacement to perform mobility in natural way.

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