# Hip Disarticulation: A Prosthetic Follow-Up

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Hip disarticulations and hemipelvectomies represent radical forms of surgery which are done rarely and only when other alternatives aren't available. Such radical surgery is often done secondarily to a malignancy, although other diseases or conditions may ultimately lead to hip disarticulation. Although there have been several articles dealing with follow-up treatment of tumors or biomechanical modifications of prosthetic devices, few reports have been done regarding either the success of prosthetic fitting, or the problems faced by patients who wear a hip disarticulation prosthesis.

Table 2 cites the literature reporting the results of prosthetic fittings of patients with hemipelvectomies done due to a tumor. User percentages vary from six to 80 percent in groups ranging in size from ten to 60 patients. In most cases, the primary focus of the articles was not prosthetics and, therefore, the data were not well developed.

In a report by Sneppen, et. al.,[1] on 41 consecutive cases done for malignant tumors, prosthetic fitting occurred in 30 of the 41 cases. Six patients were primarily supplied with prostheses utilizing leather bucket-type sockets (Figure 1) and 24 with

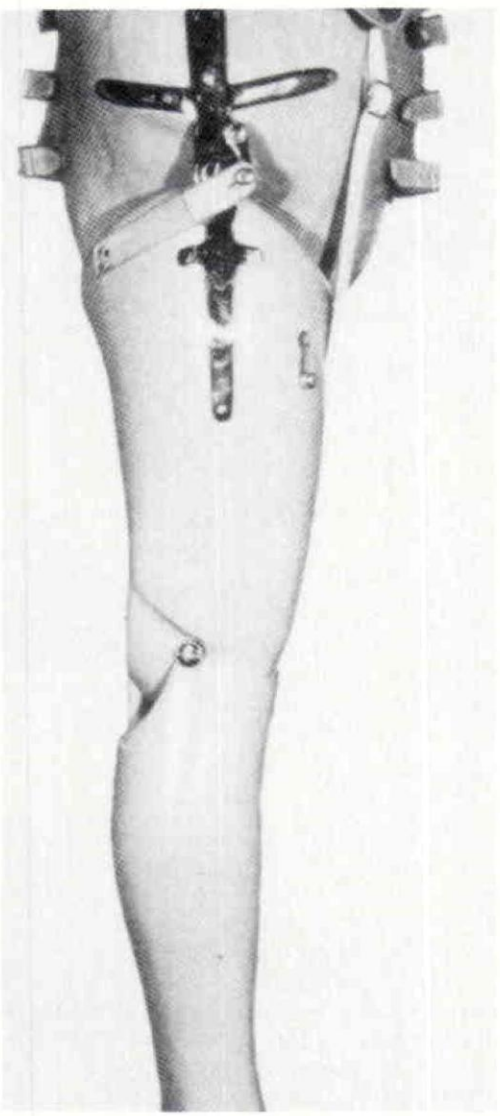

**Figure 1. Leather Bucket Type, Tilting-Table Prosthesis. (Reprinted from *Orthopaedic Appliances Atlas*, J. W. Edwards, 1960).**

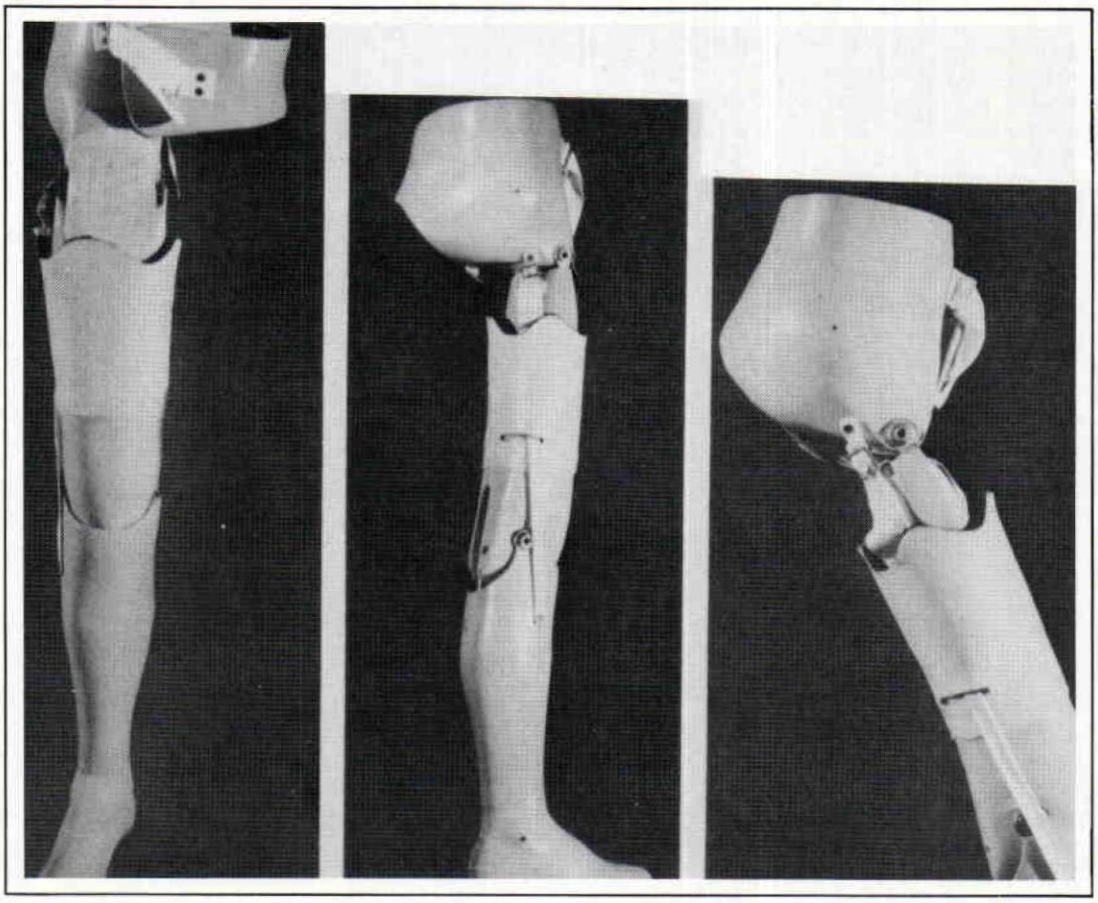

**Figure 2. Canadian Hip Disarticulation Prosthesis. (Reprinted from *Orthopaedic Appliances Atlas*, J. W. Edwards, 1960).**

Canadian style Hip Disarticulation (CHD) prostheses (Figure 2).

There has been some discussion about the philosophical problems faced by surgeons regarding the prosthetic fitting of children having amputations done for tumors. In 1972, Lambert[2] studied a group of 85 children with primary bone tumors at the University of Illinois and concluded that, since the average wear time was 15.5 months per case, the cost of prosthetic fitting was justified in all cases. Unfortunately, he made no record of whether the children began with a prosthesis and then discountinued use prior to death, or surgery, or were alive, well and not using a prosthesis at follow-up. This group included 11 upper limb prostheses, and does not deal with any problems encountered in lower limb prosthetic fitting or wearing at follow-up.

Most authors agree that hip disarticulations are performed almost exclusively for the treatment of tumors. For example, the 1975 revised edition of New York University's Limb Prosthetic Manual states, "In the rare instances in which amputation is required by trauma or nonmalignant disease, . . .". Such a statement leaves the reader with the impression that virtually all such surgery is done for reason of malignancy.

The most commonly used hip disarticulation prosthesis is the so-called Canadian hip disarticulation (CHD) version, introduced by McClaurin in 1957. More re-

cently, the Otto Bock Modular (OBM), endoskeletal version has been employed, due to lighter overall weight, improved cosmesis, and the opportunity to utilize interchangeable and adjustable components.

Since the operation is rare, and follow-up studies dealing with patients' utilization of the hip disarticulation prostheses are sparse, this study was conducted to determine: 1) the incidence and reasons for amputation at the hip disarticulation and hemipelvectomy level; 2) the incidence of prosthetic fitting in these patients; 3) the factors affecting it; 4) the incidence of prosthetic use among those patients fitted with a device; and 5) the factors which contribute to or detract from prosthetic use.

# METHOD

We obtained the records of all University of Iowa patients having had either a hip disarticulation or hemipelvectomy since 1962, and reviewed these records to determine the diagnosis, surgical procedure, prosthetic fitting, and follow-up information. Following the categorization of all cases by cause (Table 1), we attempted to contact patients fitted with prostheses to determine fit and use of the prosthesis, problems relative to the amputation level, and problems encountered which specifically relate to the parts or design of the prostheses. We derived the above information from patient follow-up, or by telephone call.

## Etiology of Hip Disarticulation or Hemipelvectomy

| Etiology | # Pt. (%) | # Fitted | # Users at Follow-up |
|---|---|---|---|
| Tumor | 24 (48%) | 9 | 8* |
| Infection | 10 (20%) | 1 | 0 |
| Trauma | 5 (10%) | 4 | 3 |
| Congenital | 1 (2%) | 1 | 1 |
| Vascular | 20 (20%) | 0 | 0 |
| TOTAL | 60 | 15 | 12 |

*3 died following fitting and documented wearing history prior to death

**Table 1. Etiology of Hip Disarticulation or Hemipelvectomy**

## Fitted/Users of Hip Disarticulation Prostheses

| Author(s) | Date | # of Patients Fitted | # of Patients Using at F/U |
|---|---|---|---|
| Lewis & Bickel[4] | 1957 | 25 | 2 (8%) |
| Miller[6] | 1959 | 32 | 22 (69%) |
| Watkins [3] | 1962 | 10 | 8 (80%) |
| Higinbothom[7] | 1966 | 60 | 24 (40%) |
| Douglas[8] | 1975 | 50 | 3 (6%) |
| Sneppen[1] | 1978 | 30 | 15 (50%) |
| Shurr | 1983 | 15 | 12 (80%) |

**Table 2. Fitted/Users of Hip Disarticulation Prostheses**

# RESULTS

## Incidence and Cause of Amputation

As listed in Table 1, tumor led to amputation most frequently (24 of 60 cases [40 percent]). Ten amputations (17 percent) were the result of secondary infection, usually related to another problem such as paraplegia, multiple sclerosis, or osteomyelitis. In five patients (8 percent), hip disarticulation resulted from trauma, most frequently caused by farm equipment. One patient had a congenital hip disarticulation. Ten procedures (17 percent) were done for vascular insufficiency.

## Incidence of, and Factors Affecting, Prosthetics Fitting

Criteria for HD level prosthetic fitting include: patients who 1) have a healed wound; 2) can expend the energy needed; 3) desire to learn to walk with a prosthesis; and 4) have no illness at the time of fitting which would negate learning how to use a prosthesis. In tumor cases such a condition might ultimately occur.

Table 1 shows that 15 (or 25 percent) of the patients were fitted with a prosthesis. Most of these patients had an amputation for either tumor (nine cases) or trauma (four cases). In only one of the ten cases of amputation done for infection did the patient's overall medical condition allow for a realistic expectation of prosthetic fitting. The one congenital hip disarticulation patient was fitted with a prosthesis at age 16 months, without difficulty. None of the ten patients who had amputations for vascular reasons were fitted. One trauma patient was never fitted because of severe depression. In the tumor-caused amputation group, nine were fitted with prostheses. Patients who had demonstrable metastatic chest lesions were not considered prosthetics candidates. For this last group, the time of death after surgery ranged from three to 60 months.

## Incidence of Prosthetics Use

The initial fitting time of the four patients with trauma-induced amputations ranged from one to three months after injury. Three learned to use the prosthesis readily and continued to use it at follow-up, ranging from 15 to 24 months. The fourth patient also had a shoulder disarticulation and an above-knee amputation on the other lower extremity. His gait training was understandably difficult, and at follow-up, he reported that the energy costs were too great for the benefit derived.

The one fitted patient whose amputation had been caused by infection discontinued wear of his prosthesis after two months because of discomfort in the socket and around the waist.

All nine of the fitted patients, whose cause of amputation was a tumor, learned to use the prosthesis without difficulty. Three of these patients died secondary to their disease. Time of prosthesis use prior to death ranged from 11 to 60 months. The remaining six patients were alive and well at follow-up, with five of them still using their prosthetic devices.

## Factors Affecting Use of a Prosthesis

The factors which effect the use or lack of use of a hip disarticulation prosthesis can be illustrated by examining the cases of six tumor patients and three trauma patients who became regular prosthesis users. Follow-up information about many facets of prosthetic use and fitting demonstrates these factors.

Patient TU-1 was 29 years old when the hip disarticulation was done for a metastatic lesion in the proximal femur. An OBM prosthesis was fitted three months after surgery. Twelve sessions of physical therapy for gait training allowed TU-1 to be discharged with a walker. At his nine-year follow-up visit, the patient reported that he had completely given up using his device, stating that it was easier to use a wheelchair at his home. He does not work outside of the home and stated that he believed fitting of the socket should be done following the patient's return home when the patient's weight has stablized. Since this patient also required a walker, he was unable to use his hands in the upright position. The cosmetic loss of the limb and its

appearance was not worth the discomfort he sustained while wearing the socket, remaining in a wheelchair nearly all day.

TU-2 had an osteogenic sarcoma of the femur which resulted in a hip disarticulation at age 15. She was fitted two years postoperatively with a CHD prosthesis and discharged from physical therapy following 15 visits, using one cane. At three years post-op, she was fitted with an OBM system. At last follow-up, nine years after fitting, she was wearing her prosthesis every day, all day, in her job as a desk clerk at a motel. She compared the two prostheses, saying that she prefers the lighter weight and more cosmetic OBM system. Tearing of the cosmetic foam cover and breaks in the rubber bands of the hip joint have been recurrent problems. The foam covering the knee tears, leaving a separation line visible when she sits in a short skirt. She carries rubber bands in her purse, to replace those in the hip joint when they wear out.

TU-3 underwent hip disarticulation for a femoral chondrosarcoma at age 14. She was fitted with an OBM one month post-operatively. She was discharged from physical therapy after 15 visits, walking well and using one cane. While in high school, she became a cheerleader and broke numerous hip joint attachment plates (Figure 3). Following graduation from college, she became an elementary education teacher. She uses her prosthesis full-time. This case demonstrated the prosthetic adjustability needed for longitudinal growth.

TU-4 is a 20-year follow-up of a hip disarticulation done for a metastatic fibrosarcoma. She was fitted four months post-operatively with a CHD prosthesis, which she described as adequate, yet heavy, and one in which she could never control the knee. Following 20 physical therapy visits for gait training she was discharged, using crutches. Twenty years later, she was converted to an OBM, which she much preferred due to its lighter weight and safety knee, which she can more easily control. She only uses the prosthesis indoors, and uses crutches when she is outdoors. The conversion to the OBM system has not altered this habit. Sitting in her prosthesis is still quite uncomfortable.

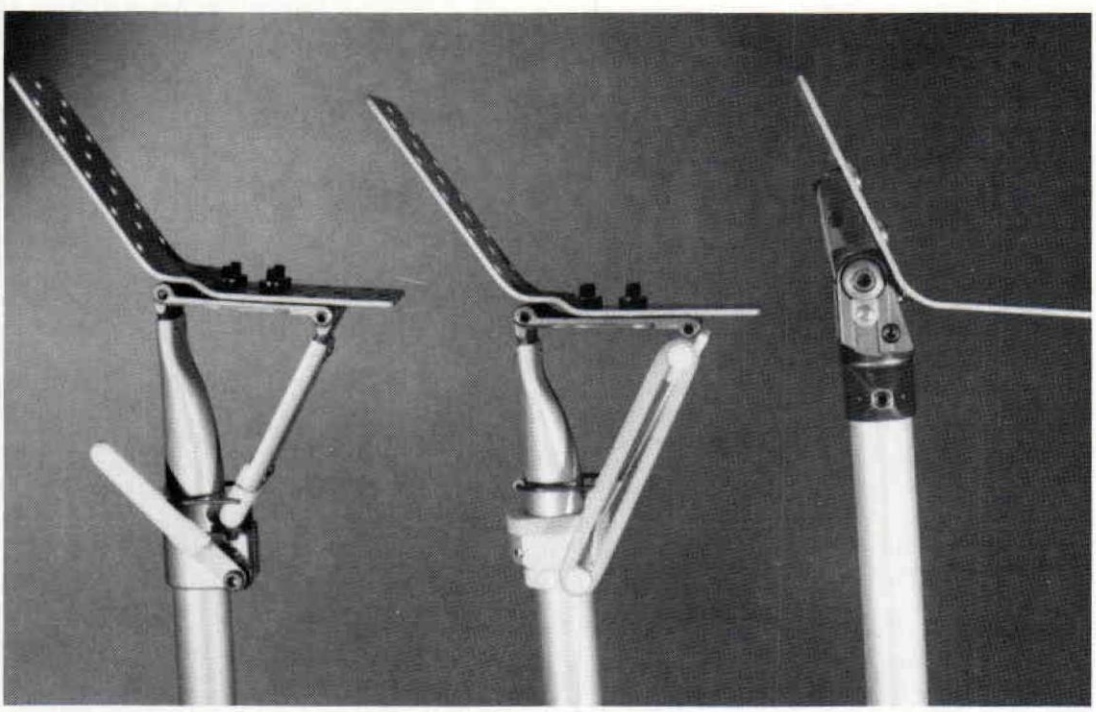

**Figure 3. The chronological progression of the Otto Bock Modular Prosthetic Hip Joints.**

TU-5 had a hip disarticulation for a mixed sarcoma of the femur. This 49 year-old patient was fitted five months post-operatively with a CHD prosthesis. He was discharged from physical therapy following 24 visits for gait training, walking well and using a cane only part time. One year later he was using the prosthesis occasionally, but was more pleased using crutches. The prosthesis proved to be too heavy for this patient.

TU-6 was amputated at age two weeks for a rapidly enlarging femoral sarcoma present at birth. He was fitted with a CHD prosthesis at age two years. Twelve years later he continued to use a CHD device with a minimum of complaints, other than those related to skeletal growth. He has completely mastered functional ambulation, and while he walks slower than normal, this does not concern him. He uses no canes or crutches.

Three of the five patients fitted after disarticulation because of trauma reported daily use of their prostheses at an average follow-up time of two years. Their case information obtained from follow-up visits identifies specific individual situations.

TR-1 was fitted with an OBM system six months post-operatively, at age 23. Following seven visits in physical therapy, he was able to walk 100 meters and climb stairs easily, using no assistive devices. At three-year follow-up he had changed occupations from farming to light industry work, wore his prosthesis all day, every day, using no cane. He had fractured the hip joint pylon attachment on two occasions. He also had complained about the discomfort associated with long periods of sitting.

TR-2 was fitted at four months post-injury with an OBM system. He required 14 visits to physical therapy and was discharged walking independently with two canes. He was age 46 at the time of injury, and at 28 months post-fitting he remained an independent, all-day wearer with no complaints about prosthesis failure.

TR-3 was fitted at 15 months post-amputation with a CHD prosthesis. His medical records were not specific, except to note that he was discharged home walking well with one cane. He returned to farming 120 acres, and ten years later still walked well, using his device daily. He has been subsequently lost to follow-up.

# DISCUSSION

Although most hip disarticulations and hemipelvectomies are due to tumor, other etiologies occur. Tumor accounted for 24 of 50 amputations in our series. The etiologies of vascular insufficiency and infection are often lumped together in classic studies. However, in this series the records were sufficiently clear to warrant separation, with equal numbers of cases together accounting for 20 (40 percent) of the cases. Trauma accounted for five cases and congenital for one. Other reports have not grouped cases similarly.

If only the patients fitted with prostheses are considered, our percentage of patients still wearing prostheses equals that reported by Watkins[3] (80 percent). Compared to Watkins, however, our series includes more than tumors. Authors have alluded to the possible decreasing interest in prosthetic usage associated with age, despite etiology or functional level. However, no author has clearly identified this trend. Much more information is necessary to elucidate the issue.

Questions concerning type of prosthesis and the subjective evaluation of the devices allowed for interesting comparisons in those four patients fitted with CHD prostheses. Two of the four were subsequently fitted with the OBM system and, without exception, the patient's responses were positive. The improved cosmesis and soft-cover accounted for the positive response. The apparent lighter weight was also a positive factor. One patient prefers the safety knee in her OBM system, since the chronic buckling of her CHD prosthesis was a problem. Both patients, however, have complaints about hip joint rubber-band breakage, a problem which the manufacturer has addressed. Likewise, the location of the hip joint and the uncomfortable sitting it produces deserves consideration and redesign. Otto Bock has recently developed the 7E7 hip joint, which addresses this problem (Figure 4).

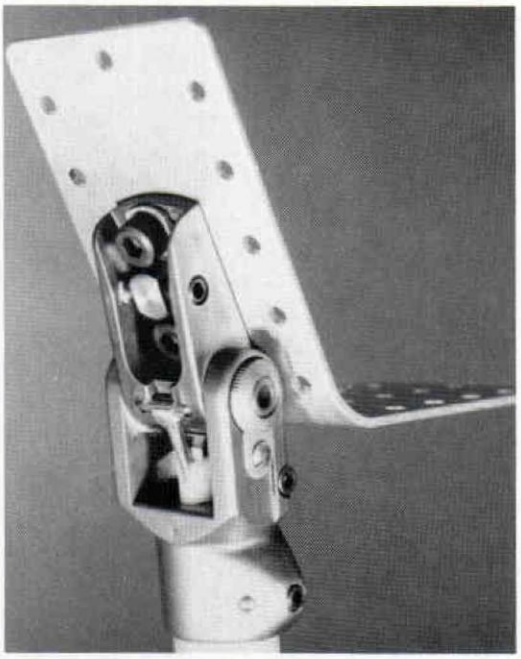

**Figure 4. The Otto Bock 7E7 Hip Joint, positioned more anterior than distal.**

Fracture at the hip joint of the OBM system appeared to be related to intense use of the prosthesis. However, the second generation of hip joint has apparently corrected that problem.

The foam cover also produced problems. Additionally, the prosthetic skin soiled easily. None of these problems were severe enough to coerce any patient to desire to change to an exoskeletal system.

The issue of residual limb/socket problems remains. One patient was advised that fitting would be withheld until preoperative weight was regained. This comment assumed no weight gain past pre-operative status, which, in our experience, does occur. It also ran counter to our early fitting concepts. All patients tolerated the pressures generated at the residual limb/socket interface. However, relatively minor local irritation or volume fluctuation was common. These were usually dealt with by socket modification and were not chronic in any patient.

Only the article by Watkins (1962)[3] speaks to the number of visits necessary to teach the patient to walk at an acceptable level. His comparisons were between leather "Tilt Table" sockets and the then-new CHD prosthesis. An average of 20 visits for physical therapy was necessary to achieve independent gait with the "Tilt-Table" type. An average of 17 visits was necessary to achieve independent gait with the CHD, with or without a cane. An average of nine sessions was required to achieve independent use of the OBM, with or without a cane. These figures do not include the triple amputee who failed to learn, or any cases who subsequently gave up. Age appears to affect the number of sessions necessary for gait training. However, because of the small size of the group, no conclusions can be drawn.

Only one patient was dependent on crutches. Gait using crutches and prosthesis is less than acceptable because the prosthesis normally can afford independent use of both upper limbs. The inability to use the upper limbs was a contributing factor in the prosthesis rejection by TU-1.

One trauma patient who was fitted at age 35 with the CHD later gave up his prosthesis use because he believed crutch walking was easier. He also farmed 120 acres. This should not be related necessarily to the CHD or any prosthesis. Further case evaluation is needed to answer the question of why prosthesis use was discontinued.

## CONCLUSIONS

Hip disarticulation/hemipelvectomy are rather rare procedures made necessary by tumor, trauma, infection, vascular insufficiency and congenital abnormality. Prosthetic devices may be fitted to suitable candidates, with success in usage dependent upon 1) prosthetic socket fit; 2) the patient's ability to walk independently enough to free hands from assistive devices; 3) the limited need for sitting for long periods; and 4) the lack of relative changes in body weight and size.

Patients appear to prefer the modular endoskeletal system. Improvements in the biomechanics of the devices have made learning to walk easier and quicker. More research is needed to better define this patient group and to identify further pros-

thetics and ambulatory problems experienced with long term utilization of hip disarticulation prostheses.

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## NOTES

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