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Knee disarticulation versus above-knee amputation*

R. F. BAUMGARTNER

Balgrist Orthopaedic Hospital, University of Zurich.

Abstract

If below-knee amputation is impossible, knee disarticulation should be considered before above-knee amputation, regardless of age and etiology. Knee disarticulation which leaves the femur and patella untouched offers many advantages. The surgical technique is simple and non-traumatic since no bone or muscle tissue is to be dissected. The thigh muscles are completely preserved and thus there is no muscular imbalance. The stump permits total end bearing and its bulbous shape permits easy and firm attachment of the prosthesis. A specially designed double-wall socket and various types of knee joints are presented. Modern prostheses are superior to above-knee prostheses with regard to function, comfort and cosmesis. Results of 72 patients of all age groups are presented and discussed.

Introduction

If it is impossible to obtain a short below-knee amputation, *knee disarticulation* should be considered before above-knee amputation regardless of etiology and patient's age. There is no level of amputation between the ankle and the hip joint where one can perform an amputation which does not require separation of bone or muscle tissues. At knee disarticulation level the surface of the wound is the smallest possible which minimizes the danger of haemorrhage or infection. In children, the distal epiphyseal line of growth is fully preserved. In contrast to above-knee amputation the stump resulting from knee disarticulation permits full endbearing. All the muscles of the thigh are entirely preserved.

Despite all these advantages, knee disarticulation is still unpopular compared with above-knee amputation. The main objection comes from the prosthetists who complain that there is not enough space for the prosthetic knee joint and have difficulties in fitting the bulbous shape of the stump into a regular socket. For this reason many surgical techniques of through-knee amputation indicate the removal of parts or all of the femoral condyles and the patella to facilitate prosthetic fitting (Fig. 1).

However, knee disarticulation leaving the femur and patella untouched offers many advantages, particularly with regard to surgical technique, stump qualities and finally even prosthetic fitting. The following technique (Kjolbye, 1970; Vitali et al, 1978) is recommended.

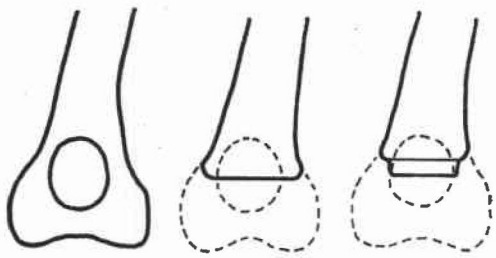

Fig. 1. Some of the most common through-knee amputations. Except for knee disarticulation they involve resection of part or all of the femoral condyles and the patella.

Operative technique

It is preferable to have the patient in a supine position which gives easy access to the knee joint and also permits an above-knee amputation to be done if necessary, without changing the patient's position. Furthermore, the supine position does not give any particular problems to the anaesthetist which is of great importance in poor risk cases, such as geriatric patients. A tourniquet may be used except for vascular patients. However, as there are only a few easily identified vessels a tourniquet is not an absolute necessity.

All correspondence to be addressed to: Dr. R. F. Baumgartner, Orthopädische Universitätsklinik Balgrist, Forchstr. 340, CH–8008 Zürich, Switzerland.

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The knee joint is flexed to a right angle. A skin incision is made with respect to the condition of the particular patient. If possible, an attempt should be made to obtain two lateral flaps with the scar placed longitudinally at the dorsal side of the femur between the two condyles. This scar is placed far from the end bearing area of the stump and permits a high resection of the sciatic nerve. This procedure necessitates a circular incision at about 50 mm distally from the tibial plateau (Fig. 2). However, previous operative scars and the viability of the tissue might require other types of skin flaps, such as a long anterior flap. It is important to include existing scars into the new skin incision and not to create additional scars whenever possible.

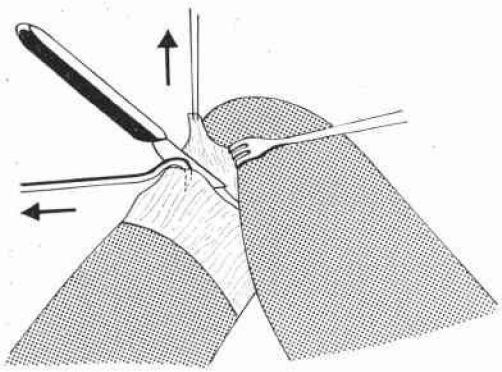

Fig. 2. A circular skin incision 50 mm distally from the tibial plateau is necessary to obtain two lateral flaps with a longitudinal skin closure at the dorsal side of the femur. The patellar ligament is disinserted at the tibial tuberosity which gives free access to the tibial plateau.

Disarticulation of the joint begins by removing the patellar ligament from the tibial tuberosity which gives free access to the tibial plateau (Fig. 3). In the anterior-posterior direction, the tibial plateau is separated from the meniscal cartilages, the cruciate and lateral ligaments and the joint capsule. Finally the tibial plateau is completely dislocated anteriorly. It is then easy to identify popliteal vessels and nerves, the latter being cut at least 70 mm proximally from the end of the stump. The procedure is completed with sectioning of the hamstrings and the complete removal of the gastrocnemius muscles. In vascular cases, it might be safer to remove the meniscal cartilages as well, otherwise they can be left in place and act as an additional cover

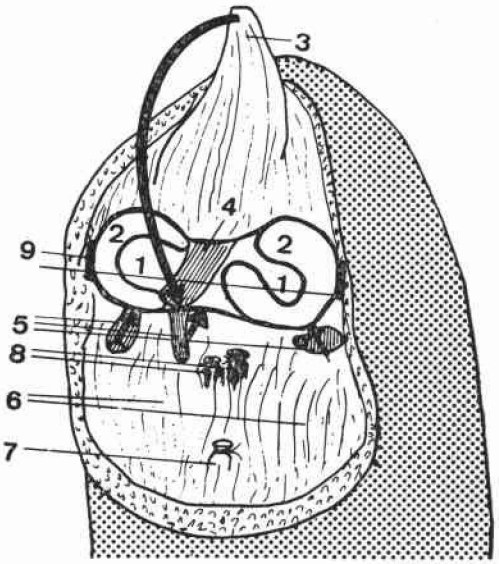

Fig. 3. Knee disarticulation. Distal-dorsal view of the stump. 1: femoral condyles, 2: meniscal cartilages, 3: patellar ligament to be sutured to the posterior cruciate ligament (4), 5: tendons of the hamstrings which might be connected with the posterior joint capsule or a cruciate ligament, 6: the gastrocnemius muscles, 7: sciatic nerve, 8: popliteal artery and vein, 9: collateral ligaments.

for the end bearing femoral condyles. Before closure, the patellar tendon is sutured to the cruciate ligaments or to the anterior knee capsule and the hamstrings to the posterior knee capsule. To avoid granulomas, it is preferable to use resorbable material for suturing. In vascular cases, the author has started not to suture any ligament at all and there is surprisingly little retraction of the patella even if its ligament is not anchored. Haemostasis and drainage are most important at any amputation level, but particularly so in the knee disarticulation. There is no space for a haematoma and if one leads to necrosis and infection, the result might be an above-knee amputation. The skin flaps are carefully shaped and closed with only a skin suture. Due to the considerable retraction of the skin in the area of the knee joint, the size of the flaps must be large enough to guarantee a skin closure without any tension (Fig. 4).

Stump qualities

Knee disarticulation preserves all the muscles of the thigh. Therefore, there will be no retraction of muscles and no muscular imbalance

Fig. 4. Eighteen year old male patient. Knee disarticulation following trauma. Anteroposterior flap with large scar formation at the thigh. The patient is now fitted with a total end bearing prosthesis, four bar linkage with hydraulic knee and swing phase control.

which is unavoidable in above-knee amputation even using myoplastic techniques. In above-knee amputations parts of the adductors always have to be sacrificed whilst the abductors between the iliac bone and the greater trochanter always remain intact. Bony outgrowth which often compromises a good above-knee stump is impossible in the knee disarticulation. One of the main advantages of the knee disarticulation stump is its total end bearing quality. Therefore, the ischial seat, which causes so many problems in above-knee amputees, becomes superfluous. The range of motion of the hip joint remains completely free, including flexion and rotation movements and thus permits a more natural, less energy consuming gait (Table 1).

Post-operative management

There will be considerable shrinking of the stump, even if all the muscles of the thigh are intact. The distal part which is not covered by muscles is extremely sensitive to pressure, especially the patella and the dorsal sides of the condyles. Therefore, care must be taken to avoid pressure sores due to bandaging, bed rest, plaster casts or poor prosthetic fitting. For gait training immediately after surgery, it is therefore preferable to fit an inflatable plastic splint. When the patient lies in bed, the femoral condyles must be relieved by padding similar to the well known procedures that prevent pressure sores at the heel (Fig. 5).

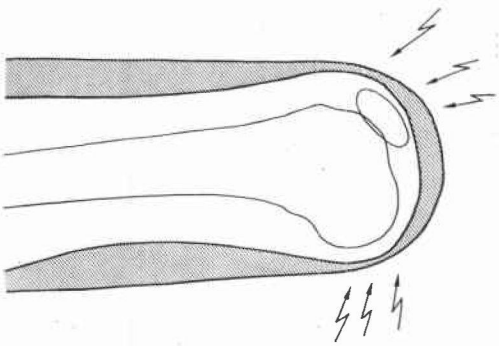

Fig. 5. The dorsal sides of the femoral condyles and the patella are most sensitive to pressure.

Table 1

Stump	Knee disarticulation	Above-knee amputation
Thigh muscles	**preserved**	partially preserved
Bony outgrowth	**impossible**	possible
Lever	long	short
Shape	bulbous	conic
End bearing	**total**	none (or partial)
Ischial bearing	**none**	total
Hip joint range of motion	**free**	limited

Fig. 6. Twenty-two year-old male patient. Knee disarticulation after motorcycle accident. Local infection at the medial condyle. Stump revision with partial resection of the femoral condyles. Healing occurred within four weeks.

Post-operative complications

As at any other amputation level, problems in wound healing might also occur in knee disarticulation. As long as there is only superficial necrosis of soft tissues on a rather small surface, healing can be achieved by conservative treatment within a reasonable time. However, larger necrosis including ligaments, cartilage and bone requires operative treatment. In this case, the modified techniques removing the patella and the condyles totally or partially are most suitable as a second line of defence (Fig. 6).

Prosthetic fitting

The objections from the prosthetists against the shape and the length of the stump in knee disarticulation have almost completely disappeared during the past years. New designs of prostheses are now available which are superior to the best above-knee prostheses with regard to function, comfort and cosmesis. This has led to prosthetists advocating knee disarticulation even more than the surgeons do.

The two major features are the socket and the knee joint.

The type of socket used at Balgrist has been developed by Botta and uses the double-wall technique. There is an inner soft socket made from polyethylene foam. Its purpose is to provide total contact and at the same time to transform the bulbous stump into a conic one. The patient puts on this socket first and then he can don the outer socket which is made from laminated plastic. The bearing surface at the distal end must exactly fit the shape of the femoral condyles and avoid pressure on the patella otherwise pressure sores are the inevitable consequence (Fig. 7). The rigidity of the socket decreases gradually distally to proximally. Thus a semi-flexible socket is obtained which gives more comfort particularly in sitting, donning and doffing the prosthesis. The upper border of the socket follows a line which is approximately 50 mm below the inguinal ligament. This fact is particularly appreciated by female patients and by double amputees. Donning and doffing the pros-

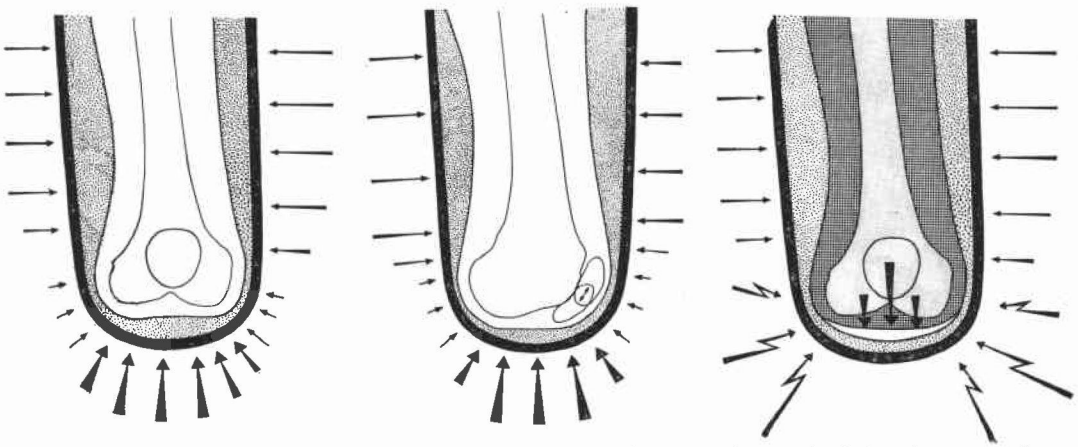

Fig. 7. Double wall socket for knee disarticulation. The inner socket, made from polyethylene foam, transforms the bulbous stump into a conic one. The outer shell is made from laminated plastic. Total contact is most important especially in the weight bearing areas, left and centre. Otherwise pressure sores at both femoral condyles are inevitable, right.

Fig. 8. Donning and doffing the prosthesis presents no problems even to geriatric patients.

thesis is very simple since it does not require any particular effort or skill which again is especially appreciated by double amputees and by geriatric patients (Fig. 8).

Knee joints as they are commonly used in above-knee prostheses are of no use with knee disarticulations. Joints especially designed for knee disarticulation are now available, the first one being developed by Lyquist at the Orthopaedic Hospital in Copenhagen. Other types of knee joints have since been developed, most of them using four bar linkage mechanisms and permitting knee flexion far in excess of 90°. They are available with or without swing phase control. Further research is being done with regard to improving the solidity of the knee mechanism. Prostheses for knee disarticulation and above-knee amputation are compared in Table 2.

Results

From 1968—1978, the author has performed 72 knee disarticulations, mainly for peripheral vascular occlusion. Four patients presenting congential deformities corresponding to knee disarticulation also have been fitted with the new type of prosthesis. Re-amputation at an above-knee level was necessary in 7 cases, all of them being vascular patients. They all had to be amputated at a high above-knee level due to advanced tissue necrosis. Local complications in wound healing occured in 16 cases.

Table 2

Prosthesis	Knee disarticulation	Above-knee amputation
Socket contact	total	partial to total
Socket quality	**soft**	rigid
Belt suspension	**none**	frequent
Ischial seat	**none**	compulsory
Skin hygiene	**good**	poor
Knee design:		
friction unit swing phase control lock	available	available
Modular prosthesis	available	available
Cosmesis	satisfactory	satisfactory

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