

Lower Extremity Amputation Problems: Etiology, Manifestations, and Prevention

by Gustav Rubin, M.D., FACS
Malcolm Dixon, M.A., R.P.T.
Erich Fischer, C.P.

INTRODUCTION

It is the purpose of the authors to document, in a concise chart format, a selection of amputation problems encountered by the Clinic Team at our Center, with suggestions for prevention and treatment. Such problems for the amputee may be caused by any of the individuals concerned with his care.

Under ideal circumstances, a surgeon qualified to do amputation surgery will select the most appropriate level for amputation and properly contour the amputation stump;¹ a hospital team will provide efficient rehabilitation; a prosthetist will achieve a satisfactory fit; and the amputee, fully informed about the function of his prosthesis and its components, will ambulate in relative comfort, and will cooperate in a follow-up to allow adjustments to be made for anticipated changes.

Unfortunately, ideal circumstances do not always exist. This paper is presented as a plea to prevent those relatively small, yet significant, number of deviations from less than ideal circumstances. When the amputee has the potential to ambulate, and to ambulate well and relatively comfortably, it is his right to be given the fullest opportunity to realize that potential.²

The type of trauma and, in the case of disease states, the character of the neurovascular involvement, will affect the surgeon's decisions. A very effective method for determining the optimum amputation level for the vascularly impaired limb is that of employing xenon^{133,3}

THE SURGEON

Chart I

When the surgeon has been presented with a patient, whose limb has sustained extensive trauma of a degree which mandates amputation, his choices are frequently limited. The status of the traumatized limb may require surgical ingenuity and maximum use of the remaining anatomic structures to contour a residual limb that will provide optimum function. He should not, however, insist on saving all length when such heroic measures will result in a poor residual limb. For an individual of average height, a six inch below-knee residual limb is far more desirable than an amputation eight to 10 inches in length. The feature was discussed many years ago by Thomas and Haddan in their text, "Amputation Prostheses," but is still overlooked. In the case of below-knee am-

CHART I: THE SURGEON

Etiology	Manifestations	Treatment and/or Prevention
<p>Overenthusiastic dedication to saving all length particularly in case of:</p> <p>1. Circulatory impairment (Figure 1).</p>	<p>1. Circulatory impairment of residual limb: intermittent claudication, pallor, pain, breakdown of soft tissues.</p>	<p>1. (a) Length of residual limb should be consistent with circulatory status, as, for example a 4" B/K residual limb with adequate circulation is preferred to a 6" or 8" residual limb with precarious circulation.</p> <p>(b) Gel socket for the B/K amputee with precarious circulation.</p> <p>(c) Quad socket prosthesis for the B/K if above, (b), is inadequate.</p> <p>(d) Revision if conservative measures fail or overall situation will be improved by revision.</p>
<p>2. Short partial foot amputations such as Chopart (Figure 2).</p>	<p>2. Chopart causes problems in satisfactory fitting, unless equinus deformity is prevented or corrected.</p>	<p>2. Ankle fusion will improve Chopart alignment and weight bearing status, as will tibialis anticus transplant. (Prostheses are available for Chopart and Lisfranc).</p>
<p>3. Excessively long B/K amputated distal to the gastrocnemius tendon junction. Occasionally confusing a long B/K with a Syme amputation (Figure 3), or an ankle disarticulation with a Syme (Figure 4).</p>	<p>3. If excessively long B/K: poor soft tissue coverage, and tendency to breakdown of soft tissue.</p>	<p>3. Revision if conservative measures fail.</p>
<p>4. Retention of a short A/K residual limb of less than 5cm. (Figure 5).</p>	<p>4. Difficulty in fitting a very short A/K with a Canadian hip hip disarticulation prosthesis. Hip joint must be placed forward of usual position, resulting in uncosmetic appearance when patient is clothed.</p>	<p>4. (a) If the surgeon anticipates an A/K residual limb of less than 5cm. during the surgical procedure, he should proceed with true disarticulation.</p> <p>(b) If the prosthesis is presented with a less than 5 cm. A/K residual limb, a modified Canadian hip disarticulation prosthesis can be fabricated.</p>
<p>Deviation from accepted amputation procedures as:</p> <p>1. Tibial crest not properly bevelled distally (Figure 6).</p> <p>2. Fibula left longer than tibia.</p> <p>3. Quasi-Syme amputation.</p> <p>4. Stripping and shredding of periosteum.</p> <p>5. Improperly contoured residual limb with poor placement of surgical suture line and adherence of scars to bone.</p> <p>6. Poor skin coverage of potential weight-bearing areas or limb-socket interface support areas (Figure 7).</p> <p>7. Inadequate stabilization of Syme pad (Figure 8).</p>	<p>1. Tibial crest not bevelled distally is a potential cause of breakdown of B/K residual limb (Figure 9); adequate relief is necessary.</p> <p>2. Fibula prominence—pain and fitting problems.</p> <p>3. Quasi-Syme—inability to end bear (Figures 3, 4, 7).</p> <p>4. Stripped and shredded periosteum may yield spurs.</p> <p>5. Scars poorly placed may result in soft tissue breakdown (scars attached to bone, Figure 10, invaginated scars, scars over patellar tendon of B/K or beneath medial tibial flare).</p>	<p>Quasi-Syme must be fitted as a long B/K—or revised.</p> <p>Spurs may be accommodated by proper relief in prosthesis. (Rarely is revision necessary for spurs).</p> <p>Poorly placed or attached scars should have proper reliefs in socket and proper suspension to minimize piston movement and traction on attached scars.</p> <p>Surgical correction may be needed. A relief should be provided in the prosthesis. If not adequate, then surgical correction.</p>

CHART I: THE SURGEON (continued)

Etiology	Manifestations	Treatment and/or Prevention
Nerves not properly treated to allow retraction of distal ends to protected or pressure free areas.	Painful neuromata exposed to socket pressure.	Revision if prosthetic fitting procedures are unsuccessful, i.e. use of appropriate relief.

putations, they reported that "amputations below the middle of the leg are to be condemned. The additional bone length offers no advantage in leverage, and the longer stumps are apt to be tender and are prone to vascular difficulties with edema and ulceration of the end of the stump."⁴ Saving all length should be an axiom followed with discrimination.

Useful functional length should not be

sacrificed. When the amputation is elective, it is the responsibility of the surgeon to make a very careful determination of the level of amputation, particularly, to avoid an above knee amputation if a functioning below knee residual limb can be salvaged. Although it is not possible to cover every eventuality, the chart refers to important problems.



Figure 1. This vascular amputee would have benefitted with a more proximal amputation.



Figure 2. The unmodified Chopart, in equinus, provides the amputee with a poor weight-bearing surface, unless the equinus has been prevented by either ankle fusion in a functional position or tendon transplantation to prevent the equinus deformity.



Figure 3. This amputation is just proximal to the true Syme level³ and had to be fitted as a long B/K.



Figure 4. Although this ankle disarticulation amputee was fitted with a Syme prosthesis with maximal proximal PTB support, he continued to have residual limb problems and rejected reamputation to the below-knee level.

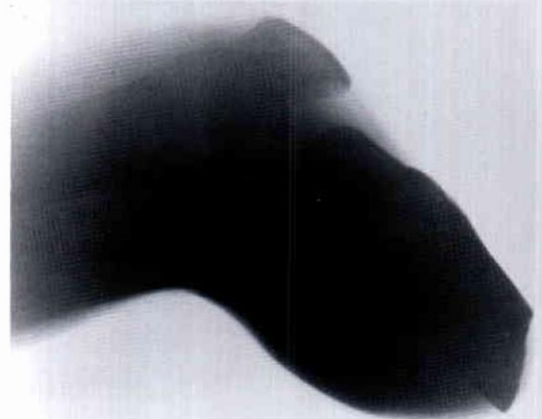
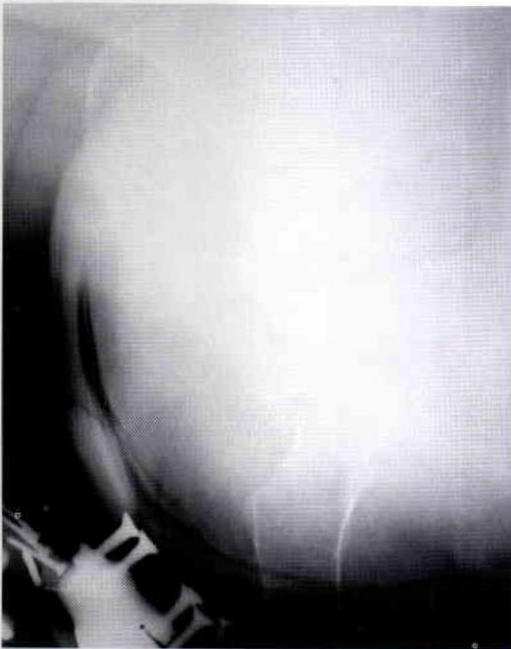


Figure 6. The distal anterior crest should be properly bevelled. A sharp bone prominence causes overlying skin problems.

Figure 5. This amputee, as demonstrated on the x-ray, had to be fitted with a modified Canadian Hip Prosthesis because of the retained short residual limb.



Figure 7. (left) Poor skin coverage of underlying bone will be recurring cause of skin breakdown.

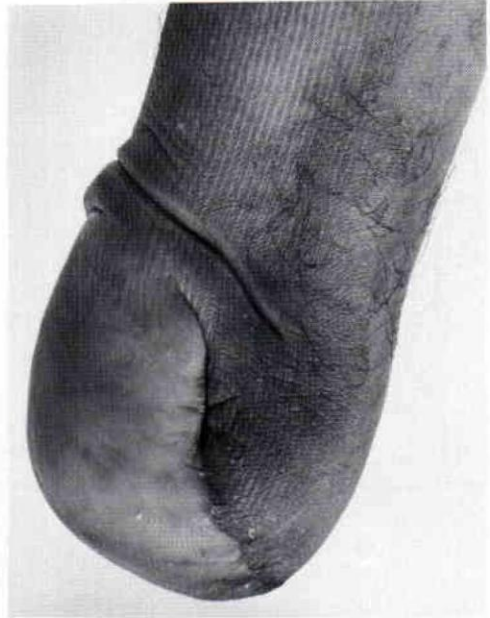


Figure 8. (right) Inadequately stabilized Syme pads frequently interfere with distal weight-bearing and are often associated with painful callosities at the scar margin.

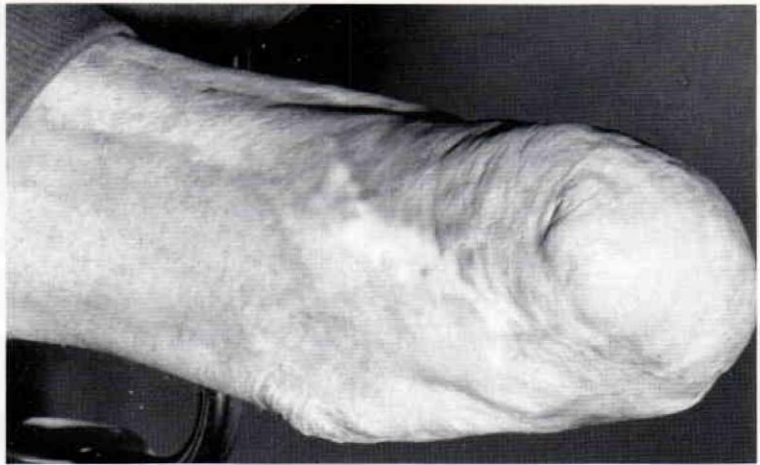


Figure 9. Soft tissue appearance of lack of beveling of the tibia crest distally (see chart).



Figure 10. When the scar is adherent to the underlying tibia, it is not unusual for soft tissue piston motion, during ambulation, to result in episodes of soft tissue breakdown. It is almost impossible to totally eliminate small amounts of piston motion.

THE PROSTHETIST

Chart II

Many of the more frequently encountered problems traceable to the prosthetist are listed in the accompanying Chart. The prosthetist has a major responsibility for the optimum rehabilitation of the amputee. Less than total satisfactory fit, alignment, and suspension may cause any

variety of problems such as those referred to in the chart. A large selection of prosthetist related problems has been detailed. There will undoubtedly be areas of controversy particularly with reference to the posterior of the socket. At our center we eliminate the popliteal bulge entirely, but at other centers this is frequently retained. When this bulge is exaggerated, as in the illustration, problems may arise.

CHART II: THE PROSTHETIST

Etiology	Manifestations	Treatment and/or Prevention
Lack of total contact (Figure 11).	Distal edema with subcutaneous induration and eventual "peau d'orange" appearance. When chronic this produces distal tissue "weeping," ulceration, and gait deviations.	Achieve total contact with soft distal pad which should be repeatedly replaced as shrinkage progresses, so that total contact is maintained.
1. Improper socket configuration with localized pressure on bone prominences (Figure 12). 2. Inadequate suspension with piston movement.	1. Irritation, abrasion, and ulceration. 2. Callosities. 3. Bursal enlargement.	Modify prosthesis to: (a) Relieve local pressure area in socket, and (b) Minimize pistoning by correcting suspension system. (c) Stabilize residual limb in socket. (d) Apply material such as Op-site [®] or Tegaderm [®] to skin of irritated area to protect skin from shear, and use DAW prosthetic sheath.
Brim margin soft tissue pressure and shear (Figure 13).	1. Inclusion cysts which can become infected (usually anterior A/K brim level and posterior B/K brim level). 2. Abrasions.	1. Rotator or SAFE foot. 2. Bring flesh rolls into socket if possible. 3. Padded A/K brim. 4. Flare brim in appropriate areas. 5. Use of DAW sheath.
Pressure on bow-stringing tendons (Figure 13).	1. Irritation over abductor longus in A/K socket. 2. Irritation over hamstrings. 3. Irritation over prominent tensor fascia lata in PTS.	Provide adequate channel in socket with appropriate flaring of brim.
Choking.	Hourglass edema, pain, and potential soft tissue breakdown.	Modify socket to remove hourglass constriction, or replace socket if uncorrectable.
A/K valve malfunction or improper selection.	Localized valve area irritation.	1. Change spring. 2. Relocate valve ⁹
Uncured glue of insert or uncured plastic of the plastic laminate socket.	Skin redness and irritation at contact area.	Proper caring. Use of DAW sheath.
Poor alignment (Figure 14).	Gait abnormalities.	Re-align.

CHART II: THE PROSTHETIST (continued)

Etiology	Manifestations	Treatment and/or Prevention
Excessive popliteal pressure secondary to incorporating central bulge in socket for theoretical relief of hamstrings, but with actual interference with popliteal neurovascular structures (Figure 15).	Claudication and limited activity.	Febricate prosthesis with total elimination of mid-posterior socket bulge as illustrated.
Excessive patellar tendon bar prominence of sharp patellar bar (Figure 16).	Soft tissue breakdown (Figure 17).	1. Ambulate on crutches pending skin recovery. 2. Modify patellar tendon bar.
Excessive prominence of Scarpa's triangle bulge (should be especially avoided in sockets of elderly A/K amputees).	Interference with function of neurovascular structures, numbness and/or claudication.	Modify socket; decrease bulge.
Inadequate relief over distal lateral A/K residual limb.	Callosity or abrasion & pain distal lateral A/K residual limb.	Provide relief locally or a build-up above the area. Check suspension and correct if piston movement is present.
Low placement of the supracondylar wedge of PTS.	Soft tissue irritation, redness, and ulceration if neglected (Figure 18).	Adjustment and proper placement of wedge. (pistonning will occur if too high).



Figure 11. Repeated episodes of distal edema produce a "peau d'orange," or orange skin effect. This is known as verucous hyperplasia.

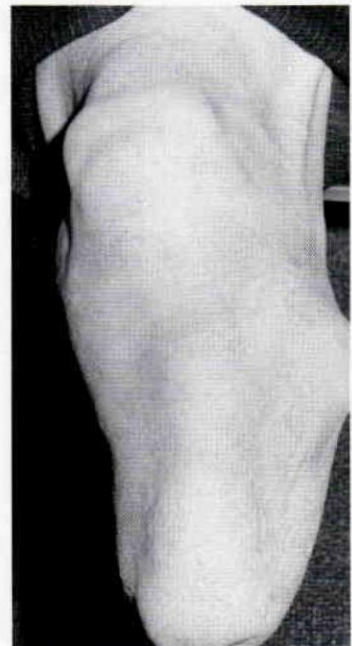


Figure 12. Bursal formation over the fibula head (see chart).



Figure 13. (left) Inclusion cysts secondary to pressure and shear at posterior brim margin.

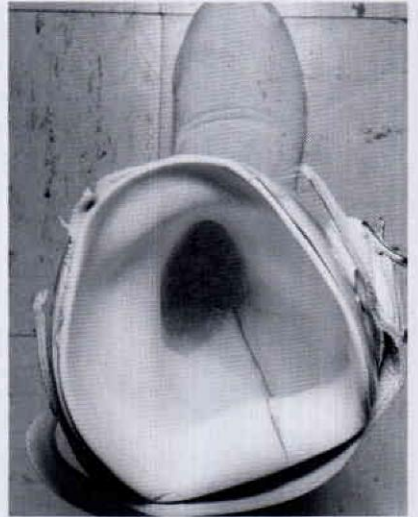


Figure 14. (right) An unusual alignment of a B/K prosthesis fabricated for a patient who did not have a fractured femur, knee, or tibia which would have distorted the anatomical structures and might otherwise have required alignment modifications.

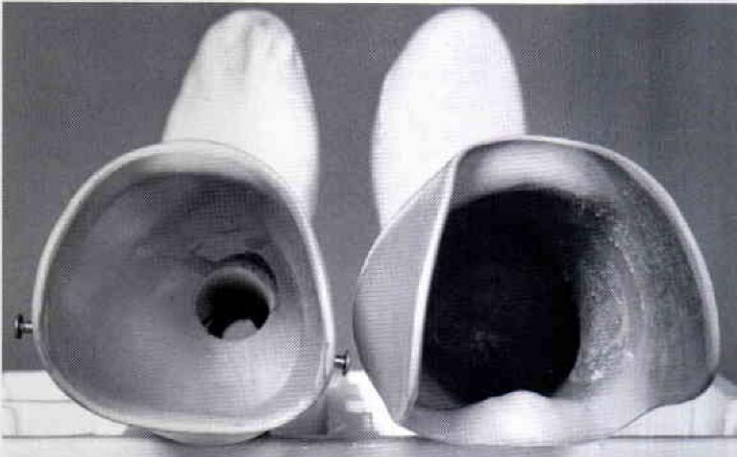


Figure 15. At our Center we have eliminated the posterior popliteal bulge. The distal opening, in this instance, was covered by a soft total contact pad and the opening provided a receptacle for the moisture of excess perspiration.

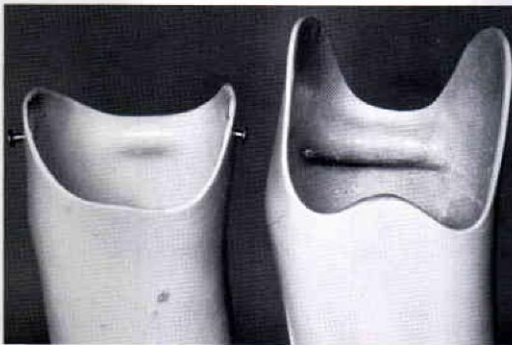


Figure 16. Excessive patellar bar prominence may cause skin breakdown.

Figure 17. Encrusted skin ulceration over a prominent patellar bar and distal choking with edema and soft tissue breakdown (see "choking" under Chart II).





Figure 18. Improper placement of supracondylar wedge of PTS.

THE PATIENT

Chart III

The patient may, himself, be the source of his own difficulties, usually because of carelessness or neglect of instructions. Patients are told to be seen by the clinic team or prosthetist at the first sign of residual limb irritation. Nevertheless, they will

often wait and come in after blister formation or even soft tissue breakdown and ulceration have developed.

There are occasions when the residual limb has been so contoured that revision is indicated but the patient refuses further surgery. It is necessary in these cases to warn the patient about the potential for breakdown, so that he may observe certain areas more carefully than he might do otherwise. Examples of this are the excessively long below knee residual limb with poor distal circulation or the inexcusable retention of an excessively long fibula on which the patient refused another operation.

The patient must understand that he is an important member of the clinic team and his subjective responses will be carefully listened to and acted upon when appropriate. Warning signs are: discomfort over bone prominences, redness, swelling, pain, or other manifestations of irritation. These signs should be heeded before breakdown occurs. This may be most likely to occur over the fibular head, tibial crest, or distal anterior tibia of the below-knee amputee, or over the distal lateral aspect of the residual limb of the above knee amputee, if the prosthesis has not been properly fabricated, modified, or fitted.

CHART III: THE PATIENT

Etiology	Manifestations	Treatment and/or Prevention
Progressive maturation of residual limb. (Residual limb shrinkage is anticipated and desirable following amputation). As shrinkage occurs fit is lost, the residual limb displaces downward in the socket, bone prominences will abut (and piston over) socket contours designed to conform to the undisplaced residual limb.	Irritation and skin breakdown with ulceration if neglected. (Pain and discomfort in such areas of the A/K amputee's residual limb as the pubic ramus and the distal residual limb; and in such areas of the B/K residual limb as the hamstrings, inferior pole of the patella, distal stump and fibular head, in particular) (Figures 19 and 20).	<ol style="list-style-type: none"> 1. Add residual limb sock (or socks) of appropriate ply to elevate residual limb and reachieve fit. (May increase pressure over bony prominences if overdone) 2. Place proper modifications in selected pressure tolerant areas of the insert or socket to relieve bone prominences and accommodate for areas of soft tissue shrinkage, 3. Or new socket.
Hyperhidrosis.	Maceration distally: Potentially a milieu for fungal infection (Figure 21).	<ol style="list-style-type: none"> 1. For B/K use open mesh-ventilated socket, or if tolerated, open end ventilated socket. 2. For A/K convert suction to semi-suction. Frequent change of residual limb socks necessary. 3. Medication locally if fungus.

CHART III: THE PATIENT (continued)

Etiology	Manifestations	Treatment and/or Prevention
Poor hygiene (dirty residual limb, dirty socket, and dirty residual limb socks) and total neglect.	Irritated, scaly, weeping and odorous residual limb.	Proper daily cleansing of residual limb, socket, and residual limb socks. Report to prosthetist and/or surgeon as soon as problems begin, without delay.
Excessive gain in weight.	Loss of fit due to upward displacement of residual limb may result in distal edema secondary to loss of total contact and also pressure on displaced bone prominences which are no longer appropriately positioned in relation to the socket. There may be the development of flesh rolls with irritation and breakdown at the brim and soft tissue interface with a tendency to formation of sebaceous and inclusion cysts which may become infected (Figures 13 and 22).	Refer for medical evaluation and possible weight control. Adjust, refit, or replace prosthesis. Use padded brim and flare brim for A/K. Flare posterior brim for B/K. Chronic cysts also may require surgical excision. (Also see "Prosthetist" chart with respect to choking.)
Mentally incompetent patients (drugs, alcohol, mental impairment).	Improper donning of socks and prosthesis and inability to recognize problems with subsequent soft tissue breakdown.	Careful, close, and frequent observation and assistance in-hospital or by attendant.
Excessive loss in weight.	Similar to "progressive maturation" above.	1. If intentional and to be maintained, and if socket modifications or residual limb sock additions are not adequate, then new socket should be fabricated to accommodate for the new situation. If not intentional, then a temporary prosthesis. 2. Refer for medical evaluation if weight loss unplanned.
Improper donning of residual limb socks with a wrinkling fold within socket particularly over unpadded bone.	Wrinkling causes pressure areas with soft tissue irritation and potential breakdown.	Proper instruction in donning residual limb socks, and adequate follow-up.
Changing to shoes of different heel heights from those with which prosthesis was fitted.	1. Instability. 2. Poor gait. 3. Introduction of improper pressure areas.	Properly instruct patient to avoid changing heel heights unless the foot-ankle unit can be readily adjusted or will adjust to the difference.
Acceptance of delivery of a prosthesis without clinic team checkout.	Any of the multiple problems referred to previously.	See preceding presentation. An experienced clinic team's checkout procedures would be preventive.

THE THERAPIST AND NURSE

Chart IV

Pre- and post-amputation in-hospital care are the responsibility of the therapist and nurse under the guidance and control of the amputating surgeon. Chart IV includes some of the more obvious aspects of their responsibilities. In addition, the therapist will also be responsible for teaching the patient many other essentials, such as: how to fall and how to rise from the floor, how to use crutches or a cane when



Figure 19. If the patient does not add a residual limb sock after shrinkage occurs, downward displacement of the residual limb in the socket may cause abnormal pressure on the distal pole of the patella as well as irritation of the distal limb.

Figure 20. (right) Piston motion of the residual limb in the socket often produces abnormal pressure manifestations over the fibular head.

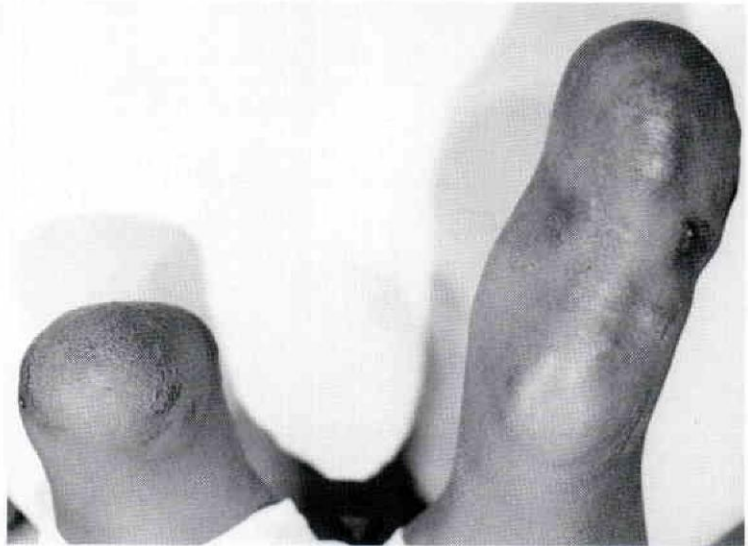


Figure 21. (left) Maceration secondary to hyperhidrosis.



Figure 22. (right) Flesh roll. This amputee gained weight and lost fit.

necessary, how to wrap the residual limb, and how to use simple hygienic measures in residual limb care. There is never a reason for one frequently encountered post-amputation problem to occur, such as the flexion contracture that is, unfortunately, seen too often. This should be avoided with proper nursing and therapy care.

Very often, it is a capable, sensitive, and experienced therapist who will take the opportunity to understand and discuss with the patient the psychological impact

of his amputation. He will be aided in the process if other actively functioning, rehabilitated amputees are brought in to talk with the amputee and to demonstrate how they have coped with their amputations and have returned to society as active working family members of that society. There is no better way to help the new amputee diminish the psychological impact of the loss of a limb than by other amputees demonstrating that there will be a future for him.

CHART IV: THE THERAPIST AND NURSE

Etiology	Manifestations	Treatment and/or Prevention
Inadequate instruction in gait.	Improper use of sophisticated knee components: faulty gait; fear of weight bearing.	Instruction, particularly with the hydraulic units.
Neglect of basic principles of pre & post amputation care.	<ol style="list-style-type: none"> 1. Flexion contractures (Figure 23). 2. Pressure sores at bed rest. 3. Swelling of residual limb. 	Follow established procedures for pre- and post-amputation follow-up and therapy. If, for example, contractures are not correctable, the prosthetist's ability to fit will be determined by the degree of contracture as related to residual limb length, for example, a 5cm. B/K residual limb at 30° can be fitted, but a 15cm. B/K residual limb with a similar contracture can only be fitted at the sacrifice of stability or cosmesis.
Neglect of upper extremity muscle development for potential crutch walkers.	Weakness of upper extremities and instability with crutches.	Course of therapy directed at achieving upper extremity muscle development.



Figure 23. (left) Flexion contractures should not be permitted to develop.



Figure 24. (right) Temporary adjustable above knee socket.

CHART V: THE PHYSICIAN

(acceptable complications secondary to therapy)

Etiology	Manifestations	Treatment and/or Prevention
Radiation therapy or chemotherapy	Edema of residual limb.	1. Temporary adjustable A/K prosthesis (Figure 24). 2. B/K—remove insert and vary number and ply of residual limb socks to conform to extent of edema. 3. Wrapping residual limb when not wearing prosthesis.
Dialysis for kidney failure.	Intermittent edema of residual limb (status before dialysis and after dialysis).	See above.

THE PHYSICIAN

Chart V

Finally, there are certain specific diseases which affect the status of the residual limb, examples of which are mentioned in Chart V. There are a multiplicity of skin problems which have been presented in detail elsewhere (and which may occur anywhere on the body). These become more serious

problems when they present themselves on the residual limb. Various skin lesions⁵ may be noted such as psoriasis, herpes zoster, or even tumors. These should be treated by a physician or dermatologist in conjunction with the prosthetist. Whenever consultation with an internist, dermatologist, neurologist, or other specialist is necessary, the clinic team should arrange such consultation.

THE CLINIC TEAM

Chart VI

The Clinic Team has the responsibility for not only prescribing a prosthesis and evaluating the finished limb, but also for follow-up and subsequent care. The prosthesis chosen should provide the amputee with optimum function for the particular stage of rehabilitation.⁶ As an example, a temporary above knee prosthesis may be an initial prescription with an adjustable

polypropylene socket and a single axis knee, but after sufficient limb maturation has occurred, the active amputee should be allowed to progress to a suction socket and a hydraulic knee if appropriate. Unless there is a financial problem, or an unusual special circumstance such as difficulty of access to a prosthetic facility, a vigorous amputee should not be required to ambulate with a single axis constant friction knee. Chart VI illustrates problems which are the responsibility of the clinic team.

CHART VI: THE CLINIC TEAM

Etiology	Manifestations	Treatment and/or Prevention
1. Improper Selection of Prosthetic Components.	Gait Deviations. Increased energy expenditure. Residual limb problems.	Selection of components should be based on many factors including health and physiological age of amputee, status of the residual limb, vocation and avocation of the amputee, home and work environment, availability of sophisticated components, and facility of access to prosthetic repair shop.
Lack of consideration of problems with contralateral limb.	Instability may be introduced by previous cardiovascular accidents (CVA's), muscular dystrophies, and neurologic or joint pathology, amongst others.	Individual evaluation and treatment, such as possible orthoses, as necessary and shoe modifications.
Lack of consideration of secondary problems with ipsilateral limb.	Malunion of fractures with deformity at fracture site will require appropriate consideration by prosthetist to achieve optimum alignment. CVA, flexion contracture, edema secondary to therapy for Ca, Kidney dialysis, etc., will cause gait deviations if not considered.	Prosthetist must take all such problems into account during fabrication.
Lack of consideration of general health problems of the amputee.	Cardiac, pulmonary, gross muscular weakness requiring excess expenditure of effort.	Refer to appropriate medical consultant for evaluation and opinion.



Figure 25. Excessively long fibula and poorly contoured distal tibia (see Chart I, items 1 and 2 under Etiology).

SUMMARY

The prevention and treatment of amputation problems is a basic goal of everyone concerned with the care of the amputee.

Fortunately, such problems are the exception rather than the rule. But when they do occur, these problems may be catastrophic for the amputee, requiring lost time from work, and even, if no other solution is satisfactory, limb revision (Figure 25). This may mean that the patient will have to start the entire process all over again.

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AUTHORS

Gustav Rubin, M.D., FACS, is Chief of the Special Prosthetics Clinic Team, Veterans Administration Prosthetics Center (VAPC), 252 Seventh Avenue, New York, NY 10001.

Malcolm Dixon, M.A., R.P.T., is Chief of Clinical Services for the Special Prosthetics Clinic Team at VAPC.

Erich Fischer, C.P., is Supervisor for Prosthetics, as well as a member of the Special Prosthetics Clinic Team at VAPC.