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Abstract

Stump problems in amputations resulting from employment related injuries were investigated in 397 cases in the Chugoku and Shikoku districts of Japan between 1987 and 1991. Ninety-seven patients (24%) had stump problems which interfered the prosthetic fitting. Stump problems of the upper extremity were seen in about 9% (17 amputees), two thirds of which were skin troubles. Stump problems of the lower extremity were seen in about 37% (80 amputees). Certain complaints were associated with specific methods of amputation; abnormal keratosis in Syme's amputation, equinus deformity in Chopart's amputation, reduced muscle power in above the knee (A/K) amputation and joint dysfunction in below the knee (B/K) amputation. Adequate prosthetic fitting was achieved by the modification of the socket and alignment in almost all amputees with stump problems. In only two cases, Chopart's amputation required subsequent Syme's amputation due to equinus deformity with abnormal keratosis. In almost every case, stump problems are avoidable by means of surgeons' deliberate evaluation of the affected limb and adequate choice of the amputation level.

KEYWORDS: traumatic amputation, stump problems, prosthetic fitting

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Stump Problems in Traumatic Amputation

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Stump problems in amputations resulting from employment related injuries were investigated in 397 cases in the Chugoku and Shikoku districts of Japan between 1987 and 1991. Ninety-seven patients (24 %) had stump problems which interfered the prosthetic fitting. Stump problems of the upper extremity were seen in about 9 % (17 amputees), two thirds of which were skin troubles. Stump problems of the lower extremity were seen in about 37 % (80 amputees). Certain complaints were associated with specific methods of amputation; abnormal keratosis in Syme's amputation, equinus deformity in Chopart's amputation, reduced muscle power in above the knee (A/K) amputation and joint dysfunction in below the knee (B/K) amputation. Adequate prosthetic fitting was achieved by the modification of the socket and alignment in almost all amputees with stump problems. In only two cases, Chopart's amputation required subsequent Syme's amputation due to equinus deformity with abnormal keratosis. In almost every case, stump problems are avoidable by means of surgeons' deliberate evaluation of the affected limb and adequate choice of the amputation level.

Key words : traumatic amputation, stump problems, prosthetic fitting

In order to achieve the highest possible prosthetic activity, and to get the ideal stump, the surgeon should evaluate correctly the affected limb and decide the adequate amputation level. In limb amputation for arterial occlusive disorders or tumors, the surgeon may have more time to evaluate the limb. However, the traumatic amputation is usually carried out as emergency surgery at the emergency hospital. The poor conditions of the injured limb may not yield an ideal stump. As a result there are some cases which have difficulty in fitting the prosthetic device because of stump problems.

Subjects and Methods

The amputees who experienced employment injuries are registered to receive artificial limbs in accordance with the Labor

Accident Compensation Insurance Law in Japan. Kibikogen Rehabilitation Center has been engaging in the limb fitting service for these amputees in the Chugoku and Shikoku districts since its opening in 1987. The limb fitting service was carried out annually at 26 places in cooperation with Prefectural Labor Standard Offices. The Center was able to conduct all three stages; prescription, pre-fitting and final check of prosthesis for each case.

From 1987 to 1991, 397 amputees underwent the limb fitting service. The amputation level and the sex of 392 amputees are shown in Table 1. Five cases were combined amputation of upper and lower extremities (Table 1). Out of 397 amputees, 97 amputees (16 upper extremity amputees, 80 lower extremity amputees and a combined amputee) had stump problems. The amputation level and the sex of these amputees are shown in Table 2. The single case of combined amputation included a right fore-quarter amputation and right hip disarticulation. The stump problem was seen in the forequarter amputation stump.

Age at the time of survey of the 97 amputees ranged from 36-77 (mean 55.9 ± 10.0) years. Age at the time of trauma ranged from 17-65 (mean 38.5 ± 11.9) years. The time between the amputation and the present survey was 1 to 40 years.

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Table 1 Amputees of upper or lower extremity and of both upper and lower extremities

Levels	Number of amputees		
	Men	Women	Total
Upper extremities			
Forequarter amputation	0	1	1
Shoulder disarticulation (SD)	1	2	3
Above elbow amputation (A/E)	16	9	25
Elbow disarticulation (ED)	0	1	1
Below elbow amputation (B/E)	58	15	73
Wrist disarticulation (WD)	19	3	22
Partial hand amputation (Hand)	35	18	53
Bilateral amputation	3 ^a	0	3
Total	132	49	181
Lower extremities			
Hip disarticulation (HD)	4	0	4
Above knee amputation (A/K)	58	3	61
Knee disarticulation (KD)	12	1	13
Below knee amputation (B/K)	98	4	102
Syme's amputation (Syme)	6	2	8
Partial foot amputation (Foot)	15	1	16
Bilateral amputation	7 ^b	0	7
Total	200	11	211
Combined amputation of upper and lower extremities			
R forequarter and R hip disarticulation	1	0	1
R shoulder and R hip disarticulation	1	0	1
R below elbow amputation (A) and L foot A	1	0	1
L above elbow A and L above knee A	1	0	1
L above elbow A and R above knee A	1	0	1
Total	5	0	5
Total	337	60	397

a: 2 cases of bilateral B/E and 1 case of B/E and Hand. b: 2 cases of bilateral A/K, 1 case of bilateral B/K, 3 cases of A/K and B/K, and 1 case of B/K and Foot. R: right, L: left

Table 2 Upper or lower extremity amputees having stump problems

Levels	Number of amputees		
	Men	Women	Total
Upper extremities			
SD	1	0	1
A/E	2	2	4
B/E	8	2	10
WD	1	0	1
Total	12	4	16
Lower extremities			
HD	1	0	1
A/K	21	3	24
KD	3	0	3
B/K	39	3	42
Syme	1	2	3
Foot	6	1	7
Total	71	9	80
Total	83	13	96

SD, A/E, B/E, WD, HD, A/K, KD, B/K, Syme and Foot: See Table 1.

Table 3 Causes of trauma

Causes	Number of cases
Entangled or caught in machinery	35
Heavy object falling	26
Traffic accidents	13
Fire burn	5
Electric burn	4
Caught in or run over by freight car	3
Fall	3
Others	8
Total	97

Causes of the trauma were shown in Table 3. Because the problems were seen in several parts of the stump, they were classified as follows:

Skin. skin grafting, scar adhered to the bone, edema, abnormal keratosis, dermatitis.

Soft tissues. excessive or inadequate amount, flabby or indurated consistency.

Joint function. limited range of motion, deformity of joint, unstable joint, reduced muscle power.

Bone. osteophyte, longer fibula in below the knee (B/K) amputation.

The types of prosthesis prescribed and corrected were surveyed.

Results

The stump problems for prosthetic fitting in upper

Table 4 Stump problems in upper extremity amputations

Causes of stump problems	Number of troubles				
	SD	A/E	B/E	WD	Total
Skin					
Skin Grafting	1	1	4	0	6
Scar adhered to the bone	0	1	5	1	7
Soft tissues					
Excessive amount	0	1	1	0	2
Inadequate amount	0	0	1	0	1
Joint function					
Limited range of motion	0	1	2	0	3
Total	1	4	13	1	19

SD, A/E, B/E and WD: See Table 1.

Table 5 Stump problems in lower extremity amputation*.

Causes of stump problems	Number of troubles				
	HD	KD	Syme	Foot	Total
Skin					
Skin Grafting	1	2	0	2	5
Scar adhered to the bone	0	1	0	1	2
Abnormal keratosis	0	0	2 ^a	3 ^a	5
Dermatitis	1	0	0	0	1
Soft tissues					
Inadequate amount	0	1	0	0	1
Indurated consistency	0	1	0	0	1
Joint function					
Limited range of motion	0	0	0	3 ^b	3
Bone					
Osteophyte	0	1	1	1	3
Total	2	6	3	10	21

a: Five amputees with abnormal keratosis had stump tenderness. b: All had equinus deformities. *End weight bearing stump.

HD, KD, Syme, Foot, A/K and B/K: See Table 1.

extremity amputations are shown in Table 4. Scar tissue adhered to the bone in one forequarter amputation among the combined amputations. Three below the elbow (B/E) stumps had double problems; in two, the scar had adhered to the bone and the range of motion of the shoulder was limited, and in one, the scar had adhered to the bone and the amount of soft tissue was inadequate. Only functional prostheses were prescribed for 6 (3%) of 181 upper extremity amputees, only working prostheses for 2 (1%), both functional and cosmetic prostheses for 14 (8%), both working and cosmetic prostheses for 31 (17%), and only cosmetic prostheses for 128 (71%). There are two types of weight bearing stumps. One is the end weight bearing stump group which include hip disarticulation, knee disarticulation, Syme's amputation and the foot amputation. The other type includes A/K and B/K amputations. The stump problems of the first group are shown in Table 5. A hip disarticulation had double stump problems; skin grafting and dermatitis. A case of knee disarticulation had triple stump problems; scar adhered to the bone, inadequate amount and indurated consistency of soft tissue. Another knee disarticulation had double stump problems; skin graft and osteophyte formation. Three foot amputations had double stump problems; equinus deformity and abnormal keratosis. The abnormal keratoses which were observed in Syme's and foot amputations caused pain. The characteristic change observed in

Table 6 Stump problems in A/K and B/K amputations

Causes of stump problems	Number of troubles		
	A/K	B/K	Total
Skin			
Skin Grafting	4	12	16
Scar adhered to the bone	2	8	10
Excessive edema	1	0	1
Dermatitis	5	9	14
Soft tissues			
Excessive amount	3	2	5
Joint function			
Limited range of motion	2	5	7
Unstable joint	0	2	2
Joint deformity	0	8	8
Reduced muscle power	9	0	9
Bone			
Osteophyte	1	0	1
Longer fibula	0	4	4
Total	27	50	77

A/K and B/K: See Table 1.

Table 7 Double stump problems observed in below knee amputation

	Excessive amount of soft tissue	Limited range of Motion	Joint deformity	Longer fibula
Scar adhered to the bone	1	1	2	1
Dermatitis	1	0	1	1

the foot amputations was the equinus deformity of the talocrural joint. All 3 cases of the equinus deformity followed Chopart's amputation.

The stump problems of the second group are shown in Table 6. Three A/K amputations had double stump problems; one had skin graft and scar tissue adhered to the bone, and two had limited range of motion of the hip joint and reduced muscle power. Eight B/K amputations had double stump problems (Table 7). Muscle weakness was observed only in A/K stumps. Limited range of motion in A/K appeared in abduction contracture and flexion contracture of the hip joint. Dermatitis was observed in the proximal area of A/K stumps, but it was observed in the patella tendon region of weight bearing area in B/K stump. Limited range of motion in B/K stumps occurred during flexion contracture of the knee joint. Four varus and 4 valgus deformities of the knee joint were observed in B/K stumps.

A total contact socket was prescribed for 47 % of the A/K amputees and plug fit socket for 42 %. A patella-tendon-bearing (PTB) socket was prescribed for 80 % of the B/K amputees and conventional sockets for 12 %.

Discussion

Most stump problems involve the socket fitting, and a few involve the alignment. However, no reports have been published about the general condition for prosthetic fitting of amputation stumps. Amputations due to trauma are carried out as emergency surgery and not always performed by a surgeon who is well versed in principle of prosthesis. Therefore, troublesome stumps were often seen. Stump problems with the prosthetic fitting were observed in 24 % of all of the amputees in this study, all of whom had traumatic amputation. Stump problems of the upper extremity amputees were seen in about 9 % (17/186 amputees), and two thirds of those stump problems were skin disorders (Fig. 1). It can be said that

socket fitting for troublesome upper extremity stumps was easier than that for troublesome lower extremity stumps, because the socket in an upper extremity prosthesis needs not bear the body weight. In our study, 95 % of upper extremity amputees used the cosmetic prosthesis whose socket fitting was looser than that of lower extremity prosthesis. Thus only a few stump problems for prosthetic fitting were reported. Improperly fitted prostheses were modified by the addition of a soft insert, and modified suspension and decompression window to the socket in those cases. None of the cases of upper extremity amputations required stump plasty and all of the problems were solved by the modification of the socket and suspension.

Socket functions in the lower extremity prosthesis are; a) encasement of the stump, b) supporting the body weight, c) transmission of the stump motion to the prosthesis and d) suspension of the prosthesis in some prosthetic types. Socket selection is a balance of several factors that attempt to match the patient's characteristics and needs with a prosthesis that yields the desired stability and mobility. Stump problems impair the socket function of supporting the body weight and were seen in about 37 % (80/216 amputees). This percentage was much higher (28 %) than in the upper extremity amputations. The socket of a lower extremity prosthesis requires a biomechanically strict fitting in order to bear the body weight. An advantage of hip disarticulation, knee disarticulation, Syme's amputation and the foot amputation is to allow the body weight to be fully supported by the stump ends. Stump ends with skin graft or scar tissue adhered to the bone in knee disarticulation can not support body weight. If stump ends are not able to support body weight, it can be said that the choice of amputation level was inappropriate. An A/K amputation would have been more appropriate. The cause of abnormal keratosis in Syme's amputation was uneven body weight support due to inadequate bone amputation level. Below the knee amputation is preferable in these cases. There were 5 Chopart's ampu-

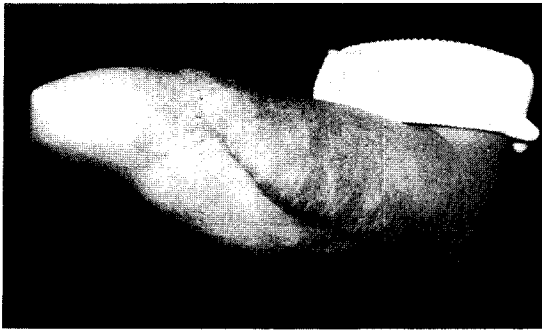


Fig. 1 Left below elbow amputation. Stump shows skin graft.



Fig. 2 Left Chopart's amputation. The amputation shows equinus deformity.

tations in this study. Two had sufficient range of motion of the talocrural joint, because insertion of the tibialis anterior tendon was functional. However, dorsiflexion was not possible in 3 cases due to equinus deformity (Fig. 2) and the consequent abnormal keratosis prevented walking on the heel. The equinus deformity observed in these Chopart's amputations was attributed to insufficient preparation of the stump. The more successful approach is either Syme's amputation or to anchor the tibialis anterior tendon. Syme's amputation performed secondarily in 2 of these cases with good results.

Muscle weakness, observed only in 13 % of all A/K, was attributed to a failure to carry out myodesis or myoplasty during the amputation resulting in conical stump ends. The plug fit socket is recommended. Surgeons should not prescribe the suction socket or total

contact socket. According to Grynbaum and Gordon (1) an absolute contraindication of the suction socket was muscle weakness of the affected limb.

Two patients with limited range of motion of the hip joint had very short stumps. In such cases the initial flexion of the socket should be considered.

Skin problems were often seen in B/K amputations (Fig. 3). They interfered with weight bearing and encasement of the socket. Pohjolainen (2) reported that scar tissue adhered to the bone in 13 % of all cases, and 5 out of 15 traumatic cases. He suggested that adhered scars were most commonly found in the trauma group and seem to be a risk factor for skin problems in these stumps. Almost all of his cases were vascular disease. In the present study, scar tissue adhered to the bone was seen in 7 %. All our cases were traumatic amputation, and skin grafts were seen in 11 %.

All dermatitis was observed at the weight bearing part of skin, particularly in stumps with scar tissue or skin grafts at the weight bearing part. For them the conventional B/K prostheses or PTB prostheses with thigh corset were prescribed. Joint dysfunction also disturbs the efficient transmission of stump motion. According to Francis and Renton (3), incidence of flexion contracture of the knee joint after B/K amputation is 7 %, and Pohjolainen (2) reported 13 %. In our study, the incidence of knee flexion contracture was 5 %. Moffat *et al.* (4) suggested that mobility with a prosthesis is still useful if the contracture is under 15°. In the present study, 2 out of 5 knee contractures exceeded 15°. One was 17° and received a conventional B/K prosthesis. The other was 35° and received a conventional B/K prosthesis with split socket. Daily walking with a prosthesis was achieved.

One of two cases with unstable knee joint in B/K amputees was the short stump without the fibula. The instability of this case was caused by dysfunction of the lateral collateral ligament, and we prescribed a conventional prosthesis. For varus and valgus deformity (Fig. 4), a conventional B/K prosthesis was prescribed in order to avoid gonalgia and to protect knee stability. Conventional B/K prostheses were prescribed for 4 other short stumps with longer fibula (Fig. 5).

Stump problems in the upper extremity that moderately impair activity are easily corrected by the modification of the socket and suspension. In lower extremity amputations, the disarticulation which can not support the body weight on the end weight bearing stump is inferior to a more proximal amputation that will have fewer stump

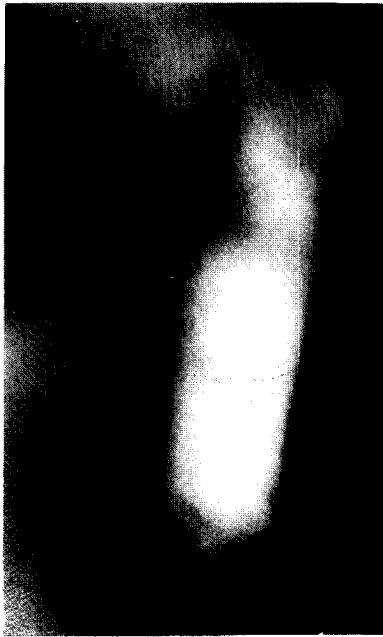


Fig. 3 Left below knee amputation. Skin of stump end adhered to the bone.



Fig. 4 Left below knee amputation. The photograph shows varus deformity.

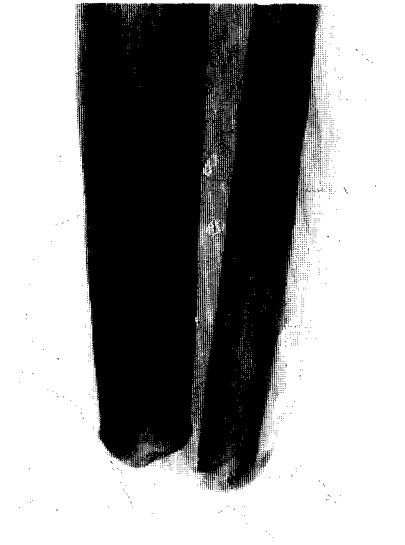


Fig. 5 Left below knee amputation. Longer fibula is shown in the X-ray film.

problems during activity. A/K amputees without myodesis or myoplasty, and B/K amputees with skin disorders at the weight bearing part or joint dysfunction have a restricted choice of prosthesis. When deliberate evaluation of the affected limb and adequate choice of the amputation level are done by surgeons, these problems are avoidable in almost every case.

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