TRAUMATIC PARTIAL FOOT AMPUTATIONS IN ADULTS

A LONG-TERM REVIEW

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A retrospective study of 260 industrial amputees was undertaken to determine the long-term functional results of partial foot amputations following trauma. Follow-up ranged from 1 to 68 years with a mean of 16 years. Of 113 partial foot amputees (118 amputations) who had retained their original amputation, the functional end-results were 43% good, 38% fair and 19% poor. Lisfranc and Chopart amputations were better than those at transmetatarsal or digital levels. Of 260 initial amputations 49 (19%) were revised to a Syme's or a below-knee amputation.

Partial foot amputations are commonly carried out for trauma, tumours, neuropathic disorders and ischaemia, especially in diabetes. Most reports address their value in diabetic or ischaemic limbs (Larsson and Andersson 1978; Wagner 1981; Pinzur et al. 1986).

Historically, there has been a debate as to the value of Chopart and Lisfranc amputations, while more distal amputations have been accepted as leaving little disability. Some authors believe Lisfranc and Chopart amputations are of much less value from a functional point of view than a Syme's or a below-knee amputation (Hulnick, Highsmith and Boutin 1949; Harris and Silverstein 1964; Lindqvist and Riska 1966; Hunter 1981; Wagner 1981; Tooms 1987).

Harris and Silverstein (1964) described partial foot amputations as being unpredictable, and highlighted poor results in association with skin grafts. Christie, Clowes and Lamb (1980) reported good results for mid and hindfoot amputations and stressed the importance of relocating tendons to balance the ankle and subtalar joints. Lange and Nascia (1984) stressed that longitudinal amputations can leave a useful foot.

At the Ontario Workers' Compensation Board Downsview Rehabilitation Centre, an evaluation was undertaken of the long-term results of traumatic amputation in the foot to determine the requirements for

success, the reasons for failure and the long-term functional results at the different levels of amputation.

PATIENTS AND METHODS

A total of 277 patients who had sustained a partial foot amputation following an industrial accident were identified retrospectively.

There were 113 patients who retained their initial amputation and 49 patients whose partial amputation was considered a failure and was later revised to a Syme's or a below-knee amputation. Seventeen patients were not included because their injury was minor and they had pre-existing diabetes and/or peripheral vascular disease which contributed to the problem. The remaining 98 patients had either died or could not be contacted.

The patients were evaluated by a standard questionnaire, a review of the records and by clinical examination. The information was analysed using the Statistical Analysis System (SAS User's Guide 1982, 1985).

The amputations were classified as digital, transverse and longitudinal. Transverse amputations were classified as metatarsophalangeal if all toes were removed, transmetatarsal, Lisfranc and Chopart. Longitudinal amputations were in the sagittal plane and involved resection of either the medial or lateral side of the foot (Table I).

A functional rating system was used based on foot pain, the quality of the stump, functional ability and employment status.

For a *good* result, the patient had to be employed in the same (or similar) occupation as before the accident, with no restriction of function or gait and no ulceration or pain; minor pain in the stump, not necessitating adjustments to footwear were tolerated in this group. A result was considered *fair* if the patient had a change of occupation to a more sedentary job, moderate pain, recurrent callosities, shoe modifications and restriction of function. *Poor* results were those in which the patient

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0301-620X/88/2038 \$2.00
J Bone Joint Surg [Br] 1988;70-B:251-4.

complained of persistent pain, had severe limitation of function and gait, recurrent ulceration, was unable to work or had retired prematurely as a result of the amputation.

A failure was defined as complete inability to tolerate the partial foot amputation with eventual revision to a Syme's or a below-knee amputation.

RESULTS

Of 167 partial foot amputations, 118 in 113 patients were retained. All the patients were male. The mean follow-up period was 16 years (range 1 to 68 years). The average age at amputation was 33 years (range 15 to 63 years) and the average age at review was 50 years (range 17 to 83 years). These 118 were rated good in 51 (43%) fair in 45 (38%) and poor in 22 (19%) (Table I).

Forty-nine amputations failed and were revised to a Syme's or a below-knee amputation. The average time before revision was 1.4 years (range 2 months to 12 years).

Reasons for failure. There were many factors causing failure and leading to re-amputation.

1. The severity of the initial crush injury.
2. The quality of the final soft-tissue cover, especially with regard to plantar or terminal skin grafts.
3. The added complication of infection.
4. Late deformity due to non-union or malunion of fractures and incongruity and arthritis of joints leading to multiple surgical procedures.

Partial foot amputation with toe loss and ray resection were more commonly revised to below-knee level, whereas transmetatarsal, Lisfranc and Chopart amputations were usually revised to a Syme's amputation (Table I). This is due to the fact that the final amputation level is not a true reflection of the extent of the injury, as many digital and longitudinal amputations had extensive fractures and soft-tissue injuries in the foot proximal to the amputation level. The Chopart amputations had a higher revision rate compared to the other levels of amputation because of the severity of the initial injury (Table I).

Table I. Outcome of 167 partial foot amputations (162 patients)

Initial level	Revised*	End-result of retained amputation				Total
		Good	Fair	Poor		
Digital	34 5	14	7	8		(29)
Transverse						
Metatarsophalangeal	13 4	4	5			(9)
Transmetatarsal	54 15	11	17	11		(39)
Lisfranc	20 5	7	7	1		(15)
Chopart	23 14	6	3			(9)
Longitudinal						
Lateral	12 6	4	2			(6)
Medial	11	5	4	2		(11)
Total	167 49	51	45	22		(118)

* Revised to Syme's or below-knee amputation

Other factors leading to a poor result included persistent pain in the stump, skin problems such as callosities and ulceration, and unsuitable footwear and orthotic devices.

Requirements for success. To determine the requirements of a successful partial foot amputation, the level of bone section was assessed. The results summarised in Table I do not support the concept that the longer foot does better. At the digital level, 8 of 29 (28%) and at the transmetatarsal level 11 of 39 (28%) had poor results, whereas in the Lisfranc and Chopart amputations only 1 of 24 (4%) had a poor result and in the longitudinal group only 2 of 17 (11%) had poor results.

Other factors were found to be of greater importance than the bony level of amputation. The presence of a fracture proximal to the amputation was significant: when this fracture was within the foot stump only 2 of 18 did well; when there was an ipsilateral ankle fracture, none of six did well. *Internal fixation of fractures* was important: in the proximal amputations with better results, internal fixation had been used more often than in the distal amputations.

Skin grafts were performed in 50% of the patients. *Patients without grafts* had better results than those with grafts. The location of the skin graft was important in relation to the results. Plantar and terminal grafts had

Fig. 1

Fig. 2

Circumferential split skin grafts and flaps are not recommended in partial foot amputations.

significantly fewer good results than dorsal grafts (Fig. 1). Other more sophisticated grafting techniques such as flaps have been used but the results were disappointing. Of 10 full-thickness grafts only two were rated good (Fig. 2).

Patients with good results had fewer operations than patients with poor results (Fig. 3); their amputations were performed sooner after injury (average 2 months vs. 8 months); and if revision was required to a more proximal level in the foot, this was performed earlier (average 2.5 months vs. 4.4 years).

Long-term functional results at each level

Chopart amputations. Fourteen of the 23 Chopart amputations failed; but of the remaining nine, six rated a good result (Table I). All these nine had good stumps with no plantar grafts or adherent skin. Four used the formal Chopart prosthesis, while two used an acrylic ankle-foot orthosis and the remainder used custom-made boots with moulded insoles. Ankle movement was retained with 5° of dorsiflexion and 20° of plantar flexion. The subtalar joints were fixed, however, either in neutral or in varus with subsequent development of callosities on the lateral border of the foot.

Lisfranc amputations. Five of the 20 Lisfranc amputations failed, but of the remaining 15 only one was rated poor (Table I). Only one quarter required custom-made shoes and the remainder used normal shoes or boots with combinations of sole stiffeners, rocker bottoms and reinforced uppers in association with moulded insoles and toe fillers.

Metatarsophalangeal and transmetatarsal amputations. Of 67 of these operations performed, 19 failed and only 15 of

the remaining 48 were rated good (Table I). It was in this group that the worst results occurred with the greatest amount of proximal soft-tissue destruction, fractures and skin grafts. Attempts had been made to conserve length, perhaps inappropriately at times. Over 90% complained of footwear problems. Most used a custom-made shoe with a steel shank, custom-made toe filler and moulded insole.

Digital amputations. Of 34 digital amputations, five required subsequent amputation to a Syme's or to below-knee level. Only 14 of the remaining 29 did well (Table I). Many with loss of one or two toes were still plagued by problems related to dorsal soft-tissue contracture and plantar scarring. These patients most commonly wore a normal shoe with some form of insole.

Longitudinal amputations. Of 23 longitudinal amputations, six failed. Nine of the remaining 17 did well, four being lateral amputations (Fig. 4) and five medial (Table I). These patients generally wore normal shoes with a custom-made insole and filler.

Fig. 4

Longitudinal partial foot amputation with a good result.

Return to work. Although over 90% of patients returned to work after their amputation, 75% changed to an occupation which required less physical activity. Patients with a good result returned to work within nine months, while those with poor results took 17 months.

DISCUSSION

The failure rate of partial foot amputations (19%) in this series compares favourably to 36% reported previously from this centre (Harris and Silverstein 1964) and to 29% for Syme's amputations also from this centre (McElwain, Hunter and English 1985).

Although a recent report by Christie et al. (1980) stressed transfer of tendons anteriorly and Pinzur et al. (1986) stressed associated release of the calcaneal tendon in amputations through the middle part of the foot, no partial foot amputation was revised to a Syme's or to a below-knee amputation solely because muscle imbalance led to joint deformity. Bone and joint deformity were

Fig. 3

Mean number of operations for each category of result.

important reasons for failure, but more as a direct result of injury with malunion of fractures and contracture of injured soft tissues rather than as a secondary consequence of the amputation itself.

Contrary to earlier reports, a longer residual foot did not give a better result than a shorter one. Lisfranc and Chopart amputations were better than transmetatarsal and digital amputations. Saving all possible length is not the major issue, but rather it is important to obtain well-covered innervated skin flaps, preferably from plantar skin. Removing bone at an early stage to obtain good soft-tissue cover is advocated in order to avoid skin grafting, particularly on plantar and terminal surfaces as they are associated with poor results in an end-bearing stump. Internal fixation for proximal fractures is recommended to avoid malunion and problems of pain and stiffness of the remaining joints in the foot. The time course for these patients has been very protracted in misguided attempts to preserve length. Early definitive surgery is advocated. Although the number of longitudinal amputations are too small to draw firm conclusions on how many rays are required for function, patients can do well with just one ray on the medial side, or at least two rays on the lateral side.

A good partial foot amputation need not be a major incapacity and can perform better than a Syme's amputation in adults, and also in children provided there is no equinus contracture (Greene and Cary 1982).

After well-performed surgery, few amputations distal to the transmetatarsal level should require orthoses to improve function; Lisfranc and Chopart amputees do require a definitive orthosis. Unsatisfactory stumps can be improved by moulded insoles, sole stiffeners, rocker bottoms and shoes with extra depth. The thinner plastic materials have allowed less cumbersome footwear to be used and have decreased problems from pressure and associated callosities (Rubin 1984).

Our review indicates that all levels of partial foot amputation can provide the patient with a durable and relatively comfortable stump that does not hinder the patient in his vocational and recreational activities. Long-term function can be good at all levels and some

excellent results were obtained in Lisfranc and Chopart amputations. The success or failure of a partial foot amputation after a crush injury is related to the degree of bony and soft-tissue trauma proximal to the level of amputation.

We would like to thank Mr G. Suranyi for statistical analysis, Ms C. Moore for the photographs, and Mrs A. Howes for secretarial assistance.

The financial support of the Ontario Workers' Compensation Board has allowed review of these patients and a grant from the Physicians Services Incorporated Foundation is appreciated.

REFERENCES

- Christie J, Clowes CB, Lamb DW. Amputations through the middle part of the foot. *J Bone Joint Surg [Br]* 1980;62-B:473-4.
- Greene WB, Cary JM. Partial foot amputations in children: a comparison of several types with the Syme amputation. *J Bone Joint Surg [Am]* 1982;64-A:438-43.
- Harris WR, Silverstein EA. Partial amputations of the foot: a follow-up study. *Can J Surg* 1964;7:6-11.
- Hulnick A, Highsmith C, Boutin FJ. Amputation for failure in reconstructive surgery. *J Bone Joint Surg [Am]* 1949;31-A:639-49.
- Hunter GA. Minor foot amputations. In: Kostuik JP, ed. *Amputation surgery and rehabilitation: the Toronto experience*. New York, etc: Churchill Livingstone, 1981:87-92.
- Lange TA, Nasca RJ. Traumatic partial foot amputation. *Clin Orthop* 1984;185:137-41.
- Larsson U, Andersson GBJ. Partial amputation of the foot for diabetic or arteriosclerotic gangrene: results and factors of prognostic value. *J Bone Joint Surg [Br]* 1978;60-B:126-30.
- Lindqvist C, Riska EB. Chopart, Pirogoff and Syme amputations: a survey of twenty-one cases. *Acta Orthop Scand* 1966;37:110-6.
- McElwain JP, Hunter GA, English E. Syme's amputation in adults: a long-term review. *Can J Surg* 1985;28:203-5.
- Pinzur M, Kaminsky M, Sage R, Cronin R, Osterman H. Amputations at the middle level of the foot: a retrospective and prospective review. *J Bone Joint Surg [Am]* 1986;68-A:1061-4.
- Rubin G. The partial foot amputation. *J Am Podiatry Assoc* 1984;74:518-22.
- SAS User's guide: statistics. Carry, North Carolina: SAS Institute, 1982.
- SAS User's guide: basics. 5th ed. Carry, North Carolina: SAS Institute, 1985.
- Tooms RE. Amputations of lower extremity. In: Crenshaw AH, ed. *Campbell's operative orthopaedics*. St Louis, etc: CV Mosby 1987:607-27.
- Wagner FW Jr. Partial foot amputations. In: The American Academy of Orthopaedic Surgeons *Atlas of limb prosthetics, surgical and prosthetic principles*. St Louis, etc: CV Mosby, 1981:315-25.