Juvenile Amputees Classification and Revision Rates

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INTRODUCTION

The care of the juvenile amputee presents special problems for the physical therapist, prosthetist, and orthopedic surgeon. Optimum surgical treatment and prosthetic fitting demands careful planning and frequent clinical and radiographic followup, as growth alters the size and configuration of the residual limb. Growth of the residual limb and soft tissues may be disproportionate, resulting in bony overgrowth. This problem, as stated by Lambert[1], represents the most common unfavorable sequela of the surgical treatment of the juvenile amputee. Parents of these children and third party payers often request information from medical personnel concerning the anticipated nature and frequency of surgical and prosthetic modification due to bony overgrowth. Ideally, a classification of the juvenile amputee by type, age and bones involved, and an analysis of patients with such classifications, would help to answer these questions.

PURPOSE

The purpose of the study is to present a classification of juvenile amputees, and to describe the relationship of classification, treatment, bones involved, and patient age at the time of amputation to the necessity for surgery for bony overgrowth (Fig. 1).

REVIEW OF LITERATURE

Aitken[2], Lambert and Pellicore[3] describe the bony overgrowth in the juvenile amputee as appositional bone growth independent of ephiphyseal growth. Aitken[5] documented the order of overgrowth frequency as: humerus, fibula, tibia, femur, and tibia/fibula. Once the bone pierces the skin, treatment of choice is bony excision and soft tissue closure. Pellicore[3] demonstrated that, in addition to the specific bone involved, age at amputation and occurrence of transection through bone lead to recurrence of bony overgrowth. According to him the bones involved in order of frequency were: tibia, humerus, fibula, femur, and tibia/fibula. He and Aitken concluded that prevention of overgrowth can best be accomplished by joint disarticulation.

Many children with acquired amputations need revision, particularly of the humerus and fibula. True congenital am-

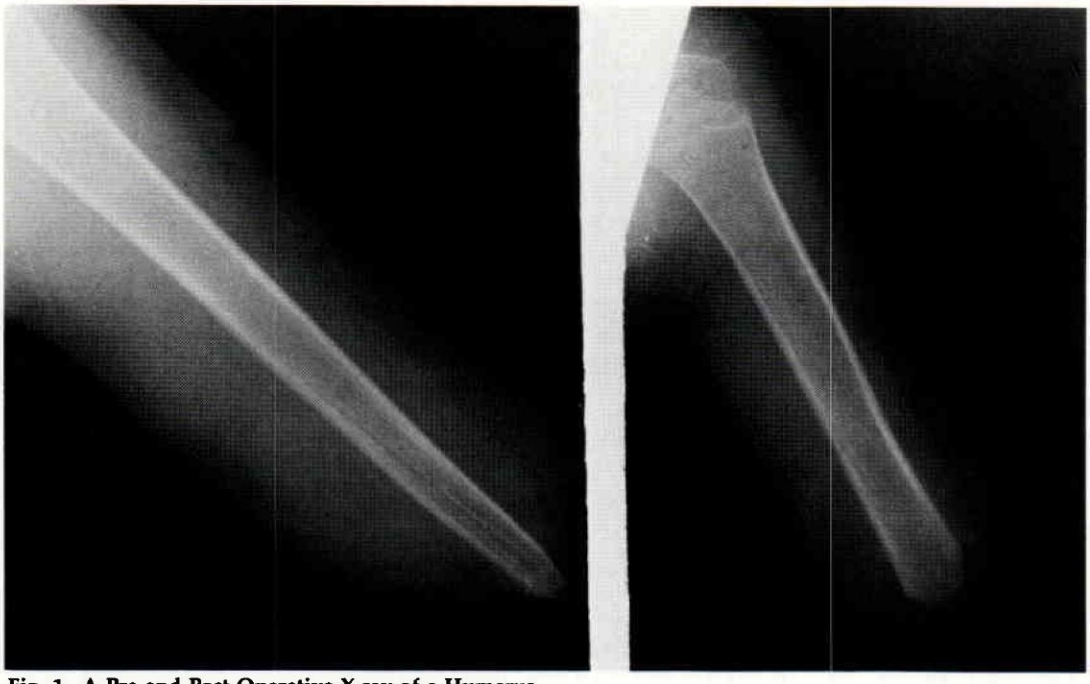

Fig. 1—A Pre and Post Operative X-ray of a Humerus.

putations which need revision, although rare, have been reported by Lambert and Aitken[7], although they did not describe these cases.

METHOD

We identified juvenile amputees in two ways. First, by computer search of "limb reduction deficiencies" in the Medical Record Department of the University of Iowa Hospitals and Clinics from 1965 through 1981. These patients had at least one hospital admission during that period, though not necessarily related to the amputation. Additionally, we identified congenital amputees by limb and level from the Congenital Hand Project, which extended from 1960 to 1980. The charts of all patients were reviewed. For inclusion in the analysis, the initial amputation or first revision had to be completed prior to skeletal maturity. For each patient, we documented the following: age at amputation, etiologic factors, bones involved, level, and the nature and number of operations on bone. The data were tabulated and graphed for analysis.

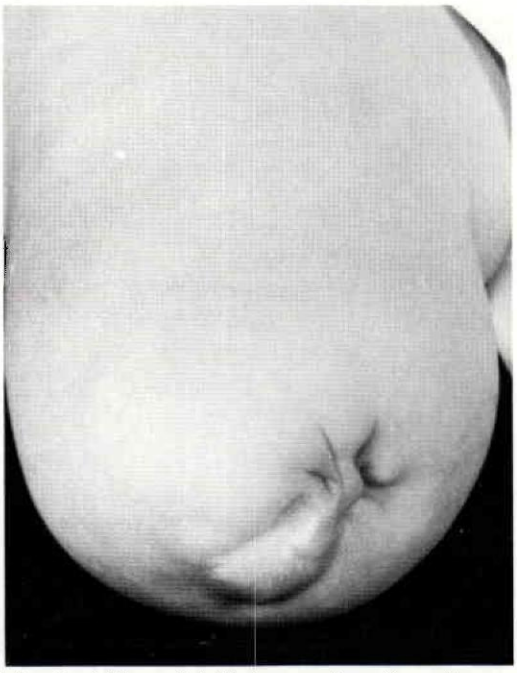

Fig. 2—A Type II BK Amputation, Secondary to Constriction Ring Syndrome.

RESULTS

One hundred twenty patients with major limb deficiencies or amputations prior to skeletal maturity were classified to the following five-category system:

Type	Description	Number of Cases
I	Acquired amputations (infection, trauma, etc.)	26
II	Congenital amputations through long bones.	8
III	Congenital deficiencies surgically converted by amputation through bone.	3
IV	Congenital deficiencies surgically converted by disarticulation.	4
V	Congenital deficiencies treated non-surgically with prostheses.	79
		120

The distinction between Type II and Type V amputations is important. Type II includes true congenital amputations through long bone and may result from such defects as constriction ring syndromes (Fig. 2). Type V includes terminal transverse deficiencie, in which vestigial appendages are usually present (Fig. 3).

Type I cases range at amputation from 3 months to 14 years. The humerus overgrows most frequently and requires as many as six revisions, demanding a total of 14 procedures on four patients. The fibula was revised in three cases, the tibia/fibula twice, and the tibia alone once. Cases acquiring amputation after age 12 needed no revision, regardless of the bone involved. Only seven cases are skeletally mature, and only one of these occurred at the above-elbow level. Of those skeletally mature, the only case requiring revision was for a tibia and fibula on separate occasions in a below-knee acquired at age 10. The revisions were done at ages 15 and 16 respectively.

Fig. 3—A Classic Congenital BE, with vestigial hand.

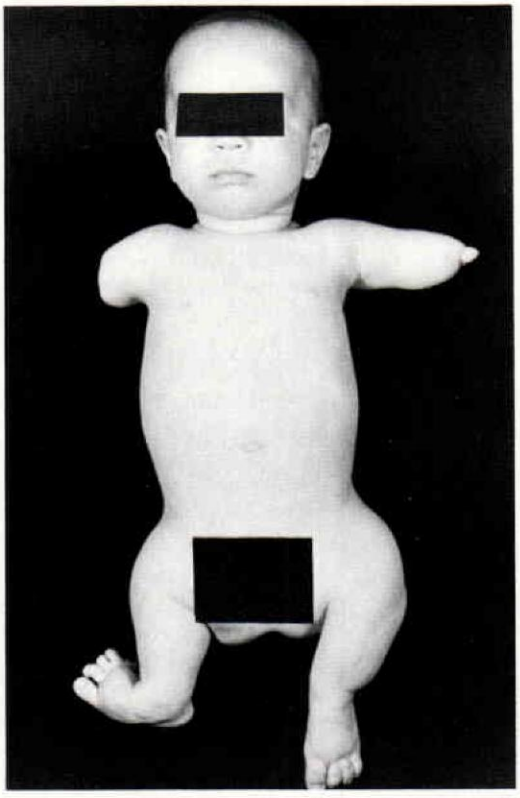

Fig. 4—A Type II Congenital Quadramembral, who had two revisions of the right humerus.

Type II cases, true congenital amputations, are defined as amputations through the long bones, present at birth. We excluded the classic terminal transverse below-elbow deficiency, with vestigal hand or nubbins, and all other congenital limb deficiencies not through the long bones. We included these (PFFD, phocomelias and amelias) in Type V. Of the eight Type II cases, seven underwent at least one revision. One fibula was revised five times, and two humeri were revised twice. Of interest was one patient (Fig. 4) who had bilateral PFFD and bilateral above-elbow amputations, one longer than the other. In 20 years, he underwent two revisions for the right and no revisions for the left.

Type II congenital, through bone, amputations do overgrow. The humerus, the most common bone involved, required six revisions in four patients. Two tibia/fibulae were revised a total of four times: three in one case and one in another (Table 5).

Since all patients in Type II had at least three limbs involved and had at least simple syndactylys, this group appears to respond differently than the classical limb deficiency or the patient with only one limb involved. From our data, patients with congenital amputations of the humerus and fibula react much like Type I or Type III, even though they appear to be true congenital amputations.

Type III cases are those in which surgical conversion of congenital limb deficiency involved a cut-through bone. All are at the below-knee level (Table 4). Two were congenital pseudarthroses of the tibia and fibula, and one was a congenital absence of the fibula. Like the type I amputations, Type III require bony revision. Of the below-knees, two needed revision of the tibia, one at age 12 and one at age 15, and one required revision of the fibula. All amputations were done prior to age 5 and, predictably, acted similar to Type I.

Type IV encompasses congenital deficiencies converted surgically by disarticulation. PFFD and single or double ray feet without a hindfoot are examples. Surgical conversion enhances prosthetic fitting without concommitant loss in function. No bony overgrowth occurred in this

Type I by Level and Cause

Level			Cause		
AE	=	7	Farm Equipment	=	11
BE	=	4	Lawn Mower	=	5
WD	=	2	Infection	=	6
BK	=	13	Burn	=	3
			Motor Vehicle	=	1
		26			26

Table 1—Type I by Level and Cause.

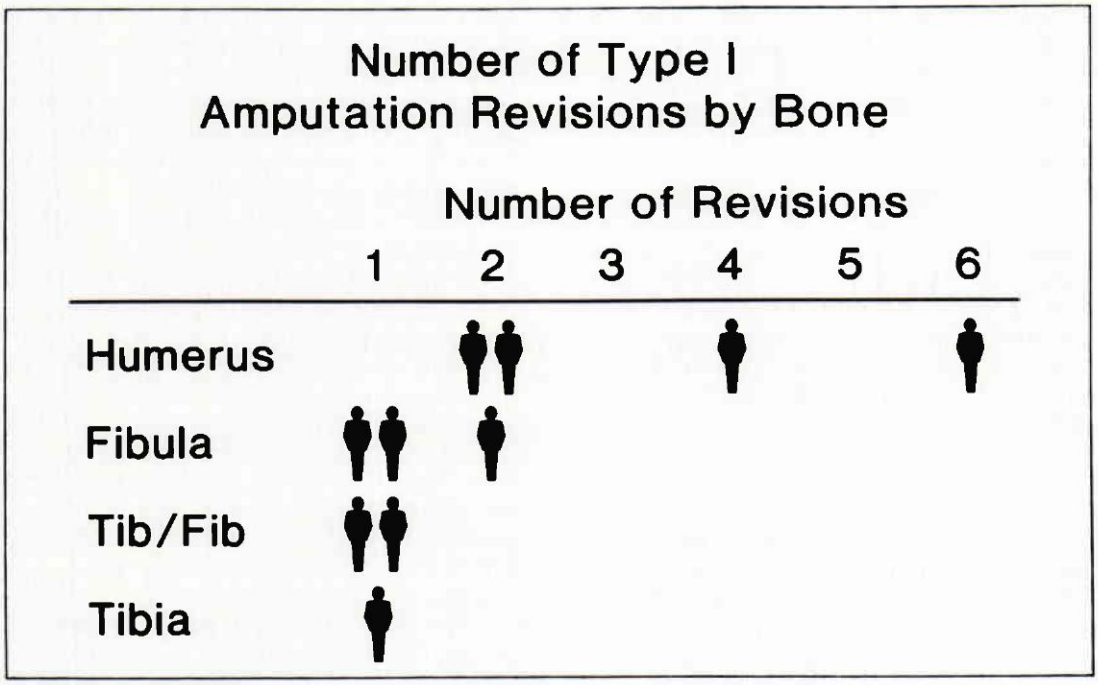

Table 2—Number of Type I Amputation Revisions by Bone.

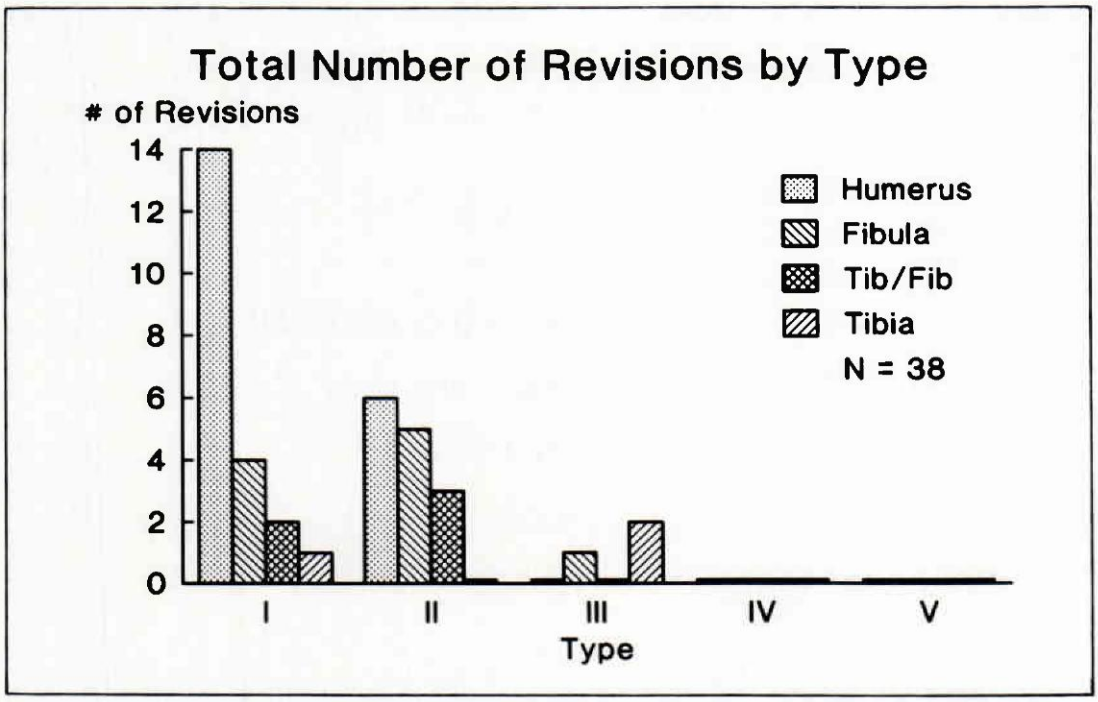

Table 3—Total Number of Revisions by Type.

Total Cases by Type and Level

Level	Type I	II	III	IV	V	Total
AE	7	5	0	0	0	12
BE	4	0	0	0	33	37
WD	2	0	0	0	0	2
AK	0	0	0	0	0	0
BK	13	2	4	0	0	19
AD	0	0	0	0	0	0
All Others	0	0	0	4	46	50
Total	26	7	4	4	79	120

Table 4—Total Cases by Type and Level.

Type II Congenital Amputations Through the Long Bones

Level	F/U Years	Number of Revisions	Age, in Years, at Revision Humerus	Fibula	Tib/Fib
AE	8	1	7		
AE	8	2	8, 10		
AE	3	1	2		
BK	14	3			2,4,14
(L)AE	20		3, 7		
(R)AE		2(R)			
BK	7	1			5
BK	9	5		1,3,6,7,9	

Table 5—Type II Congenital Amputations through the Long Bones.

group.

Type V comprises the largest sub-group of these congenital deficiencies, treated non-surgically by prostheses. Type V includes the classic terminal transverse below-elbow amputation which occurs more often in females, and on the left side[6]. A vestigial hand or nubbins are usually present. In review of 33 unilateral cases with no other abnormalities, we found no case of bony overgrowth. Since no bony overgrowth occurred, we believe that these are true limb deficiencies, and therefore belong in our Type V classification.

DISCUSSION

After analysis of this group of juvenile amputees, we concluded that for prognostic purposes the proposed classification system is valuable. The known tendency of acquired amputations (Type I) to require revision, sometimes multiple revisions, is confirmed. Twenty-six patients underwent 21 revisions. The analysis indicates that congenital transverse amputations (Type II) through long bones frequently require revision, occurring 14 times in seven patients. This confirms the opinions of Aitken and Lambert. For prognostic purposes, the transverse congenital amputation (Type II) should be considered an entity distinctly different than non-surgically treated congenital terminal transverse deficiencies (Type V), in which revisions were not required.

When congenital deficiencies were treated by amputation through long bones (Type III), they behaved, relative to surgical revision, as a congenital amputation through long bone. The congenital deficiency treated by amputation through long bone changed from an entity in which revision was unlikely to one in which revision was nearly predictable. If the congenital deficiency was surgically treated by disarticulation instead of amputation (Type IV), revision was not necessary, suggesting that, when possible, disarticulation is the preferred surgical procedure.

Our data cannot be used to accurately describe relative incidence for the five amputee types. The data and classification system does provide guidelines by which other investigators may further explore the question of surgical revision in juvenile amputees, especially in patients with congenital amputations of long bones.

CONCLUSIONS

Surgical revision of the juvenile amputee occurs in both congenital and acquired cases. The younger the patient at the time of amputation, the more likely the need for revision. In our series, the humerus was most often revised, followed by the fibula, tibia/fibula, and tibia. The data supports the frequent need for revision for bony overgrowth in true congenital amputations through the long bones, particularly through the humerus and fibula. It also reaffirms the contention that through-bone amputations should not be done if disarticulation is possible.

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