INJECTION-INDUCED CONTRACTURES OF THE QUADRICEPS IN CHILDHOOD

A COMPARISON OF PROXIMAL RELEASE AND DISTAL QUADRICEPSPLASTY

A. M. JACKSON, P. A. N. HUTTON

From The Hospital for Sick Children, London

Thirty-two contractures of the quadriceps induced by injection in 17 children have been reviewed. The average age at presentation was 3 years 4 months. All the children had suffered a severe illness within the first few weeks of life and all had received intramuscular injections into the thigh. Three methods of treatment were used: conservative, distal quadricepsplasty, and proximal release. At follow-up none of the patients treated by proximal release had an extension lag, which was present in 70% of those treated by distal quadricepsplasty. Apart from one case with slight improvement in the range of knee flexion, conservative treatment, at best, could only prevent further loss. The clinical presentation and management is described, and the advantages of proximal release are discussed.

Quadriceps contractures in infants and young children were at first thought to be congenital, or secondary to progressive idiopathic fibrosis of the vastus intermedius muscle (Fairbank and Barrett 1961; Hněvkovský 1961; Chiu *et al.* 1974). In 1964 two reports, one by Lloyd-Roberts and Thomas and the other by Gunn, drew attention to the relationship between intramuscular thigh injections and the subsequent development of quadriceps contractures, an observation which has gained further support in recent years (Chiu *et al.* 1975; Alvarez *et al.* 1980).

To date the recommended treatment of injection-induced contractures has been a distal quadricepsplasty. After operation a significant extension lag has been reported (Lloyd-Roberts and Thomas 1964; Williams 1968; Alvarez *et al.* 1980) which, in older children, may persist for up to three years (Bose and Chong 1976).

This study reports the clinical presentation and management of 17 children with a total of 32 progressive quadriceps contractures. Each child had suffered a severe illness within the first few weeks of life for which drugs had been given by intramuscular injection into the thighs. Two distinct operative procedures were used to restore flexion of the knee: one group was treated by distal quadricepsplasty, and the other by proximal release at the site of the lesion. The advantages of the

proximal release, an approach not previously described, are discussed.

Fig. 1

Bilateral contractures in a 12-year-old girl (Case 13). The ability to squat is greatly impaired.

MATERIAL AND METHODS

Clinical material. Since the series of six cases reported by Lloyd-Roberts and Thomas (1964), a further 17 children with progressive contractures of the quadriceps have been treated at The Hospital for Sick Children. All the children had suffered a severe illness within the first few weeks of life and had received intramuscular thigh

A. M. Jackson, FRCS, Consultant Orthopaedic Surgeon
107 Harley Street, London W1N 1DG, England.

P. A. N. Hutton, FRCS, Orthopaedic Senior Registrar
Westminster Hospital, Dean Ryle Street, Horseferry Road, London
SW1P 2AP, England.

Requests for reprints should be sent to Mr A. M. Jackson.

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0301-620X/85/1004 \$2.00

Table I. Details of the 17 children with injection-induced contractures of the quadriceps

Case	Age at presentation		Sex	Delivery	Primary illness	Injections	Side(s)	Treatment	
	y	m						Left	Right
1	1	6	M	Full-term	Meningitis	Antibiotics	Bilateral	Distal quad.*	Conservative
2	2	3	F	Premature	Meningitis	Antibiotics	Bilateral	Conservative	Distal quad.
3	3		M	Premature	Hypocalcaemia with fits	Anticonvulsants	Bilateral	Distal quad.	Distal quad.
4	1	4	M	Premature	Coarctation of aorta	Antibiotics, analgesics	Bilateral	Conservative	Conservative
5	3	3	F	Premature	Subarachnoid haemorrhage, hydrocephalus	Antibiotics	Bilateral	Proximal release	Conservative
6	10	7	M	Premature	Pyloric stenosis, pneumonia	Antibiotics, analgesics	Bilateral	Distal quad.	Distal quad.
7		3	F	Premature	Respiratory arrest	Antibiotics	Bilateral	Distal quad.	Conservative
8	2		F	Full-term	Febrile convulsions	Antibiotics, anticonvulsants	Bilateral	Conservative	Distal quad.
9	3		M	Full-term	Meningitis and cerebral abscess	Antibiotics, anticonvulsants	Bilateral	Distal quad.	Conservative
10	1	9	M	Premature	Tracheo-oesophageal fistula	Antibiotics, analgesics	Bilateral	Proximal release	Distal quad.
11	1	4	F	Premature	Multiple congenital heart defects	Antibiotics, analgesics	Right		Conservative
12	5	8	F	Full-term	Malabsorption syndrome	1 α -hydroxycholecalciferol	Bilateral	Proximal release	Proximal release
13	12		F	Full-term	Meningitis	Antibiotics	Bilateral	Conservative	Conservative
14	2		F	Premature	Hyaline membrane disease	Antibiotics	Bilateral	Proximal release	Proximal release
15		5	M	Premature	Subglottic stenosis, pneumonia	Antibiotics	Bilateral	Conservative	Conservative
16	3		F	Full-term	Cystic fibrosis	Antibiotics	Bilateral	Conservative	Proximal release
17	3		M	Premature	Failure to thrive, pneumonia	Antibiotics	Left	Proximal release	

* Distal quadricepsplasty

injections—mainly antibiotics, analgesics and anticonvulsants (Table I).

Eleven of the children were born prematurely. There were eight boys and nine girls with an average age at presentation of 3 years 4 months (range 3 months to 12 years). Fifteen children had bilateral contractures; the right side was involved in one child with unilateral involvement, and the left in the other.

In the 17 children reviewed a total of 32 progressive quadriceps contractures were treated. Fourteen of the contractures were managed conservatively (Group 1), 10 by a distal quadricepsplasty (Group 2), and eight by a proximal release (Group 3).

In Group 1 the average follow-up was 7.5 years, in Group 2, 10 years and in Group 3, 2.6 years.

Clinical presentation. The essential presenting symptom in all the children was a progressive painless limitation of knee flexion. Their parents were usually aware of the difficulty their child had in squatting, kneeling, sitting cross-legged, running, or climbing stairs (Fig. 1). In each case the affected leg had a dimple in the thigh, which deepened on forced flexion of the knee (Fig. 2).

Fig. 2

The typical dimple seen in the thigh with contracture. The dimple became deeper when the knee was flexed.

The range of knee movement was measured first with the hip flexed and then with it extended (Figs 3 and 4). This demonstrated the contribution of rectus femoris to the contracture.

On presentation, none of the patients with progressive loss of flexion complained of patellofemoral symp-

Fig. 3

Fig. 4

By measuring the range of movement of the knee first with the hip flexed and then with it extended the contribution of rectus femoris to the contracture can be demonstrated.

toms. One child (Case 10) with bilateral quadriceps contractures had bilateral genu recurvatum; he had no other stigmata of joint laxity. Two of the other children with bilateral contractures had clinical evidence of external tibial torsion.

Treatment. In Group 1 the contractures were treated conservatively by passive stretching of the quadriceps.

In Group 2 the contractures were treated by a distal quadricepsplasty. Through a long, distal, anterolateral incision the quadriceps mechanism was explored. The vastus lateralis and intermedius muscles were examined and if tight released. If full flexion was still impaired the rectus femoris tendon was elongated by a Z technique. After operation the knee was immobilised in plaster at 90° for three to six weeks, depending on the extent of the soft-tissue release, and whether a suture line had to be protected. This was followed by intensive physiotherapy.

The main contractures appeared to involve rectus femoris in six children, vastus intermedius in two, and a combination of vastus lateralis and rectus femoris in a further two. Vastus medialis was not involved in any of the contractures.

In Group 3 the contractures were treated by a proximal release. Through a proximal longitudinal incision centred at the dimple, the thigh muscles were explored. In all of the patients the subcutaneous tissue under the dimple was normal both in thickness and in consistency; the dimple was caused by tethering of thickened, scarred fascia lata to the underlying vastus lateralis. The affected fascia lata was excised to reveal in every case either a mass of dense fibrotic tissue replacing muscle, or more commonly, numerous tight fibrous bands tethering the affected muscle groups to relatively normal muscle.

All masses of dense fibrous tissue were excised; the knee could then be fully flexed without difficulty. In those cases where the adjacent muscle groups were tethered by tight fibrous bands release was more difficult. By carefully forcing the knee into flexion the bands were placed under tension and could then be divided in turn; damage to muscle branches of the femoral nerve may be avoided by using a nerve stimulator. Thus treated, the knee will suddenly give way and more flexion will stretch the quadriceps and allow the knee to flex.

After operation the knee was immobilised in a front slab at 90°. As soon as pain had settled the slab was removed and physiotherapy begun. A femoral nerve block greatly diminished postoperative pain.

The main contractures involved rectus femoris and vastus lateralis in four children, vastus lateralis and tensor fascia lata in three, and vastus intermedius and tensor fascia lata in one.

RESULTS

Group 1. Of the 14 contractures treated conservatively, five had deteriorated by the time of follow-up, and a further two (Case 4) had clinical evidence of severe rectus femoris involvement (Table II). One child (Case 2) had undergone a patellectomy for retropatellar pain at the age of 15 years. No change was seen in the severity of four contractures between presentation and follow-up, averaging 10.6 years later. In each of these four cases, the range of movement on presentation had been 0° to 130°.

One patient (Case 4) with bilateral contractures improved with conservative treatment. On presentation at the age of 16 months, the range of movement in both knees was 0° to 100°. His mother devoted most of her time during the day to regular passive stretching of his knees. Eighteen months after the start of treatment the child sustained a greenstick fracture of the right distal femur during a course of stretching. At follow-up, 14 years later, the range of flexion in the left knee had improved by 20° and in the right knee by 10°, although there was clinical evidence of severe bilateral involvement of the rectus femoris.

Group 2. The average follow-up was 10 years, ranging from 5 years 10 months to 16 years. All 10 who had contractures treated by distal quadricepsplasty had, at

Table II. Results of conservative treatment (Group 1)

Case	Side	Range of flexion* on presentation (degrees)	Length of follow-up		Range of flexion at follow-up (degrees)	Comments
			y	m		
1	Right	0-120	17		0-120	No change
2	Left	0-120	—		—	Patellectomy at the age of 15 years for retropatellar pain
4	Left	0-100	14		0-120	Severe rectus femoris involvement at follow-up
4	Right	0-100	14		0-110	Severe rectus femoris involvement at follow-up
5	Right	0-130	12	2	0-130	No change
7	Right	0-130	7		0-130	No change
8	Left	0- 85	6	9	0- 65	Deterioration
9	Right	0-130	6	5	0-130	No change
11	Right	0-110	2	10	0- 90	Deterioration
13	Left	0- 90	2	6	0- 90	Late presentation, probable deterioration
13	Right	0- 80	2	6	0- 80	Late presentation, probable deterioration
15	Left	0-105	1	4	0- 45	Marked deterioration
15	Right	0-140	1	4	0- 90	Marked deterioration
16	Left	0-110	10		0-110	Deterioration

Table III. Results of treatment by distal quadricepsplasty (Group 2)

Case	Side	Range of flexion before operation (degrees)	Age at operation		Muscles involved	Length of follow-up		Range of flexion at follow-up (degrees)	Extension lag at follow-up (degrees)
			y	m		y	m		
1	Left	0-20	3		Rectus femoris, vastus lateralis	16		0-115	5
2	Right	0-10	2	8	Rectus femoris, vastus lateralis	16		0-140	5
3	Left	0-40	10		Rectus femoris, tensor fascia lata	14		0-110	0
3	Right	0-40	10		Rectus femoris, vastus lateralis	14		0- 90	0
6	Left	0-45	11		Vastus intermedius	8	10	0-140	10
6	Right	0-100	13		Rectus femoris	6	10	0-140	0
7	Left	0-30	1		Vastus intermedius, vastus lateralis	6	6	0-120	5
8	Right	0-10	3	5	Rectus femoris, vastus lateralis	6	3	0-125	20
9	Left	0-50	3		Rectus femoris, vastus intermedius, vastus lateralis	6	2	0-125	5
10	Right	0-15	2	8	Rectus femoris, vastus lateralis	5	10	0-120	20

Table IV. Results of treatment by proximal release (Group 3)

Case	Side	Range of flexion before operation (degrees)	Age at operation		Muscles involved	Length of follow-up		Range of flexion at follow-up (degrees)
			y	m		y	m	
5	Left	0-80	3	5	Vastus lateralis, tensor fascia lata	12	2	0-110
10	Left	0-20	8	4	Rectus femoris, vastus lateralis		5	0-110
12	Left	0-30	5	10	Rectus femoris, vastus lateralis	2	4	0-130
12	Right	0-30	6	4	Rectus femoris, vastus lateralis	1	5	0-125
14	Right	0-30	2	5	Vastus lateralis, tensor fascia lata	1	6	0-145
14	Left	0-30	2	6	Vastus intermedius, tensor fascia lata	1	5	0-120
16	Right	0-65	11	6	Rectus femoris, vastus lateralis	1	6	0-140
17	Left	0-90	7	5	Vastus lateralis, tensor fascia lata		2	0-130

* In all cases the amount of flexion was measured from full passive extension

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Secondary changes occurring as a result of contracture. Figure 5—Patella alta (Case 13). Figure 6—Elongation of the inferior pole of the patella (Case 3). Figure 7—Fragmentation of the inferior pole of the patella (Case 2). Figure 8—Hypoplastic patella with a small articular surface (Case 9).

follow-up, a significant increase (averaging 86.5°) in the range of flexion.

The most notable adverse finding was a persistent extension lag in seven of the 10 knees examined. This lag varied between 5° in four knees, 10° in one knee and 20° in two knees (Table III).

Group 3. The average follow-up was 2.6 years ranging from 2 months to 12 years 2 months. All eight contractures treated by proximal release had a marked increase in the range of flexion, which averaged 79.4° at follow-up. None of the knees demonstrated an extension lag (Table IV).

Involvement of the patellofemoral joint. One child (Case 2) with a conservatively treated contracture had a patellectomy for retropatellar pain at the age of 15 years. A second child complained of pain on patellofemoral

compression (Case 16). Patella alta was noted in three knees (Fig. 5), an elongated inferior pole of the patella in another three (Fig. 6) and fragmentation of the inferior pole of the patella in two (Fig. 7). There was clinical evidence of retropatellar crepitus in two knees; two others had hypoplastic patellae with small articular surfaces (Fig. 8), while the patellae in a further two had irregular surfaces.

DISCUSSION

Contracture of the quadriceps in childhood may be congenital or secondary to a variety of different causes. This study is concerned with contractures induced by injection, and presenting with progressive painless limitation of knee flexion. All the children had suffered a severe illness within the first few weeks of life for which

they had received intramuscular thigh injections. A thigh dimple (Lloyd-Roberts and Thomas 1964) was present in all patients.

The mechanism by which these injection-induced contractures develop is speculative. In infants the muscle mass is small and in this series, many of whom were born prematurely, it must have been even smaller. Compression of the muscle bundles and capillaries due to the volume of drug injected may result in significant muscle ischaemia (Gray 1967). Experimental trauma of a single intramuscular injection has been shown to produce disruption of the muscle fibres with local necrosis and subsequent muscle fibrosis (Engel 1967); the local toxicity of the drug also may play an important part (Chiu *et al.* 1974). It is of interest that the damage to muscle after injections presents in a different way from damage caused by vascular injury. Unlike the ellipsoidal forearm infarct described by Seddon (1972) where Volkmann's contracture is immediately apparent, after injection therapy there is considerable delay before contractures develop in the thigh. In our series the average age at presentation was 3 years 4 months.

Williams (1968) has suggested that the reason for the delay in development of the contracture may be related to unequal growth of muscle and bone. At first the healthy distal muscle fibres are able to compensate for the bone growth, and as a result the effect on the knee is not apparent for a number of years after injection treatment. Subsequently a point is reached when the healthy muscle can no longer lengthen in proportion to bone growth and the contracture becomes apparent.

This theory has not been fully substantiated by our findings. Only two of the contractures were diagnosed during a period of maximal growth, and neither those treated conservatively nor those treated operatively deteriorated during the adolescent growth spurt. One child (Case 6) first presented with bilateral contractures at the age of 10 years 7 months with a range of flexion in

the left knee of 0° to 90°. Within five months this had rapidly deteriorated to 0° to 45°. Differential growth between bone and muscle cannot alone account for the rapid deterioration in this patient's condition.

If contractures of this type are left untreated secondary changes may develop in the soft tissues, cartilage and bone of the neighbouring joint (Bose and Chong 1976). In our series three of the contractures were associated with patella alta, five with elongation or fragmentation of the inferior pole of the patella, and two with a hypoplastic patella. One child had a patellectomy for severe retropatellar pain. The relationship between habitual dislocation of the patella and quadriceps contracture is well recognised; significant involvement of the rectus femoris may produce a high-riding hypoplastic patella and varying degrees of genu recurvatum (Euliano 1970; Chiu *et al.* 1975).

Other authors have noted that distal quadriceps-plasty is often complicated by an extension lag. It has been suggested that this lag always resolves between 18 months and 3 years after operative treatment (Bose and Chong 1976; Alvarez *et al.* 1980). Our experience has been the opposite: 70% of the contractures treated by this method showed an extension lag after an average follow-up of 10 years. None of the eight contractures treated by proximal release had an extension lag at the time of review.

In conclusion, we believe that the surgical treatment of choice for injection-induced quadriceps contractures in children is a proximal release. The operation is performed at the site of the pathology and the procedure eliminates the complication of a persistent extension lag. Postoperative mobilisation is quicker and the high scar produces a more acceptable cosmetic result. A satisfactory range of flexion has been achieved in all our patients, though it must be conceded that the follow-up is short and the children have not yet been followed through the adolescent growth spurt.

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