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Departments of Thoracic and Cardiovascular Surgery and Orthopaedic Surgery, University Hospital, Uppsala, Sweden.

FUNCTIONAL STATUS OF THE LOWER EXTREMITY AFTER RESECTION OF FASCIA LATA

A Clinical and Physiological Follow-up Study in Patients with Fascia Lata Heart Valve Replacement

WIESLAW T. DUBIEL & ANDERS WIGREN

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Since Senning in 1962 introduced the fascia lata in aortic valve surgery (Senning 1966), the use of autologous fascia lata in replacing the heart valves has rapidly increased (Ionescu & Ross 1969, Edwards et al. 1969, Ross 1970, Dubiel et al. 1973 a, b).

Fascia lata resection for the construction of one or more valves constitutes an extensive intervention on the support fascia of the leg. What consequences can this have on the function of the leg? Does gait deterioration or other functional derangement occur in these patients and in that case how can it be prevented?

On the basis of these questions we have analysed the operative technique employed in the fascia lata resection, postoperative complications and late course in patients with fascia lata heart valve grafts. Moreover a follow-up study which included clinical investigation, gait test and an isometric muscle strength test has been performed on 39 patients over a period of 1–3½ years after the operation.

PATIENTS

During the period between Nov. 13, 1969 and June 7, 1972, 84 resections of fascia lata were performed on 83 patients at the Department of Thoracic and Cardiovascular Surgery, University Hospital, Uppsala.

The following analysis comprises the first 57 patients. Of these, 51 patients received ring-supported fascia lata graft implantation in the aortic ostium, four received a graft in the mitral ostium and 2 received a graft in both the aortic and mitral ostia (Dubiel et al. 1973). The patient material comprised 18 females and 39 males ranging from 17 to 63 years of age, with an average of 51 years.

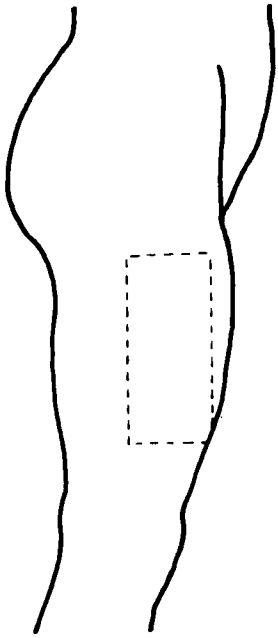

Figure 1. Illustration of the lateral contours of the operated leg. The rectangle indicates the location and the size of the resected fascia lata piece. Tractus ilio-tibialis is left intact.

A follow-up study 1–3½ years after the operation included 39 patients of whom 15 were females and 24 males.

METHODS

Technique of fascia lata resection

Under general anaesthesia resection of fascia lata was performed on the right thigh in 13 cases and on the left thigh in 44. The skin incision was approximately 25 to 30 cm long and stretched from approximately 15 to 20 cm below the spina iliaca anterior superior to about 10 cm above the upper margin of the patella. The resected fascia lata measured approximately 10×20 cm. The size of the fascia varied somewhat depending on the need as well as the quality. In all cases, the fascia was removed from the middle third of the thigh (Figure 1). Preference was given to fascia from the lateral side of the thigh where the fascia is of greater tensile strength and its consistency is firmer. After meticulous haemostasis and drain insertion, the wound was primarily sutured in the first 10 cases. This however, resulted in large haematomas following heparinization during the bypass period of the heart operation. Subsequently we have always packed the wound initially and delayed closure until completion of the heart operation and after giving protamine hydrochloride to neutralize the heparin effect. Suction drainage (— 10 to — 15 cm H_2O) was left for 18 to 36 hours after the operation. Simultaneously the thigh was bound with elastic bandages. It was then recommended that the patient should wear a support dressing on the thigh for approximately six months. A biopsy was taken from all the resections for a microscopic study.

Clinical study

All patients were investigated by each of the authors with regard to the condition and the function of the operated leg. An attempt was made to record any possible injuries or disorders of the leg prior to the resection. The leg was investigated with regard to the condition of the excised area, the appearance of the scar, possible neuroma formation and sensory disturbances. Special attention was paid to the presence of residual fascia lata defect and muscle herniation. Muscle strength in the thigh and knee joint was estimated and the range of movement of the hip, knee and ankle joints was recorded. A general neurological examination was performed. Possible deviations in gait pattern were also observed. Thereafter the results from each of the authors were assembled.

Physiological study

Gait pattern analysis. The gait pattern analysis was performed only on 12 males between the ages of 19 and 65 years, of whom seven were below the age of 50. Six of these patients had right-sided fascia lata resection and six had left-sided resection. Gait analysis was performed according to the method described by James & Öberg (1973). The measurements were made on a 20-meter long, level floor covered by paper. The patient wore specially constructed shoes that were available in all sizes. The shoes were supplied with two micro-switches, one placed back on the heel and the other on the tip of the sole. The switches were connected by long cables to an 8-channel electronic pen recorder (Elema-Schönander, Mingograph 81). Electric

Figure 2. Illustration of the typical appearance of the thigh after fascia lata resection. Proximal depression in the scar is probably caused by atrophy of the musculus tensor fasciae latae.

impulses representing the beginning and the end of the stance phase for each leg were recorded on millimeter paper running at a speed of 50 mm/s. While walking the heel prints of the patients were obtained with stamping ink. During 5 consecutive walking cycles and under steady state conditions, various walking components such as the duration of the stance and swing phase, stride length and stride width were recorded. The mean values of these 5 cycles were then calculated. From these parameters the walking speed and the step frequency were also calculated. The patients were encouraged to use their normal walking speed during the experiment. The material of Murray et al. (1966), which included 30 normal subjects was chosen as a reference. Nomenclature and definitions used correspond to those employed by Murray et al. (1966). Comparison was made with the non-operated leg.

Isometric muscle strength measurements. Measurement of the maximal isometric muscle strength of the leg was performed on 34 patients, of whom 13 were females and 21 males between the ages of 18 and 65 years, the average being 48.8 years with 16 patients below 50 years. The mechano-electric force transducers were used as dynamometers (Pressductor®, ASEA, Västerås, Sweden). The patients were investigated in a specially constructed chair on which dynamometers were mounted. The measuring impulses were recorded by a one-channel potentiometer recorder. For further details the reader is referred to Bäcklund & Nordgren (1968). Under standardized conditions measurement of isometric muscle strength was performed in the following manner: vertical pull downwards, vertical push upwards, hip flexion and extension, knee flexion and extension. The measured parameters of the operated leg were compared with those of the non-operated leg which served as a control. No attempt was made to compare the present patient material with a normal reference material. This is mainly due to the present patients' frequently long lasting heart diseases and old age. The majority of patients (53 per cent) were in their fifties and sixties.

RESULTS

Complications

Table 1 shows the postoperative and late complications in the leg where the fascia lata was resected. Postoperative haemorrhage from the thigh incision necessitating reoperation occurred in 4 cases. All these haemorrhages occurred in the first 21 patients of the series. Superficial thrombophlebitis in the lower leg of the operated extremity developed in one case subsequent to the operation, while in another it occurred two months after the operation.

Wound infection developed in 3 cases of which 2 had only mild infections, resulting in secondary healing within a period of 2 months. Patient A 10 had a generalized bleeding tendency which necessitated several reoperations of the thoracotomy and thigh wound. Infections of the thigh and sternotomy wounds, with growth of staph. albus and E. coli developed, together with an E. coli bacteremia. This patient

Table 1. Analysis of all complications following fascia lata resection in 57 patients who were subjected to implantation of fascia lata heart valves.

Case No.	Sex	Age	Diagnosis	Operated leg	Early complications (within 28 days)	Late complications
A 6	♀	54	AS	Right	Bleeding – Reoperation.	Superficial thrombophlebitis in the right leg.
A 10	♂	46	AI	Left	Bleeding – Reoperation Wound infection (Staph. albus, E. coli) Skin necrosis. Septicaemia.Death.	
A 13	♀	45	AI	Left	Bleeding – Reoperation.	
A 19	♂	27	AI	Left	Bleeding – Reoperation. Trivial wound infection. Prolonged wound healing	
A 22	♂	45	AI	Left	Superficial thrombophlebitis in the left leg	Meralgia paraesthetica – Exaeresis nerv. cutan. femoris lat. sin.
A 45	♂	39	AS–AI	Left	0	Exudate in the left knee-arthrocentesis 2 x
A 48	♀	48	AS	Right	Wound infection. Healed within 6 weeks.	

AS = Aortic stenosis.
AI = Aortic insufficiency.
AS–AI = Aortic stenosis and insufficiency.

developed a purulent mediastinitis and died of sepsis two months after the operation.

One patient had slight pains and paraesthesia surrounding the operation scar. This necessitated excision of the nervus cutaneus femoris lateralis, thus resulting in subsequent regression of the disorder.

Preoperative fascia lata biopsy

In 55 cases, the morphological picture was completely normal. A heavy collection of round cells was found in one case; however, neither rheumatic granuloma nor giant cells were detected. This change was

Table 2. The objective findings in patients with orthopaedic complaints,

Case No.	Sex	Age	Factors affecting the operated leg; not related to the resection of fascia lata	Present complaints	Fascial defect Large	Fascial defect Small
M 1	♀	59	Gonarthrosis before operation.	Numbness of the R. knee.	0	
A 6	♀	56	Sciatica dxtr. before operation.	Paraesthesia and weakness of knee extension.		+
A 14	♂	19	0	Weakness (slight).		+
A 20	♂	49	0	Weakness.	+	
A 22	♂	47	Claudicatio intermittens.	Pain on walking.		+
A 25	♂	44	Unspecified trauma in the operated leg in childhood. Actual X-ray 0.	Weakness of hip flexion and knee extension. Occasional pain on exertion.	+	
A 36	♀	62	0	Weakness of knee extension.		+
A 45	♂	40	Gonarthrosis before operation.	Weakness.	0	

difficult to interpret (non-specific inflammation?, clinical reaction after injection?). Partial fragmentation of the fascia with spaces between the collagen fibres has been found in another case, possibly due to oedema.

Clinical study

Disorders in the operated leg were reported by 8 patients. In Table 2 these disorders were analysed in relation to possible preoperative defects and to the objective findings. In 4 patients the disturbances were related to preoperative defects. One patient had a positive Babinski sign indicating central damage rather than an effect of fascia lata resection. Two patients had disturbances that were related to the fascia lata resection.

The period during which the patients wore a support dressing post-

together with possible relationship to the preoperative defects.

Muscle herniation		Clinical estimation of muscular strength	Neurological defect	Gait pattern	Isometric muscle strength as compared to the intact leg
At rest and during activity (large h.)	At rest only (small h.)				
	0	Normal	0	Normal	Equal
	0	Knee extension reduced	Pos. Lasègue sign (dxtr.)	Normal	Reduced 32 %
	+	Normal	0	Normal	Reduced 10 %
+		Normal	0	Normal	Reduced 20 %
	+	Normal	0	Normal	Reduced 42 %
+		Hip flexion and knee extension reduced	0	Normal	Reduced 14 %
	0	Knee extension reduced	Pos. Babinski sign	Normal	Reduced 11 %
	0	Normal	0	Normal	Reduced 12 %

operatively varied between 8 days and 1 year, although for the majority it was only 3 weeks (Figure 3).

Signs of secondary healing were detected in 8 patients. Symptoms of neuroma formations were not encountered. Movement restriction of the hip or the knee was not seen, neither was gait deviation observed in any of the patients. Table 3 presents certain objective findings in patients subjected to fascia lata resection. A permanent fascia deficiency comprising more than half of the resection area occurred in 5 cases and in all cases was closely related to muscle herniation which appeared not only during muscle relaxation but also during activity.

In 83 per cent of the cases with minor deficiency of the fascia lata small muscle herniation appeared. In 2 cases a decrease in muscle strength was noted during physical examination, which can be related to the fascia lata resection. A decrease in the strength of hip flexion and knee extension was found in one case, while in another only a

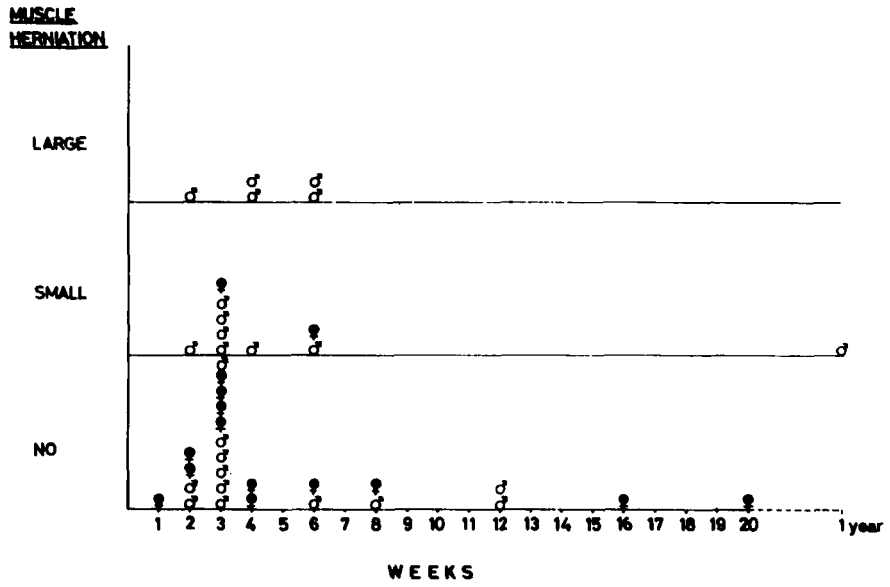

Figure 3. Illustration of the time during which the patients had worn a support dressing on the thigh and its relation to the possible emergence of muscle herniation. The sex of the patients is indicated by the symbols ♂ ♀.

decrease in the knee extension strength was detected. Two cases had apparent paraesthesia surrounding the operation scar and nine had non-disturbing paraesthesia. Minor neurological symptoms found in 2 cases were not related to the fascia lata resection.

Physiological study

Gait pattern analysis. Table 4 presents the mean values and range of walking speed, together with the duration of the walking cycle, step frequency, stride length and stride width found in 12 patients during the gait pattern analysis. The values given by Murray et al. (1966) were referred to for comparison. Those patients investigated had a normal gait pattern when compared with normal subjects.

In Table 5 mean values of the duration of the stance and swing phases are presented. The step length is given in centimetres and per cent of the stride. The values for each leg are presented separately and are further compared with the normal material of Murray et al. (1966). No deviation in the operated leg, compared with the non-operated leg, was observed, which means that a complete symmetry of gait, as in normal individuals, was present.

Table 3. The objective clinical findings in 39 patients after the fascia lata resection.

	Number of cases	Per cent
Fascial defect: Large*	5	13
Fascial defect: Small†	18	46
Muscle herniation: at rest and during activity	5	13
Muscle herniation: at rest only	15	38
Reduction of muscular strength: Knee extension	2 (2§)	5
Hip flexion	1	3
Paraesthesia:	11	28

* Large = Equal to or more than half the length of the skin scar.

† Small = Less than half the length of the skin scar.

§ Additionally 2 cases with objective signs not related to the resection of fascia lata: Case A 6 with sciatica on the operated side and case A 36 with residual symptoms of hemiplegia on the operated side.

Isometric muscle strength measurement. Values obtained from 34 patients are presented in Table 6. Muscle strength in hip flexion and knee extension in the operated leg show a probably significant decrease ($0.05 > P > 0.01$). The other muscle functions investigated here did not show any significant difference between the operated and non-operated leg.

Table 4. Gait variables in 12 males after the fascia lata resection and comparison with the respective variables found by Murray et al. (1966) in 30 normal subjects.

	Present material (no. = 12) Normal walking speed M Range	Material of Murray et al. (1966) (no. = 30) Normal walking speed M (SD)
Walking speed cm/s	123 94–169	151 (20)
Walking cycle s	1.21 1.06–1.44	1.06 (0.09)
Step frequency steps/min	99 84–114	113
Stride length cm	148.4 129–185	156 (13)
Stride width cm	9.6	7.7 (3.5)

Table 5. Walking cycle components and step length in 12 males after fascia lata resection and comparison with the respective variables found by Murray et al. (1966) in 30 normal subjects.

	Present material (no. = 12) Normal walking speed M		Material of Murray et al. (1966) (no. = 30) Normal walking speed M (SD)
	Intact leg	Operated leg	
Stance phase s	0.72	0.73	0.65 (0.07)
Per cent of cycle	60	60	61
Swing phase s	0.49	0.48	0.41 (0.04)
Per cent of cycle	40	40	39
Step length cm	74.4	74.0	78.0 (7)
Per cent of stride length	50	50	50

DISCUSSION

For a long time autologous fascia lata grafts have been used in various forms of reconstructive surgical intervention. As a rule only small parts of the fascia are resected. Thus little attention has been given to the possible local changes following fascia lata resection. Construction of heart valves requires a large amount of fascia. Thus in most cases, in order to obtain a fascia piece free from vascular perforations and other defects, the resected fascia must be 3–4 times larger than that required for the construction of a valve, normally 3×12 centimetres. Surplus fascia should be available for possible additional valves. Due to this, the fascia defect is always large primarily and the local operative intervention is rather extensive.

The early complication in this material was mostly haemorrhage with haematoma. In heart operations with extracorporal circulation, heparin is used. Thus in primary closure of the wound even meticulous haemostasis is not effective. Since attention was paid to the risks of haematoma, the operation techniques were modified and thereafter haematomas did not develop. The importance of preventing haematoma is illustrated by the case where haemorrhage and haematoma probably contributed to sepsis with a lethal outcome.

Superficial thrombophlebitis occurring in 2 cases had no definite relation to the resection, although a surgical intervention in the leg is in itself a contributing factor to the emergence of thrombosis and thrombophlebitis. Early physiotherapy is therefore important prophylactically.

Table 6. Isometric muscle strength in kiloponds in 35 patients after a one-sided fascia lata resection.

Tests	Intact leg M, Kp	Operated leg M, Kp	Difference M SD S.E.M P	Difference Per cent
Vertical pull downwards	39.9	38.8	−1.1 5.4 0.9 >0.05	−2.8
Vertical push upwards	18.9	17.9	−1.0 3.8 0.7 >0.05	−5.3
Hip flexion	40.6	37.6	−3.0 7.5 1.3 0.02*	−7.4
Hip extension	37.2	36.0	−1.3 4.5 0.8 >0.05	−3.5
Knee flexion	18.4	17.8	−0.7 3.5 0.6 >0.05	−3.8
Knee extension	48.8	45.6	−3.3 7.9 1.4 0.02*	−6.8

M = Arithmetic mean value.
S.D. = Standard deviation.
S.E.M. = Standard error of the mean.
X = $0.05 > P > 0.01$ (Probably significant).
XX = $0.01 > P > 0.001$ (Significant).
XXX = $0.001 > P$ (Highly significant).

Symptoms of meralgia paraesthetica were difficult to explain in terms of the fascia lata resection. It is possible that the peripheral branches of the nervus cutaneus femoris lateralis had been injured during the operation.

Table 7. Analysis of the results of the follow-up study of patients with complications following the fascia lata resection.

Case No.	Complaints	Clinical status	Gait pattern		Isometric muscle strength in comparison to the intact leg	Comments
			Clinical investigation	Physiological investigation		
A 6	Paraesthesia. Weakness of knee extension.	Small fascial defect. Reduced muscular strength of the knee extension.	Normal		Lowered 40 %	Sciatica dxtr. before operation. Positiv Lasègue sign.
A 13	Paraesthesia.	Small fascial defect.	Normal		Equal	
A 19	0	Small fascial defect.	Normal	Normal	Equal	
A 22	Intermittent pain in the calf.	Small fascial defect.	Normal		Lowered 42 %	Claudicatio intermittens.
A 45	Weakness of knee extension.	0	Normal		Lowered 12 %	Gonarthrosis before operation.
A 48	0	0	Normal		Equal	

During the follow-up study no definite consequences of the early complications were established (Table 7).

Two young males had complaints which were directly related to the operation in the extremity. Subjective muscle weakness during extension combined with slight pains was reported in one case. Defect of the fascia with muscle herniation was found in both cases. Clinically, the muscle strength decrease during knee extension and hip flexion was diagnosed in one of the two cases, while deterioration in the isometric muscle strength in hip flexion and knee extension occurred in both cases. This mainly affected the functions that are mediated by the fascia lata from the musculus tensor fasciae latae and the musculus gluteus maximus. Accentuation of disturbances related to preoperative defects might have occurred in some patients due to the fascia lata resection.

Muscle herniation found in half of the patients investigated had neither functional nor as a rule, cosmetic importance. Kleinschmidt (1914), Gratz (1937) and Foshee (1947) have found that fascia lata regenerates after the resection. Foshee is of the opinion that "herniation will be prevented by the newly formed regenerated fascia." He claims that herniation developing postoperatively disappears after approximately six months, when the regenerated fascia is fully developed.

In our material 50 per cent of the patients had muscle herniation—13 per cent had large herniation—observed after a period of 1–3½ years. After such a long period of observation, the muscle herniation should be considered as permanent. Of the 15 female patients only 2 had small muscle herniation (Figure 3). This is in contrast to Foshee's view that athletic individuals have better fascia regeneration. Possibly the consistent use of a support dressing on the thigh for a long time would diminish the number of muscle herniations in our material (Figure 3). Re-transplantation of surplus fascia, when possible, would be a further preventive measure, although not proven in this investigation.

Gait analysis, with recordings of various walking components, is a reproducible and objective method for revealing and analysing pathological deviations in gait pattern. This method has been used on 12 males of various ages. During the experimental conditions, i.e. level floor and self-selected walking speed, no deviations from normal walking have been detected. Thus the fascia resection does not seem to have affected the walking ability.

Due to rather large age differences and permanent heart disorders, the absolute values of the isometric muscle strength test showed both inter- and intra-individual variations. Therefore it has been of interest to compare the muscle strength of the operated leg with that of the non-operated leg. Variations were found even here i.e. both very low or rather high values for the operated leg were obtained. This was due to other defects such as osteoarthritis, vascular diseases, post embolisms and neurological disorders. On the whole, no significant decrease in the muscle strength was found other than in hip flexion and knee extension i.e. for functions mediated by fascia lata.

SUMMARY AND CONCLUSIONS

The effect of an extensive fascia lata resection on the function of the operated leg has been studied in 57 patients for whom fascia lata grafts have been used for heart valve replacement. A follow-up study of 39 patients 1–3½ years after the operation included a clinical investigation, isometric muscle strength test and a gait test.

1. An extensive fascia lata resection produces no serious functional disorders, except, possibly, in young active males.
2. The frequent occurrence of muscle herniation seems to have only a cosmetic interest. However it might be prevented by a long lasting consistent use of a support dressing on the thigh.
3. Meticulous operative technique, reopening of the wound following neutralization of heparin, suction drainage for at least 18 hours postoperatively and early physiotherapy are recommended.

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Correspondence to:

Dr. Wieslaw T. Dubiel
Department of Thoracic Surgery
University Hospital
Uppsala, Sweden