



Original article

Functional and socioprofessional outcome of surgery for Volkmann's contracture



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ABSTRACT

Objectives: Volkmann's ischemic contracture is rare and surgical treatment remains a challenge. The goal of treatment is to obtain permanent recovery of joint range of motion and strength. The goal of this study was to evaluate the functional and socioprofessional outcome of surgical treatment of Volkmann's ischemic contracture.

Methods: This retrospective study was performed in two centers with one surgeon. Seven patients were included; mean age 23.6 years old. The Quick-Dash score, Patient Rated Wrist Questionnaire (PRWE) scores were obtained. Grip strength was compared to the contralateral side. Satisfaction was evaluated by the question: would you have surgery again? The surgical technique included 7 muscle slide procedures.

Results: Wrist and finger range of motion was good at least 6.1 years in all cases according to the system by Buck-Gramcko. Grip strength on the operated side was 72.3% of the contralateral side. The mean PRWE was 14.64/100, mean QUICK-DASH score was 7.9/100. Patients returned to their professional activities in all cases. Patients who were questioned were all satisfied with surgery.

Conclusions: Once the contracture is established in Volkmann's contracture Page-Scaglietti-Gosset muscle slide procedure can be used with good results allowing a return to socioprofessional activities.

Level of evidence: IV, retrospective study.

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1. Introduction

Volkmann's ischemic contracture is defined by a group of clinical symptoms indicating ischemic contracture of a muscle compartment. It is secondary to compartment syndrome whose etiologies may be multifactorial [1]. The deep compartment is usually involved [2,3]. Volkmann's contracture has become rare and needs to be recognized. Volkmann's ischemic contracture is caused by the development of irreversible fibrosis and necrosis of muscle fibers. Fibrosis adheres to the peripheral structures and limits the function of intact musculotendinous units. In the upper extremity the clinical signs of Volkmann's contracture vary. In moderate forms of this disease it presents as a claw deformity of the fourth and fifth rays. In more severe forms the upper extremity presents with the elbow in flexion, pronation of the forearm, the wrist in flexion, metacarpophalangeal (MCP) extension, proximal interphalangeal (PIP) flexion of the long finger, and a thumb in fixed adduction to the palm [4].

In 1881, Richard von Volkmann [3] described the first cases of ischemic contracture called Volkmann's contracture. He identified them more frequently in the upper extremity.

The most frequently involved muscles are the flexor digitorum profundus and the flexor pollicis longus [1,2]. The median nerve, which is located in the center of this critical area, is often more severely injured than the ulnar nerve. If the extensors are involved, the deepest extensor is the most vulnerable. The predictive factors of necrosis are: the duration and extent of ischemia. In young patients, sequelae from Volkmann's ischemic contracture can result in decreased range of motion and strength.

The goal of treatment of Volkmann's contracture is permanent recovery of joint range of motion and function and a return to professional activities. Our goal was to evaluate the functional and socioprofessional outcome of surgery for Volkmann's ischemic contracture of the upper extremity.

2. Methods

This continuous, retrospective, single surgeon study was performed in two centers. All patients who underwent surgery for Volkmann's ischemic contracture of the upper extremity with a

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Table 1
Distribution of Volkmann's contracture.

Patients	Revision	Sex	Age (years)	TypeSundrararaj	Recurrence	Follow up(years)
1	No	F	27	Slight	No	16
2	No	M	41	Slight	No	18
3	No	M	23	Severe	Yes	1
4	Flexor release cal	M	13	Slight	No	1
5	No	F	13	Slight	No	5
6	Flexor release D3D4D5 and FUC	F	21	Slight	Yes	1.16
7	No	M	17	Slight	No	1

minimum postoperative follow-up of one year were included. Ten patients who had been operated for Volkmann's ischemic contracture since 1997 were contacted. Three patients were excluded because of other procedure that Page-Scaglietti-Gosset (flexor release, lengthening tenotomy, muscle slide with pronator tenotomy).

At least seven patients with Page-Scaglietti-Gosset desinsertion (PSG) were reevaluated at a follow-up consultation by a neutral observer (Table 1). The following preoperative data were obtained: profession (light or heavy manual labor or non-manual labor), dominant side, etiology, delay between the diagnosis and surgery and the presence of recurrence. The severity of injuries was classified into 3 stages according to Sundrararaj based on the severity of muscle contracture [5,22].

The surgical procedure [4] underwent forearm in supination with a tourniquet. A skin incision was made for three centimeter above the inner condyle on the line of the ulnar nerve to the inner side of the subcutaneous border of the ulna at the junction of the middle and the lower thirds of the forearm. The ulnar nerve is first isolated and transposed. All of the flexor groups of the forearm are systematically detached from their origin. Next, the aponeurosis on the ulnar side of the ulna is cut through in its whole length close to the bone. The muscle mass so loosened is raised with a raspator. Below the coronoid process any tendinous origin are divided. The insertion of the brachialis anticus being fully exposed. Lastly, the bicipital fascia is cut through if it appears to offer any opposition to the descent of the muscle group. The separation of muscles and fascia is carried out to such an extent with full correction of the contracture, apart from phalangeal joint deformities. The whole muscle group will be made to descend an inch or more from its origin.

Postoperative immobilization was a brachioantebrachiopalmar splint; wrist and finger at full extension for a month. The patients were regularly followed-up by the surgeon (every 3 months) until postoperative year 1 in the absence of any complications.

The final follow-up visit, performed by a neutral observer, was based on objective clinical results: motor and nerve sensitivity scores (Weber test) and subjective functional scores (Patient Rated Wrist Questionnaire or PRWE [6], Quick Disability of Arm-Shoulder-Hand or Quick-DASH [7] with professional and leisure activity sections). The clinical examination determined postoperative range of motion of the elbow, wrist and finger joints, the pulp-to-palm distance in centimeters and grip strength: grip strength was measured with the Jamar[®] dynamometer and pinch-grip strength (Pinch Gauge, Bailey, Laboratory, Lodi, Ohio, USA) in kg/F.

Wrist and finger joint range of motion were classified according to the system by Buck-Gramcko et al. [8]. Forearm flexor strength was evaluated according to the British Medical Research Council (BMRC) scale. Recovery of nerve sensitivity was evaluated by the Weber test: a two-point discrimination test to determine the presence of a protective reaction. This was considered to be abnormal above 5 mm.

Return to professional activities was reported. Patient satisfaction was evaluated by the question: would you undergo surgery again? If the response was positive the patient was considered to

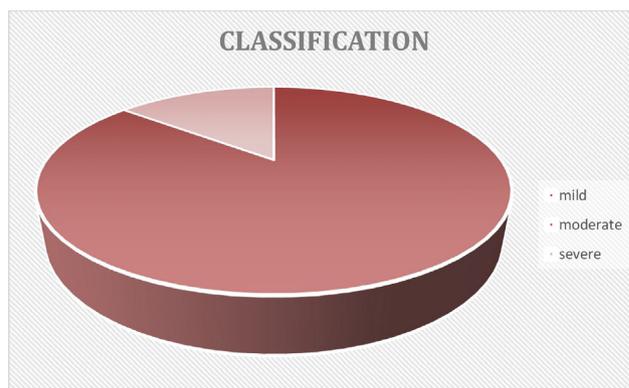


Fig. 1. Distribution of stages of contracture according to Sundrararaj.

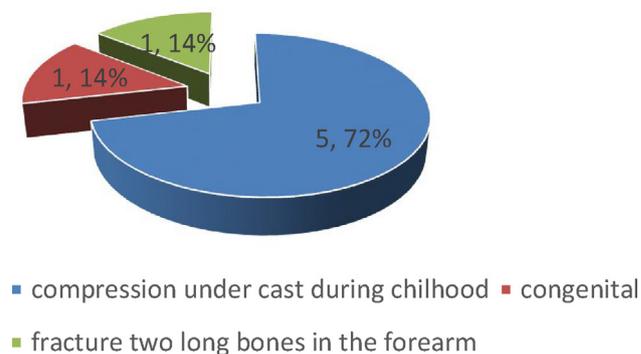


Fig. 2. Distribution of the etiology of Volkmann's contracture.

be satisfied with the intervention. If the response was negative the patient was asked to explain the reason for his/her dissatisfaction.

Results are expressed as means and standard deviations. Because of the absence of reliable preoperative data and of missing data, a comparative statistical test could not be performed. Analysis of range of motion and strength were compared to the contralateral side.

3. Results

This was a series of seven patients: four who underwent surgery in one center and three in the second center. Mean age at surgery was 23.6 years old SD 9.8 [13–41]. There were three women and four men. Patients were followed-up for a mean 6.1 years SD 7.5 years [1–18]. The mean delay between the diagnosis of acute compartment syndrome and surgical repair was 5.3 years SD 5.9 years [1.2–18]. The dominant limb was involved in half the population.

Most forms of the disease were mild (6 cases) Fig. 1. The etiology of Volkmann's contracture is presented in Fig. 2.

Diagnosis of compartment syndrome was made retrospectively in all patients.

Table 2

Functional outcome after Page-Scaglietti release.

Patient	Motion			Strength (kg comparative to other side)		Sensitivity recovery Weber test (millimeters)		Return to work		Functionnal scores	
	Wrist	Thumb	Long finger	Grasp	Pinch	Median	Ulnar		QUICK DASH/100	PRWE/100	
									Professionnal	Leisure	
1	Good	Good	Good	33%	28%	4	6	Yes light	6.3	6.3	21.5
2	Good	Good	Good	90%	87.5%	4	4	Yes heavy	0	6.3	2.5
3	Good	Good	Good	72%	81%	5	5	Yes heavy	3.6	0	17.9
4	Good	Good	Good	94%	100%	4	4	Yes light	0	31.3	2
5	Good	Good	Good	87%	70%	4	4	Yes non manual	0	12.5	15.5
6	Acceptable	Good	Good	59.1%	52%	4	6	Yes non manual	18.8	11.8	30
7	Good	Good	Good	71%	82.7%	4	4	Yes light	0	0	13.5

**Fig. 3.** Photographs of thumb to index pinch and grip one year after the page scaglietti gosset procedure.**Fig. 4.** Results one year after page scaglietti muscle slide procedure.

All patients returned to work: two heavy manual laborers to the same job, three light manual laborers, two non manual workers. Grasp strength on the operated side was 72.3% of the contralateral side [33–94%] (Table 2). Mean pinch grip strength in kilograms on the operated side was 71.6% of the contralateral side [28–100%]. The thumb to index pinch-grip was restored in all patients (Fig. 3). The ability to write, which is proof of a stable pollicidigital grip was preserved in all patients on the operated side when the dominant side was involved (Fig. 4). One patient changed sides although function of the extremity was generally satisfactory, for esthetic reasons.

Mean forearm flexor strength was 4.4 BMRC [3,4,9]. Elbow range of motion was functional in all sectors except for extension in one patient. Mean flexion, extension, pronation and supination was 141.7° [130–150], 3.3° [0–10°], 75.8 [60–80] and 72.5° [70–90] respectively.

Patients who were questioned were all satisfied with surgery.

The mean PRWE was 14.7/100 [2/100–30/100]. The mean QUICK-DASH score was 7.9/100 [0.8–28.4]. The mean scores in the professional and leisure sections were 4.1/100 [0–18.8] and 9.7/100 [0–31.3], respectively. There were two cases of early recurrence in our series. One following the PSG procedure in a patient with a severe form of disease. The second patient presented with recurrence 8 months after revision PSG for a mild contracture. For two patients the PSG procedure was an iterative surgery. The first procedure was a flexor release cal in the two cases. The first patient present a cal behind a forearm fracture during childhood. There was an early recurrence. In the second case, the spontaneous cal was completely removed during the first procedure. But an early recurrence, few months underwent.

4. Discussion

Volkman's contracture is now a rare disease. Most of the patients in published series are children (80%) [10]. The injury occurred during adolescence in 6/7 cases in our series. In the literature Volkman's contracture secondary to supracondylar fractures is found in 10.07%–60% of cases [5,10–12], and fractures of both the forearm bones in 54.6% of cases. Supracondylar fractures are associated with the most severe forms of the disease, which explains the low rate of severe contracture and the absence of bone repair or tendon transfers in our series. Nerve injuries were also minor, and did not require associated nerve repair.

One patient in our series presented with minor bilateral congenital Volkman's contracture which probably explains the delayed diagnosis and the absence of bone deformity as well as the good results in mobility and strength of the long fingers. Neonatal Volkman's contraction is rare, and is usually diagnosed at birth. The results of surgical treatment are poor with loss of grip strength and finger mobility [13,14]. Our results show that there is satisfactory overall recovery of function of the upper extremity, even with surgical revision.

Table 3
Results after Volkmann's contracture treatment.

Authors	Number of cases	Mean age (year)	Follow up (year)	Procedure	Results		Delay after injury months	Satisfaction	Recurrence
					Grip	ROM			
Ultee & al. 2005	24	13	10	Neurolysis tenolysis (2)	67%	Good	4	Good	No
				Tendon lengthening (8)	49%	Poor	74.2	Poor	All
				Tendon Transfer (3)	40.6%	Poor	17.6	Mild	No
				Tendon lengthening and bone resection (4)	40.5%	Poor	30.7	Poor	No
				Free microrvascular innervated muscle transfer (7)	26.8%	Good	37.7	Good	No
Parkes 1951	2	6.5	x	Transfer the extensor carpi radialis longus to the profundus tendons	x	poor	x	x	x
Nisbet 1952	1	12	0.5	Page Scaglietti procedure	x	good	6	Good	No
Page 1923	4	x	x		x	Good	44.2	Good	x
Griffart & al. 2017	7	23.6	6.1	Page Scaglietti procedure	72.3	Good	63.6	Good	No (5/7)

The different series in the literature [5,10,15] (Table 3) analyzing postoperative loss of strength suggest that there is loss in the operated side compared to the contralateral side during tenotomies, tendon transfers, and flexor disinsertion. Strength is preserved in free neurotized muscular transfers. Recovery of strength is gradual and late. Patient satisfaction is good even in case of amyotrophy of the forearm.

In one series of 25 patients [10] long term range of motion was good, however when growth was complete an arm length discrepancy was reported in certain cases. Although we did not observe any significant difference in forearm length in our study, surgery was performed after growth was complete in all cases.

The preoperative assessment by MRI made it possible to evaluate the muscles, to search for fibrosis, nodules and necrosis, as well as to plan the surgical procedure and estimate postoperative functional outcome.

No preoperative MRI's were performed in the series in the literature. Nevertheless, when available, this examination provides a topographic evaluation of the zones of muscle necrosis as well as the number of injured muscles and can help plan the surgical procedure.

The delay between injury and surgery does not seem to influence the results (a mean 5.3 years in our series) as long as preoperative muscle contractibility and the severity of injuries are determined.

The different studies in the literature evaluating nerve and muscle recovery agree that at least three months are necessary before any palliative surgery can be performed on muscles and six months on nerves [10–12,16,17].

There is muscle regeneration [9,18,23] following Volkmann's contracture even in cases with prolonged ischemia. In one non-operated patient (a five-year-old child) recovery began in the extensors after 50 days until intrinsic muscle recovery after 200 days and nerve recovery began after 140 days.

The two cases of recurrence in our series developed early, three months after surgery, because one patient failed to respect guidelines for immobilization. Revision surgery was performed in the second patient after two years due to recurrence of a mild case of Volkmann's contracture. A large fibromatous lesion was discovered during surgery in contact with the interosseous membrane. The claw hand deformity was completely reduced during surgery. The severity of the muscle lesions was probably underestimated.

Special attention should be paid to « pseudo Volkmann's contracture » [19–21]. This is characterized by tethering of the flexors to the fracture and later to the callus. There is nothing to indicate acute compartment syndrome. The claw deformity of the long fingers can be reduced and active flexion of the fingers is preserved. MRI is useful to confirm the diagnosis.

In the surgical treatment of Volkmann's contracture the Page-Scaglietti-Gosset muscle slide procedure is the reference technique. Results are good with a high level of satisfaction in patients, and recovery of day to day and professional activities even in cases of revision surgery. In our series there was no revision for contractures that developed during growth [11].

The Page-Scaglietti-Gosset procedure is indicated in young patients who want to rapidly recover durable strength and range of motion. A preoperative clinical evaluation can confirm that conditions are met to obtain satisfactory results: moderate to severe contracture without muscle necrosis and no severe nerve injuries. The PSG procedure should be performed long enough after injury to allow union of bone lesions, when growth is complete and the potential for muscle regeneration is optimized.

The prognosis is related to the severity of fibrous contractures and nerve paralysis.

Volkmann's contracture causes functional sequelae in young patients who wish to return to physical professional and leisure activities. Its incidence has decreased in the past few years as a result of emergency management of compartment syndrome.

The severity of these lesions has also improved, with mainly mild and moderate forms of the disease, simplifying treatment.

Compartment syndrome should be diagnosed and treated at the acute stage. However, when contracture is established, reliable surgical procedures are available such as the Page-Scaglietti-Gosset muscle slide technique. Clinical results are satisfactory with this procedure and long term recurrence is rare if management is adapted to the stage and severity of disease and patient management is global. Socioprofessional insertion and restoring overall function of the upper extremity should be a priority for these patients.

Disclosure of interest

The authors declare that they have no competing interest.

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Authors' contribution

AG and FM: data collection and writing of the article.

DLN: operator.

Other authors: data collection and writing participation.

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