



VOLKMANN'S ISCHEMIC CONTRACTURE; POST-CIRCUMFERENTIAL CONTRACTURE OF THE FOREARM

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ABSTRACT... Objective: To share our experience of post-circumferential Volkmann's Ischemic Contracture (VIC) of the forearm seen in our setup. **Design:** A descriptive case series study. **Setting:** National Orthopedic Hospital, Bahawalpur, Pakistan. **Period:** January 2005 to December 2013. **Methodology:** A total of 42 patients were registered during the study period. Patients with VIC of the forearm resulting from direct circumferential compression were included in the study. Patients who developed VIC of forearm indirectly secondary to arm pathology or other causes were excluded from the study. Assessment was made by detailed history, clinical examination and radiographs of the involved extremity. The age, sex, duration, side and type of contracture, length and width of forearm and resulting deformities were all documented on a detailed proforma. Patients were categorized into three types accordingly. **Results:** Forty two patients comprising 29 males and 13 females were seen. Their ages ranged from 1 to 53 years with mean age of 14.47 years. Duration of established VIC of the forearm after insult ranged from 3 months to 6 years with mean duration of 2 ½ years. Most frequent type of contracture was moderate variety seen in 19 patients (45.23%) with 14 cases on the right and 5 cases on left side followed by severe varieties which were present in 13 patients (31%) with 10 cases on the right and 3 cases on left side. Mild contractures were found in 10 patients (23.9%) with 6 cases on the right and 4 cases on left side. In 26 of 42 patients, a difference in forearm length that ranged from 79% to 94% (mean, 80%) was observed. Majority of cases (37 cases) of VIC occurred after TBS for radius and ulna fractures while in the remaining 5 cases, contractures of forearm occurred due to tight plaster of paris (POP) splint. **Conclusions:** Post-circumferential forearm contractures after Traditional Bone Setters (TBS) are common in our society. Community awareness through health education and conducting medical camps and seminars might play a role in decreasing the influence of TBS.

Key words: Volkmann's ischemic contracture, Compartment syndrome, Treatment

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INTRODUCTION

In 1881, Richard van Volkmann described Volkmann's Ischemic Contracture (VIC) resulting from muscle ischemia, necrosis, and subsequent contracture of the forearm¹. The basis for VIC is compartment syndrome that can develop from swelling of the muscles and soft tissues that are contained in a tight osteofacial compartment. Due to this swelling, intracompartmental pressure rises sufficiently to cause blockage of capillary perfusion². Muscle necrosis occurs after 4 hours of ischemia which is followed by fibroblastic

proliferation within the muscle infarct³. Necrosed muscle mass become fixed by adhering to surrounding structures thereby reducing their excursion and mobility⁴. Peripheral nerves are secondarily compressed by surrounding necrotic muscle mass. This neuropathy can also lead to chronic pain, paresthesias and loss of limb sensibility apart from motor paralysis⁵.

The most renowned classification is the one introduced by Seddon in 1964 and later on modified by Tsuge^{6,7}. In 1975, Holden classified

VIC of the limbs into two types. Type 1 involving a major artery, occurred proximal to the site at which ischemia subsequently developed (above the elbow). Type 2 where direct trauma to a limb and subsequent ischemia occurred at the same site (below the elbow)⁸.

The deformities of VIC in forearm and wrist consists of elbow flexion, forearm pronation and wrist flexion while those of the hand consists of thumb flexion and adduction, digital metacarpophalangeal (MCP) joint extension and interphalangeal (IP) joint flexion⁹. Neuropathy of median and ulnar nerves in association leads to intrinsic muscle weakness, thereby contributing to intrinsic-minus or claw hand deformity⁵.

In developing countries like Pakistan, the stereotyped Traditional Bone Settlers (TBS) commonly known as Kumar's, Dai's, Quacks, Siyana, Pahelwan, babas etc, continue to treat large numbers of population. The stereotyped traditional method of fracture fixation uses splints made from split bamboo or strips of wood / foot scales tightly bound around the acutely injured limb to immobilize the fracture¹⁰. The tight bound splints act as a tourniquet causing interruption of blood supply resulting in compartment syndrome leading to VIC¹¹.

PATIENTS AND METHODS

A descriptive case series study was carried out at National Orthopedic Hospital, Bahawalpur, Pakistan from January 2005 to December 2013. Patients were admitted through out-patient department and written informed consent was obtained from all individuals. Patients with VIC of the forearm resulting from direct circumferential compression were included in the study. Patients who developed VIC of forearm indirectly secondary to arm pathology or other causes were excluded from the study. Assessment was made by detailed history, clinical examination and radiographs of the involved extremity. The age, sex, duration, side and type of contracture, length and width of forearm and resulting deformities were all documented on a detailed proforma. Patients were categorized into three types

accordingly. A clinical photograph was taken. All patients were followed regularly for any complication or residual deformity.

RESULTS

A total of 42 patients were registered during the study period. There were 29 males (69.05%) and 13 females (30.95%). Their ages ranged from 1 to 53 years with mean age of 14.47 years. Duration of established VIC of the forearm after insult ranged from 3 months to 6 years with mean duration of 2 ½ years. Most frequent type of contracture was moderate variety seen in 19 patients (45.23%) with 14 cases on the right and 5 cases on left side followed by severe varieties which were present in 13 patients (31%) with 10 cases on the right and 3 cases on left side. Mild contractures were found in 10 patients (23.9%) with 6 cases on the right and 4 cases on left side. In the majority of the patients in whom the contracture developed during childhood, a difference in forearm length was observed. In 26 of 42 patients, a difference in forearm length that ranged from 79% to 94% (mean, 80%) was observed. Majority of cases (37 cases) of VIC occurred after TBS for radius and ulna fractures while in the remaining 5 cases, VIC of forearm occurred due to tight plaster of paris (POP) splint. The characteristic deformity of elbow flexion and forearm pronation with normal wrist and hand occurred in 10 patients (24%) while forearm pronation and wrist flexion with no elbow or hand involvement occurred in 17 patients (40%). Claw hand deformity with forearm pronation and wrist flexion occurred in the remaining 15 patients (36%). Our results and findings are given in the following tables and figures.

Severity of VIC	Total no. of cases (n=42)	Rt. Side of forearm involved	Lt. Side of forearm involved
Mild	10 (23.9%)	6 (60%)	4 (40%)
Moderate	19 (45.23%)	14 (74%)	5 (26%)
Severe	13 (31%)	10 (77%)	3 (23%)

Table-I. Distribution of VIC severity and their forearm side involvement

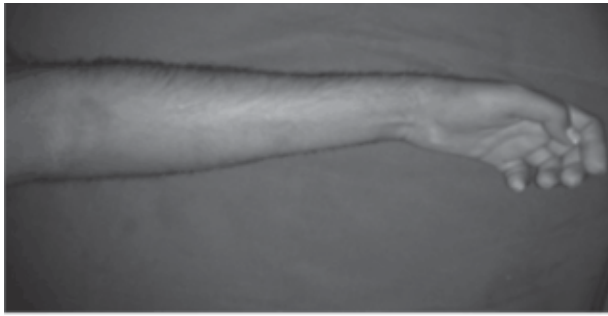


Fig-1. Mild type of VIC with mild wrist & finger flexion and pronation deformity of forearm

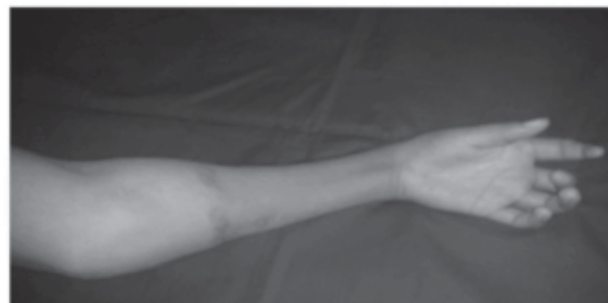


Fig-2. Moderate type of VIC with moderate degree of wrist & finger flexion, forearm pronation

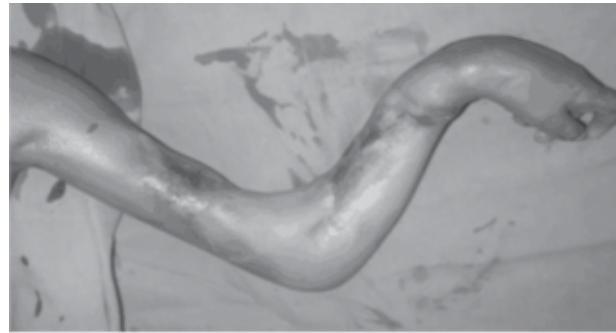


Fig-3. Severe type of VIC with elbow flexion, pronation of forearm & claw deformity

DISCUSSION

Richard von Volkmann in 1881 described the paralysis and contracture that results from the application of tight bandages to the injured extremity¹. Initially, the blame was laid upon the splints used to immobilize the fractures. Thomas, however, reported in 1909 Volkmann contracture in cases in which there had been no fracture or no splint had been used¹². Murphy (1914) and later on, Jepson (1926) demonstrated that early decompression of the limb would prevent the sequelae of paralysis and contracture^{13,14}.

We have realized now that ischemic contractures can develop from many different injuries causing swelling of the soft tissues that are contained in relatively tight osteofacial compartments. The compartmental pressure is elevated as a result of this swelling at a magnitude sufficient to occlude capillary perfusion². The compartments with the least possibility to expand are the most likely to sustain ischemic injury⁶. The intracompartmental pressure rarely exceeds 80 millimeters of mercury and is most commonly between 30 and 50 millimeters of mercury¹⁵. The duration of vessel occlusion is also very important. In 1977,

Whiteside's et al. demonstrated that six hours of tourniquet-induced ischemia in dogs produced markedly elevated intracompartmental pressure after removal of the tourniquet¹⁶.

Several authors have shown the potential risk of raised intra-compartmental pressure that may occur when a circumferential bandage is applied to a limb^{17,18}. By applying circumferential bandaging to a limb, raises intra-compartmental pressure and is a probable cause of prolonged elevation of intra-compartmental pressure. The pressure of a circumferential bandage on a limb is directly to the deep tissue in a 1:1 ratio, thereby raising the intra-compartmental pressure¹⁹. With complete arterial occlusion, either due to prolonged use of a tourniquet or tight circumferential bandages, necrosis and gangrene and not a compartment syndrome will result²⁰. This is true in all of our cases as the tight circumferential bandage was used to treat forearm bone fracture by the TBS for a prolonged time. This tight bandage had caused necrosis of overlying skin and underlying deep tissue resulting in VIC.

There is no specific classification to describe post-circumferential VIC of the forearm. In 1964, Seddon classified VIC into mild, moderate, and severe variety which is later on modified by Tsuge^{6,7}. In the mildest form, flexor digitorum profundus (FDP) to the ring and middle fingers undergoes necrosis and are involved. There is usually no sensory disturbance but, if present, it is slight. As shown in figure 1, there is mild flexion deformity of wrist and fingers due to involvement of deep flexors only in our patients. In moderate variety, FDP of all four digits as well as flexor digitorum superficialis (FDS) and pronator teres (PT) are affected. Neurologic signs are invariably present. These groups of patients in our series were having moderate flexion-pronation deformities of wrist and forearm and flexion of all the fingers as shown in figure 2. In severe cases, the digital and wrist flexors and extensors, as well as the compartments above the elbow may be involved. The neurologic signs are severe. In our series, these severe types had got the typical claw hand deformity due to involvement of all the soft

tissue as well as fixed bony deformities as also shown in figure 3. In 1975, Holden classified VIC of the limbs into two types⁸. Type 1 involving a major artery, occurred proximal to the site at which ischemia subsequently developed (above the elbow). Type 2 where direct trauma to a limb and subsequent ischemia occurred at the same site (below the elbow). We used the classification of Seddon and Tsuge as this is more practical in our case series and better describes the deformities.

The method for the management of fractures / dislocations used by the Traditional Bone Settlers (TBS) goes back to the ancient Chinese, Egyptian and Indian civilizations. Later, the Hippocrates (250 BC) introduced the concept of bandaging these fractured limbs²¹. These stereotyped traditional method fracture splint treatment is still being practiced extensively by the TBS in our country. The splints are made from split bamboo or strips of wood / foot scales and they tightly wrapped them around the acutely injured limb sparing joint above & joint below, to immobilize the fracture¹⁰. These splint if not removed in time (<48 hours), act as a tourniquet causing arterial and venous occlusion resulting in compartment syndrome with its permanent sequelae of Volkmann Ischemic Contracture¹¹. The more the splint remains there, the more severe will be the deformity. We came across mostly with moderate and severe types of deformities as these traditional splints were remained there for a significant period of time. Also, our patients were mostly from low socioeconomic status and were ignorant and illiterate. Our patients preferred this mode of treatment largely because of low cost and easy accessibility of these TBS in our society. These people have more faith in their local healers than in the qualified practitioner. Moreover, significant number of Kumhar's treated cases developed permanent deformities due to under or over reduction and mal-alignments of fractures, especially in epiphyseal injuries²¹.

Retardation of forearm growth was observed in those 26 patients of our series who developed Volkmann ischemic contractures during childhood. This difference in length of the forearm

and hand observed in our patients has been described previously in the literature²². These children with Volkmann's ischemic contractures and/or their parents should be informed about the possibility of having a length difference of the forearm. Most common cause for the development of a VIC of forearm is supracondylar fracture of the humerus followed by fractures of radius and ulna. These fractures must be carefully monitored to facilitate early diagnosis of vascular injury or compartment syndrome especially in children²³. In contrast, most of our cases of VIC occurred after fracture of forearm bones and these fractures were managed traditionally by the TBS. Only in few cases, VIC of the forearm occurred when these forearm fractures were managed in a tight plaster of paris splints by the inexperienced doctors and these splints remained there for a significant period of time.

CONCLUSIONS

Post-circumferential VIC of the forearm is very common in our society. The prevention of this form of iatrogenic disaster is by no means easy. Community awareness through health education and conducting medical camps and seminars might play a role in decreasing the influence of TBS. Additionally, the occurrence of VIC can be reduced by early detection and treatment of compartment syndromes. If symptoms of compartment syndrome are present, decompression should be done immediately to restore microcirculation.

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Waste no more time arguing about
what a good man should be.

Be one.

Marcus Aurelius

