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PDF issue: 2026-11-17

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(Citation)
Bulletin of allied medical sciences Kobe : BAMS (Kobe),10:37-44

(Issue Date)
1994-12-28

(Resource Type)
departmental bulletin paper

(Version)
Version of Record

(URL)
https://hdl.handle.net/20.500.14094/00423044

KOBE UNIVERSITY

Factors Affecting Development of Contracture in Hemiplegic Patients

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Although contracture development is a common and debilitating problem in hemiplegic patients, there is considerable controversy about its pathogenesis and appropriate treatment. The incidence of contracture occurrence as well as factors accecting its development were studied in 88 hemiplegic patients. As a result, the highest percentage of contracture occurred in the shoulder joint. The percentage of subjects with contracture tended to be greater in the upper extremities than in the lower extremities. Though immobility induced by loss of volitional movement is the most important causal factor in the development of the contracture, it was apparent that other factors such as spasticity, pain and joint edema presence play an important role in hemiplegic patients.

Key Words

Contracture development,
Pathogenesis,
Incidence,
Hemiplegia.

INTRODUCTION

The development of joint contractures is an undesirable complication and encountered in almost every clinical syndrome dealt with physical medicine and rehabilitation. Contractures produce deformity as well as pain in the joint and limit function (1-4), and they are a frequent and debilitating syndrome whose treatment remains a constant problem. Once contractures develop, they interfere with rehabilitation, especially progressive contractures in weight bearing joints contribute to the premature loss of ambulation, and decrease the overall quality of life of many patients, so that they are in poor spirits to cope with their disablement. Therefore, all clinicians responsible for the care of patients with neuromuscular disease should be aware of the incidence, type, location and severity of potential contractures.

Of the neuromuscular conditions, the hemiplegic is particularly susceptible to contracture, not only because of paralysis and immobility, but because the extremities may be drawn

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into an undesirable posture due to spasticity or the effects of gravity on a flaccid extremity. However, despite numerous hypotheses and studies, the mechanism underlying contractures in hemiplegic patients remain poorly understood. Moreover, systematic data on the incidence and location as well as factors affecting development of contractures derived from the hemiplegic patients have not been reported in detail previously.

The purpose of this study is to report the incidence and location of contractures, and to elucidate the factors affecting their development in the hemiplegic patients.

MATERIALS AND METHODS

Eighty-eight hemiplegic patients due to cerebral vascular accidents were studied. They consisted of 48 males and 40 females and their mean age was 62.5 ± 10.5 years. Thirty-seven patients were right hemiplegic, 46 were left hemiplegic and the rest 5 patients had hemiplegia on bilateral side.

All patients were assessed for contractures using standard goniometry. Measurements for contracture included all the joints of the extremities except for spines. Contracture was categorized into the mild, moderate and severe according to the severity of the restriction of mobility. Contracture as mild was defined as less than $\frac{1}{3}$ loss of normal range of motion, moderate as $\frac{1}{3} \sim \frac{2}{3}$ loss of normal range of motion, and severe as more than $\frac{2}{3}$ loss of normal range of motion. Data were collected from every joint motion and percentages of subjects with contractures for each joint were calculated based on the severity of the category of contracture mentioned above.

To clarify several determinants, which are considered intrapatient factors affecting contracture development, relationship between development of contractures and age of the patients as well as their hemiplegic side, and the duration from their onset were assessed by statistical maneuver using χ^2 Analysis ($P < 0.05$).

In adddition, χ^2 Analysis was also used to evaluated the significance of the difference between development of contractures and functional level of the hemiplegic hands, and between their development and ambulatory level, and between contracture development and existence of joint pain, edema and spasticity respectively as well.

Recognition of pain was made by patients' subjective complaints at rest or during movement. The presence of spasticity is assessed by the heightened activity of deep tendon reflex, clonus and an increased resistance to passive muscle stretch designated as the clasp-knife phenomenon.

The effects of therapeutic intervention in contracture development were not studied this time. Such a study would be difficult bacause therapeutic intervention could not be ethically withheld in this population.

RESULTS

1. The Incidence of Contracture Development at Each Joint

The incidence of contracture development at each joint are shown in Figure 1 by percentages. The high-

est total percentage of contracture occurred in the shoulder joint. Moreover, there was an apparent tendency in which the total number of contractures in the upper extremities was greater than in the lower extremity.

2. Analysis of Factors Affecting Development of Contracture

No significant relationship were found between contracture development and age of the patients as well as between its development and hemiplegic side. There was also no relationship between its development and the duration from their onset.

Table 1 shows the relationship between the total percentage of contractures from mild to severe degrees and functional level of the hemiplegic hand by joint: it is clear that the higher the functional level of the hemiplegic hand becomes, the lower the incidence of the contractures is. This suggests that the contracture development is definitely affected by severity of paralysis.

When contracture development is interpreted in relation to ambulatory function, it is clear that its development was more dominant in proportion to the severity of restriction to their daily activity (Table 2).

Table 3 through 5 also show the relationship between the total percentage of contractures from mild to severe degeree and factors considered affecting contracture development, namely: spasticity, pain and edema presence at joints in the upper and lower extremities.

In reviewing occurrence of contracture in association with whether pain, edema and spasticity are present, there were significant differences between contracture development and these 3 parameters respectively ($P < 0.05$).

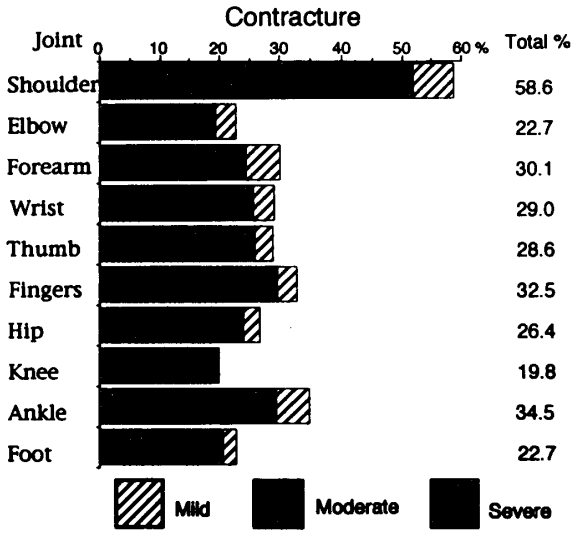


Figure 1. The Incidence of Contracture Development at Each Joint The incidence is shown by percentages. Severity of contractures are categorized into the following 3 groups: Mild: Less than $\frac{1}{3}$ loss of normal range of motion, Moderate: $\frac{1}{3} \sim \frac{2}{3}$ loss of normal range motion, and Severe: More than $\frac{2}{3}$ loss of normal range of motion.

DISCUSSION

The potential for complicating contractures is lessened because modern surgical techniques, medications and special emphasis to the care of the patients with chronic disease in rehabilitation medicine have shortened the period of immobilization in many cases, but the threat has not been eliminated. As a result of prolonged rest or immobility, the quality of patient's musculature and temperament may add a level of inactivity that was not anticipated. Nonvigorous persons are likely to develop contractures and

Table 1. Percenatges of Subjects with Contracture by Joints and Hemiplegic Hand Function as An Analyzing Determinant. Numbers shown in parentheses were calculated by the total number of subjects involved in all joint motions at each joint.

	Function of Hemiplegic Hand			
	Useful	Auxiliary	Useless	Total
Shoulder* (N=413)	2.0	10.7	45.5	58.2
Elbow (N=166)	0.0	3.0	19.9	22.9
Forearm* (N=166)	0.0	4.2	21.1	25.3
Wrist* (N=321)	0.0	5.6	24.0	29.6
Thumb* (N=160)	0.6	5.6	21.9	28.1
Fingers* (N=219)	0.0	5.9	26.9	32.8

show by percentages *P<0.05

deformities unless special precautions are taken.

It is now generally accepted that fixation of a joint with consequent immobilization of the related muscles is the basis for the development of all contractures encountered in clinical situation.

Woo et al (5) reported that following 8 weeks of joint immobilization, tissue resistance to stretch increased six times, and 50% of the increased resistance to stretch was within the muscle and skin. The increased tissue resistance is due to chemical changes and increased density of the connective tissue.

Akeson (6) and Booth (7) reported the physiologic and biomechanical results of immobility and contracture. Williams (8) also described that the reduction in mobility produced by contractures decreases the maximum tension generated by muscle and further decreases function.

Animal experiments have demonstrated that muscles immobilized in shortened positions have a 40% decerase in sarcomere number, a relative increase in connective tissue, and decreased rate of protein synthesis (9,10). The functional effects of these changes are increased atrophy and decreased muscular force production.

Management of paralysis also has been involved in the controversy as to prevent contracture development. As

Table 2. Percentge of Subjects with Contracture by Joints and Ambulatory Function as Analyzing Determinant. Numbers shown in parentheses were calculated by the total number of subjects involved in all joint motions at each joint.

	Ambulatory Function			
	Independent	Assisted	Dependent	Total
Hip* (N=431)	3.9	7.4	14.4	25.7
Knee* (N=165)	3.5	3.5	12.8	19.8
Ankle (N=168)	11.3	9.5	13.7	34.5
Foot* (N=321)	4.7	7.0	10.5	22.2

show by percentages *P<0.05

Pohl stated in care of poliomyelitis patients, the value of early passive exercise was implicit to prevent contracture (11). As for relationship between activity and contracture development, our present study also definitely supports how maintenance of the volitional movement effects on prevention of contractures in hands and legs, as shown in table 1 and 2. Table 2 shows contractures at foot, knee, or hip decrease the patients' ability to walk. Gait velocity is slowed and high energy cost are imposed by postural substitutiots required of adjacent segements (12).

However, at moment, there is no agreement as to the extent or duration of immobility which will lead to a myostatic contracture. Myostatic contracture is type of contracture which is dependent on the nervous system for its development, but which

Table 3. Percentges of Subjects with Contracture by Joints and Presence of Spasticity as An Analyzing Determinant. Numbers shown in parentheses were calculated by the total number of subjects involved in all joint motions at each joint.

	Spasticity		
	Absent	Present	Total
Shoulder* (N=413)	23.0	35.3	58.3
Elbow* (N=166)	7.2	13.9	21.1
Forearm* (N=170)	11.8	13.5	25.3
Wrist* (N=330)	10.3	17.0	27.3

show by percentages *P<0.05

Table 4. Percentge of Subjects with Contracture by Joints and Prepence of Pain An Analyzing Determinant. Numbers shown in parentheses were calculated by the total number of subjects involved in all joint motions at each joint.

	Pain		
	Absent	Present	Total
Shoulder* (N=427)	17.8	41.4	59.2
Elbow (N=169)	10.7	11.2	21.9
Forearm* (N=169)	10.1	14.8	25.9
Wrist* (N=332)	13.3	15.7	29.0
Thumb* (N=332)	13.4	15.7	29.1
Fingers* (N=222)	14.4	19.4	33.8

show by percentages *P<0.05

Table 5. Percentges of Subjects with Contracture by Joints and Presence of Edema as An Analyzing Determinant. Numbers shown in parentheses were calculated by the total number of subjects involved in all joint motions at each joint.

	Edema		
	Absent	Present	Total
Shoulder* (N=427)	26.5	32.1	58.6
Elbow (N=172)	12.2	11.4	23.6
Forearm* (N=172)	9.3	15.1	24.4
Wrist* (N=333)	12.3	17.1	29.4
Thumb* (N=335)	11.9	17.0	28.9
Fingers* (N=225)	14.2	18.2	32.4

show by percentages *P<0.05

is maintained independently of the nervous system once contracture is established (13). In other word, it is induced by nervous impulses resulting in unequal pulls upon the musculature of a joint. Thus the contracture seen in hemiplegia represents this type of contarcture.

In our study, a significant relationship was found between contracture development and presence of the spasticity. In the hemiplegic patients, under the strong pulling action of the spastic muscles, flexion contractures and internal rotation contractures are most common in the upper extremity while flexion contractures of the knee and extension contractures of the ankle are commonly seen in the lower extermity. Thus contractures patterns easily can be anticipated in the upper and lower extremities, especiallly in case of severe spasticity.

Spasticity is often associated with severe pain and becomes a major impediment to rehabilitation by interfering not only with activities of daily living, but also with skin care and decubitus management. Once severe spasticty develops, it will again develop contractures and worsen them by pain and other comlications.

According to Riemke (14), there are two types of contractures; functional and organic. The former he dected after 30 minutes of immobilization, and these were easily corrected by motor nerve section or under anaethesia. The latter developed in 2 or 3 days of immobilization and are true myostatic contractures.

However, clinical observation indicates that many patients with chronic neurologic disorders such as hemiplegia always do not develop myostatic contracture even after years of immobilization (15). Thus, it is apparent that, though immobilization is the most important causal factor in the

development of contracture, other factors must also play a role in neurologic disease.

The relation of pain to the development of contracture is undoubtedly an ancient clinical observation. Pain undoubtedly contributes to the processes which result in transfomation of a functional contracture into a myostatic contracture. Very few of the references reviewed make more than a cursory observation of this relationship (16,17). Pain contributes to the increased muscle tonus present in upper motor neuron disease. Pain act as a stimulus to increase spasticity as well. Our study also support this view as showing in Table 4.

Table 4 suggests that shoulder joint is the most susceptible to effects of pain. The presence of shoulder pain in hemiplegic patients varies, but has been found in 80% of patients in some investigators (18,19). Trauma, such as tear of the rotator cuff or the coracohumeral ligament or traction to the brachial plexus when subluxation is present, is often implicated in the etiology of the painful shoulder (20).

The tendency of joints to assume deforming postures is a natural physiologic reaction. Inflammation, trauma, and infection lead to joint swelling and increased pressure by exudates they induce. Experimental distension by intraarticular plasma infusion demonstrated that each joint has a posture of minimum pressure (21). 30°-45° flexion for the hip and knee, and 15° plantar flexion at the ankle. Clinical experience confirms that these are the postures spontaneously assumed by painful joint. Table 5 represents the relationship between percentage of contracture development and presence of edema in the upper extremity. It suggests that edema accelerates formation of contracures and this tendency may be dominant in small joints such as fingers.

As displaying Figure 1, shoulder shows the highest total percentage of contracture development in all joints. This implies that contracture development at shoulder should be considered as a complicated problem to manage and as associated with pain and other complications. If not treated appropriately, it may worsen and may be associated with shoulder and extermity pain, and interfere with functional activites accordingly.

Finally, appropriate management of contractures accompanying hemiplegic patients play a significant role in their rehabilitation. Results of the present study show evidence that immobility due to the hemiplegia and the undetermined contribution of factors such as loss of voluntary movement, persisting pain and spasticity as well as presence of edema are the underlying causes for the development of contractures in the hemiplegic patients, though it exact pathogenesis and even pathology is yet to be determined. Further work will be exhaustively necessary to explain not only pathogenesis and pathology, but also causal factors in development of contractures in the hemiplegic patients.

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