

A Dissertation on

CLINICAL PROFILE AND ECG CHANGES IN SCORPION ENVENOMATION

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CERTIFICATE

This is to certify that this dissertation in "**CLINICAL PROFILE AND ECG CHANGES IN SCORPION ENVENOMATION**" is a work done by **Dr.N.SHANMUGA PRIYA**, under my guidance during the academic year 2004-2007. This has been submitted in partial fulfillment of the award of M.D.Degree in General Medicine (Branch-I) by the Tamil Nadu Dr.M.G.R. Medical University, Chennai- 600 032.

**Prof.P.Thirumalai Kolundu
Subramanian, M.D.,**
Director, Prof. & Head.,
Institute of Internal Medicine,
Madras Medical College &
Govt. General Hospital
Chennai - 600 003.

The DEAN
Madras Medical College &
Govt. General Hospital
Chennai-600 003.

DECLARATION

I solemnly declare that this dissertation entitled "**CLINICAL PROFILE AND ECG CHANGES IN SCORPION ENVENOMATION**" was done by me at Madras Medical College and Government General Hospital during the academic year 2004-2007 under the guidance and supervision of **Prof.P.Thirumalai Kolundu Subramanian, M.D.**, This dissertation is submitted to the Tamil Nadu Dr.M.G.R. Medical University, towards the partial fulfillment of requirement for the award of M.D.Degree in General Medicine (Branch-I)

Place :

Date :

Dr.N.SHANMUGA PRIYA

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INTRODUCTION

Scorpion stings are a major public health problem in many underdeveloped countries. In India, many people are stung by the red scorpion (*Mesobuthus tamulus*) with fatalities in adults and children. Scorpion sting is a life threatening medical emergency of villagers in India.¹ Numerous envenomations are unreported. So true incidence is not known. Among the eighty six scorpion species in India, *Mesobuthus tamulus* and *Palamneus swammwe-dami* are of medical importance.²

Scorpions live in warm, dry regions throughout India. Scorpion stings are primarily due to accidental contact with scorpion. The scorpions use their stings only when roughly handled or trodded on. Scorpion does not always inject venom when it stings , thus the sting may be total, partial , or nonexistent. ³ Scorpions capable of inflicting fatal stings in humans are all members of the families *Buthus* and *Scorpionidae*. ² Fatalities due to sting by *Buthidae* have been reported from Chennai, Rayalaseema, Pondicherry and rural Maharashtra.^{4,5}

Scorpion venoms are species-specific complex mixtures of short neurotoxic⁶ proteins. The scorpion toxins target sodium, potassium, calcium and chloride channels causing direct effects and the release of neuro transmitters such as acetylcholine and catecholamine. Species difference, venom dose/weight relationship determine the toxicity and the clinical picture. In India

, Israel, Brazil and Mexico cardiac manifestations are common.⁷ Symptoms after scorpion sting progress to a maximal severity in about five hours and subside in a day or two. Alpha receptor stimulation by the toxin plays a major role, resulting in hypertension, tachycardia, myocardial dysfunction, pulmonary edema and cool extremities.⁸ Excess catecholamines cause accumulation of endothelins and vasoconstriction. Central nervous system manifestations are infrequently encountered in stings due to *Mesobuthus tamulus*. This is found to occur mainly in children

Symptoms vary depending on the species and geographical area. The most frequently encountered symptom is excruciating local pain. Early symptoms include vomiting, profuse sweating, piloerection, alternating brady and tachycardia, abdominal colic, diarrhoea, loss of sphincter control and priapism. Later severe life threatening cardio respiratory effect may appear: hypertension, shock and bradyarrhythmias, ECG changes and pulmonary edema with or without myocardial dysfunction.⁹

Literature on the manifestation of scorpion envenomation are lacking due to lacunae in reporting and there is no universally accepted protocol for the treatment of scorpion envenomation, although hospitals in Saudi Arabia follow a national protocol for the management of scorpion sting cases.¹⁰

OBJECTIVES OF THE STUDY

1. To study the clinical profile and electrocardiographic changes caused by scorpion envenomation.
2. To study the severity of scorpion envenomation.

REVIEW OF LITERATURE

EPIDEMIOLOGY

Scorpion sting is common and endemic in various regions of the world. Scorpion species of medical importance are encountered in India, Middle East, North Africa¹¹, Brazil ¹², Mexico, the Southern States of United States of America ^{13,14,15}, Central Africa, and South Africa¹⁶.

Because most envenomations occur in developing countries, where regular reporting systems are lacking, data on scorpion stings in several countries are based on estimates. High fatality rates were reported from scorpion envenomation in India, Saudi Arabia, Israel, Tunisia, Brazil & Mexico in the 1970s. In recent years there has been a marked reduction in mortality, owing to the improvement in supportive care and increased availability of antivenom therapy.

In Saudi Arabia, 2240 cases of scorpion sting were recorded in the Hail region, with an incidence of 18.7 per 1000 over a 15 month period¹⁰. The peak season for scorpion stings is June through September.

In Tunisia; almost 40,000 scorpion stings in humans are recorded annually, 1000 of them with systemic manifestation requiring hospitalization, about 100 patients die annually. In Mexico, it has been estimated that 400 to

1000 people die annually as a result of 100,000 to 200,000 scorpion stings. There were about 370 documented fatalities annually until the 1990's when immunotherapy was introduced. 15,687 exposures to scorpions have been reported to the American Association of poison control center's Toxic Exposure surveillance system – 508 involved moderate symptoms, 28 involved major symptoms and there were 2 fatalities.

CLASSIFICATION OF ARACHNIDS

Kingdom	:	Metazoa (Animals)
Phylum	:	Arthropoda
Subphylum	:	Chelicerata
Class	:	Arachnida
Order	:	Scorpiones
Superfamily	:	Buthoidea
Family	:	Buthidae
Genera	:	Mesobuthus

SCORPION – Habitat, Habits

Scorpions are arthropods with a hard exoskeleton, two anterior pinching claws and a tail. The poison gland and the stinger are located at the distal part

of the tail. Scorpions are nocturnal, preferring to hunt insects after sunset. During day eight hours they lie under rocks or logs.

Scorpions often sting human in the extremities, frequently after hiding in shoes or other clothing. children represent half of all envenomation. The scorpions sting when they are attacked or when their territory is trespassed. They seldom attack (sting) on their own without being attacked first.

Pathophysiology

Scorpion venom contains several distinct and pharmacologically active protein components. Venom from Buthidae act at ion channels on neurons, precipitating massive release of neurotransmitters ^(17,18,19,20,21). After envenomation by centruroides, significant parasympathetic stimulation may lead to contraction of visceral smooth muscle, resulting in clinical effects such as micturition, defecation and Priapism²¹. The yellow scorpion, *Leirus quinquestriatus*, found in middle eastern countries, and other members of the buthidae family found in India and other parts of the world are reported to cause the release of enormous amounts of catecholamines, precipitating a hyperadrenergic reaction characterized by hypertension, myocardial injury, dysrhythmias, pulmonary edema, severe hypertension and possibly death ^{21,22}. The North African genus *Androctonus*, one of the most venomous of that region, is often reported to cause death in infants and young children from a similar hyperadrenergic syndrome²³. Hypotension and shock often follow the

hyperadrenergic state and are thought to result from neuronal and adrenal catecholamine depletion²⁴.

Envenomation from *Tityus* (found throughout south America), *Leiurus*, and other Buthidae frequently cause pulmonary edema from both cardiac and noncardiac factors,^{23,24,25,26,27} proposed causes of the pulmonary edema include rapid increases in peripheral vascular resistance¹⁹, dysrhythmias¹⁸, and direct venom induced depressions in myocardial contractility^{24,26}.

Most scorpions found in United States cause little more than localized pain. *Centruroides exilicauda* venom, however contains at least two types of neurotoxins, differentiated by their effects on axonal membranes²⁸. The first group maintains the sodium channel in a ion-conducting state by causing incomplete sodium channel inactivation during depolarisation²⁹. The effects of these toxins, sometimes referred to as “stabilizers”, is widening of the action potential²⁹. The second group of neurotoxins initiates a slowly developing inward sodium current after membrane depolarization. together, these toxins widen the action potential and enhance membrane depolarization, causing repetitive firing of axons²⁸. All excitable membranes using sodium channels and undergoing depolarization are susceptible to this toxic effect.

Some scorpion species may cause other specific organ damage after envenomation. *Tityus trinitatis*, found in Trinidad and Venezuela, is reported to cause acute pancreatitis in up to 60 percent of victims²¹. Tissue destruction,

notably absent from most scorpion stings owing to a lack of proteolytic enzymes, can be produced along with bleeding disorders and hemolysis by *Hemiscorpius lepturus* and related species found¹⁹ in the middle east²¹.

The symptom complex of Scorpion envenomation includes sympathetic and parasympathetic stimulation. The non specific signs of tachycardia, tachypnoea, hypothermia, or hyperthermia, and leucocytosis are explained by cytokine release (Particularly interleukin-6 and interleukin-1)³³ and increased autonomic neurotransmission. The mechanism of cardio toxicity in scorpion envenomation is multifactorial : catecholamine over stimulation causing hypertension and a transient phase of increased contractility. There is a diminished systolic performance in addition to the catecholamine effect. The combination of myocardial ischemia , excessive catecholamine effect, cardiac arrhythmia, and increased oxygen demand may result in acute myocardial ischemia and infarction.

Respiratory failure, caused by pulmonary edema, is a common complication of severe scorpion envenomation. The latter is thought to occur as a result of increased vascular permeability induced by release of vasoactive substances³⁴. Central nervous system involvement is more frequent in children with severe envenomation. In the case of *L. quinquestriatus* sting, central nervous system symptoms are explained partially on the basis of hypertension, causing hypertensive encephalopathy and may respond to antihypertensive

therapy¹⁶. Central nervous system manifestations, such as agitation, hyperthesmia, hypertonus, seizures, and coma^{10,34} also occur, however, in the presence of normal blood pressure suggesting a more direct central mechanism of toxicity³⁴. Intra ventricular injection of extremely small doses of toxic *L. quinquestriatus* venom to rabbits (1/500 to 1/100 of the intravenous lethal dose) caused complex neurotoxicity.³⁴ Some scorpions, such as the *Centruroides sculpturatus* of the southern United States, exert neurotoxicity without cardiotoxicity.

CLINICAL MANIFESTATIONS

The severity of scorpion envenomation varies with the scorpion's species, age, and size and is much greater in children. Clinical severity ranges from local pain to fatal cardiotoxicity and encephalopathy.

In most cases, adults stung by scorpions experience only local symptoms and signs consisting of pain, erythema, pruritus, edema, and parasthesias³⁰. Parasthesias and localized percussion tenderness at the sting site are common.^{16,30,35} Parasthesias occasionally involving the extremities and peri-oral area also occur.³⁵ Local necrosis of any degree is rare and has been documented only from stings of *Hemiscorpius lepturus* in Iran³⁶.

Systemic intoxication reflects stimulation or depression of the central nervous system and stimulation of the sympathetic, Parasympathetic, and

skeletal motor nervous systems, skeletal motor hyperactivity, gastric and pancreatic hyper secretion, and occasionally bradycardia ^{13,32} Salivation, abdominal pain ,nausea, vomiting are common and can be attributed to stimulation of salivary glands and to pancreatitis. ²⁵

“Scorpion sting syndrome” was defined by Neale⁴² to be “the varied manifestations of presumed Scorpion envenomation”. The typical case can be described as: local pain, occasionally with proximal radiation, often with tenderness, swelling and redness at the site of envenomation. This may be followed by the onset of systemic symptoms, which most commonly include hypertension and / or tachycardia, often with nausea and epigastric discomfort.

In the cardiac vascular system, the increased sympathetic tone prevails, as reflected by the high incidence of tachycardia and hypertension (72% and 58%) and the much lower incidence of bradycardia and hypotension (14% and 5%) in victims of scorpion envenomation. ¹³ In a report of 386 children with scorpion stings from Saudi Arabia, tachycardia occurred in 32% of children and bradycardia in 0.77%.

Symptoms of envenomation due to sting by *C. Sculpturatus*, a predominantly neurotoxic scorpion in 151 patients were, in decreasing of frequency : restlessness, nystagmus, parasthesia, hypersalivation, fasciculation, blurred vision, difficulty in swallowing, local pain and slurred speech.¹⁵ In the United States a clinical gradation has been suggested for scorpion

envenomation from this species. Four grades range from local pain or parasthesias or both at the site of sting (grade I) to involvement of cranial nerves and somatic skeletal neuromuscular dysfunction (grade IV) ¹⁴. Likewise, a grading system is used for scorpion envenomation in Tunisia. Using this grading system in one series, these were 102 patients with grade 1, consisting of local signs along; moderate general symptoms; and 26 patients with grade 3, consisting of severe symptoms ¹¹.

Grades of envenomation

Grade	Clinical characteristics
1	Pain or parasthesias or both, limited to sting site
2.	Pain or parasthesias or both, remote from sting site
3.	Signs of cranial nerve or neuromuscular abnormalities
4.	Signs of cranial nerve and neuromuscular abnormalities

Envenomations by the main venomous scorpion species in North Africa and the Middle East (*L. quinquestriatus* and *Androctonus crassicauda*) and India (*Mesobuthus tamulus*) has a similar clinical course. Symptoms of mild envenomation are agitation, tachycardia, and sweating. In more severe cases, particularly in young children, additional symptoms include vomiting, abdominal pain, salivation, dehydration priapism, extreme agitation, generalized erythema, muscle rigidity and twitching, tremors, seizures, coma, pupillary changes, hyperthermia, hypertension (less of then hypotension)

cardiac and respiratory failure, and death. Idiopathic dilated cardiomyopathy was found to be eight times more frequent in patients with a past history of scorpion sting in India, despite their apparently complete recovery from the acute envenomation.⁴³

Studies have shown that if severe toxicity occurs it usually does so within 6 hrs of envenomation¹⁴.

Scorpion envenomation by species, Regions and characteristic toxicity.

Scorpion species	Geographic region	Cardioto -xicity	Neuroto- xicity	Ref:
Mesobuthus tamulus(Indian red scorpion)	India	+++	++	7,40,41, 43,44
Leiurus quinquestriatus Androctonus crassicauda	middle east	+++	++	18,32,34, 35,37
A.Crassicanda, A. austrails, A. Bicolor	N. Africa and Middle East	+++	++	15
Tityus Serrulatus	Brazil	+++	++	12
Centruroides Suffusus	Mexico	+	++	45
C. Sculpturatus	U.S. (South)	-	++	13,14,37
Parabuthus transvaalicus , P. Granulatus	Central and South Africa	+	++	16

MANAGEMENT

Diagnosis and Laboratory findings

The diagnosis of scorpion envenomation is made by the characteristic clinical presentation of the patient in an area where scorpions are endemic. Occasionally the scorpion is seen, or the sting may be witnessed.

Laboratory abnormalities have been reported mainly from scorpion stings from Middle East, North Africa and India. Hyperglycemia and leucocytosis are nonspecific but common^{9,12}. Cardiac ischemia is expressed in transient elevation of cardiac enzymes³⁴ and electrocardiogram with depressed or elevated ST segment, Q waves in leads I and avL, Prolonged QTc interval and peaked T wave³⁴. Cardiac dysfunction is evidenced by echocardiography as diminished global wall motion with decreased systolic left ventricular performance and diminished ejection fraction. Left ventricular dysfunction also has been shown by cardiac radionuclide scan.³⁸ Transient elevation of pancreatic enzymes has been reported³⁹.

TREATMENT

Proper general management measures are subject to controversy and not substantiated by adequate research to date.

1. Move the victim to a medical facility as soon as possible.

2. Apply ice at the sting site, which may slow venom absorption and relieve pain¹⁴.
3. Apply a light constricting band just proximal to the sting site to prevent lymphatic spread of the venom. This should be removed under observation when the victim has arrived at a medical facility. Several reports emphasize the critical effect on the outcome of delay in time of arrival of the victim to a medical facility³⁴, this is explained by rapid spread of venom. Increased venom concentration at the sting site should not be a problem because local necrosis is extremely rare with scorpion stings.

In most cases, adults sting by scorpions do not develop systemic envenomation. Close observation for 2-6 hrs is sufficient in these cases. Analgesics may be used for pain relief, and local application of lidocaine may be helpful. In endemic regions for cardiotoxic scorpions like India, an electrocardiogram should be performed.

In cases of systemic envenomation, the principles of management are observation, cardiac monitoring, supportive treatment with intravenous fluids and electrolytes, sedatives, and analgesics, and cautious use of cardiovascular agents including vasodilators adrenergic antagonists, or calcium channel blockers, in the hypertensive phase. Sofer and colleagues advocated the use of hydralazine and nifedipine. Bawaskan and Bawaskar⁴⁰ found prazosin to be

safer and more effective than nifedipine in patients with hypertension and tachycardia from scorpion sting. In a controlled study, these authors reported lower complication rates in patients treated with prazosin compared with patients treated with nifedipine or supportive care alone. (Fatality rates of 35% and 25% respectively)⁴¹.

Elatrous and coworkers from Tunisia reported the efficacy of Dobutamine infusion at 7 to 20 mg / kg / min in 19 patients with severe scorpion envenomation and acute pulmonary edema of whom 10 also had severe hypotension. In these patients, cardiac output, blood pressure, tissue oxygenation, and clinical outcome improved significantly, but there were two fatalities³⁹. Anti arrhythmics, such as lidocaine, may be required³⁴.

Use of sedatives to reduce anxiety and agitation has an important role in the treatment of symptomatic patients. Rimsza and colleagues¹³ reported that phenobarbital was the most commonly used medication in a series of 24 children with scorpion envenomation in Arizona.¹³ BZD have replaced them as drug of choice. Steroids have no role in the treatment of scorpion envenomation.

Antivenom Therapy : ^{12,14,15,16,34}

Specific antivenom therapy has been used for several decades. Numerous reports exist on the clinical use of specific antivenom preparation

from seven geographic regions. Because of ethical consideration most are retrospective, observational or historical controls. There are only a few prospective, randomized control trials.

Ismail ¹⁷ from Saudi Arabia reported data on 24,000 patients with scorpion envenomation treated by a National Protocol. Thousands of these patients were treated with antivenom with a reduction in the fatality rate from 4% to 6.8% to less than 0.005%.

Several reported from Mexico claimed a reduction in mortality from several hundred to zero. In a study from Arizona of 116 patients, mostly children, who received Centruroides antivenom, only 4 developed mild, self limited, immediate reactions. 60% developed some form of serum sickness, which responded to oral steroids, anti histaminics or both. Important features regarding optimal use of antivenom that can be inferred from literature are :

1. Because of regional variations in Scorpion species and specific antivenom preparation, always obtain the advice of local experts.
2. Reserve antivenom preparation for patients with significant toxicity
3. In the event of hypersensitivity decrease the rate & add anti histaminics, continue cautiously.

There is no antivenom for *Mesobuthus tamulus* available in India.

MATERIALS AND METHODS

SETTING

This study was carried out in the toxicology ward of Madras Medical College and Government General Hospital, Chennai.

This study was done with the collaboration of the Department of Biochemistry, G.G.H.

Design of study

This is a single centre prospective study.

Period of Study

This study was carried out in G.G.H from July 2005 to September 2006.

Consent

Informed consent was obtained in all cases.

Sample Size

All the patients admitted to the toxicology ward with scorpion envenomation during the study period were included in the study. A total number of 53 cases of scorpion envenomation were included in the study.

20 healthy patients from the out patient department of Government General Hospital , Chennai were taken as controls.

Selection of Study Materials

The patients admitted to the toxicology ward of G.G.H , Chennai who fitted the inclusion criteria were taken as study subjects.

Selection of Controls

The patients who attended the general health check up of the out patient department of the G.G.H and were healthy were taken as control subjects.

Inclusion Criteria

All patients who were admitted with scorpion sting in the toxicology ward during the study period .

Exclusion Criteria

1. The patients with doubtful scorpion bite [by history] were excluded from the study.
2. The patients who had history of diabetes were excluded.
3. The patients who had history of recent myocardial infarction were excluded in the study.

DETAILS OF STUDY SUBJECTS AND CONTROLS:

A detailed history was obtained from the patients admitted for scorpion envenomation and the following findings were recorded in the proforma-1.time of envenomation, 2.nature of the incident, 3.description of the scorpion, 4.local and systemic symptoms,5.number of stings,6.site of envenomation.

The cases of scorpion envenomation and controls were subjected to clinical examination, complete blood count. Blood urea, blood glucose, serum creatinine, serum creatinine kinase, serum creatinine kinase-MB were measured . The routine investigations were repeated twenty-four hours after admission for the study subjects. Chest X-ray and electrocardiogram were taken for both study and controls. The serial electrocardiogram was taken for the study subjects at twelve hours and twenty –four hours after admission. The study and control subjects also underwent echocardiography .

The victims of scorpion envenomation were evaluated and graded according to the severity of envenomation.[grading was done according to the grade used in the study in Saudi Arabia by Ken Dittrich et al, Scorpion sting syndrome- a ten year experience,1995.modified from Curry S.C. et al. envenomation by the Scorpion *Centruroides Sculpturatus*. J Toxicol – Clin Toxicol 1983-84;21(4&5):417-419.].

Grade	Description
1	Local pain and/or erythema and/or parasthesia at site of envenomation.
2	Pain and/or parasthesia remote from the site of the sting and/or tachycardia and mild hypertension in addition to local findings.
3	Cranial nerve or somatic skeletal neuromuscular dysfunction or cardiovascular dysfunction.[moderate to severe hypertension , dysrhythmias, myocardial ischemia, pulmonary edema]
4	Any combination of cranial nerve dysfunction, somatic skeletal neuromuscular dysfunction or cardiovascular dysfunction.

DETAILS OF MATERIALS

The complete blood count, serum CK, serum CK-MB, routine biochemical analysis was done using semi- auto analyser.

TEST	Reagent type	Reagent/litre	Serum/litre	machine
CK	CK reagent	500micro U	10micro U	ERBA
CKMB	CKMB reagent	500micro U	25micro U	ERBA

LIMITATIONS

The electrocardiogram and echocardiography could not be repeated after 2 weeks owing to technical difficulties.

STATISTICAL ANALYSIS

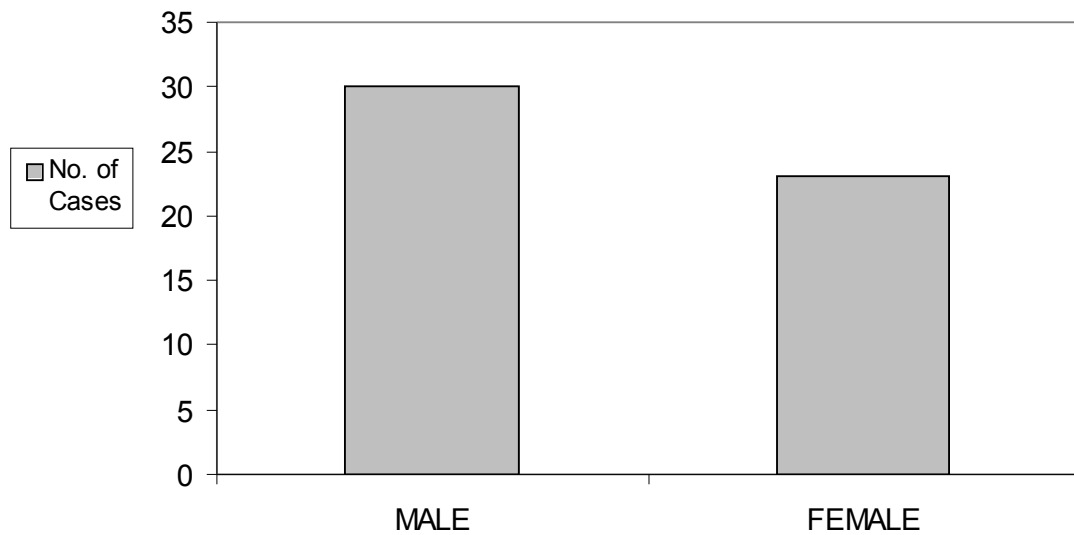
Data obtained from the records of the study were analysed with SPSS software, using analysis of Pearson's chi-square method and student t-test.

RESULTS

1. Distribution of scorpion sting cases according to patient's gender:

Patient's gender	Number of patients(n=53)	Percentage (%)
Male	30	56.6
Female	23	43.4

GENDER DISTRIBUTION IN SCORPION STING



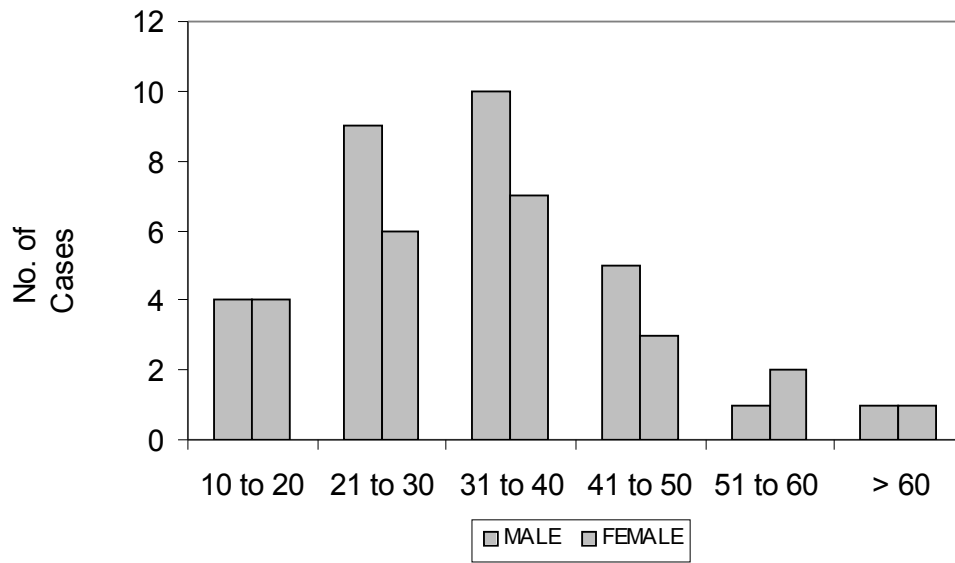
2. Distribution of scorpion envenomation cases according to age:

Age group(yrs)	Number(n=53)	Percentage (%)
11-20	8	15.09
21-30	15	28.3
31-40	17	32.07
41-50	8	15.09
51-60	3	5.6
>60	2	3.7

3. Distribution of cases according to patient's gender within the age group:

Age group (yrs)	Number (n=53)	Male(n=30)	Female(n=23)
11-20	8	4	4
21-30	15	9	6
31-40	17	10	7
41-50	8	5	3
51-60	3	1	2
>60	2	1	1

AGE DISTRIBUTION IN SCORPION STING



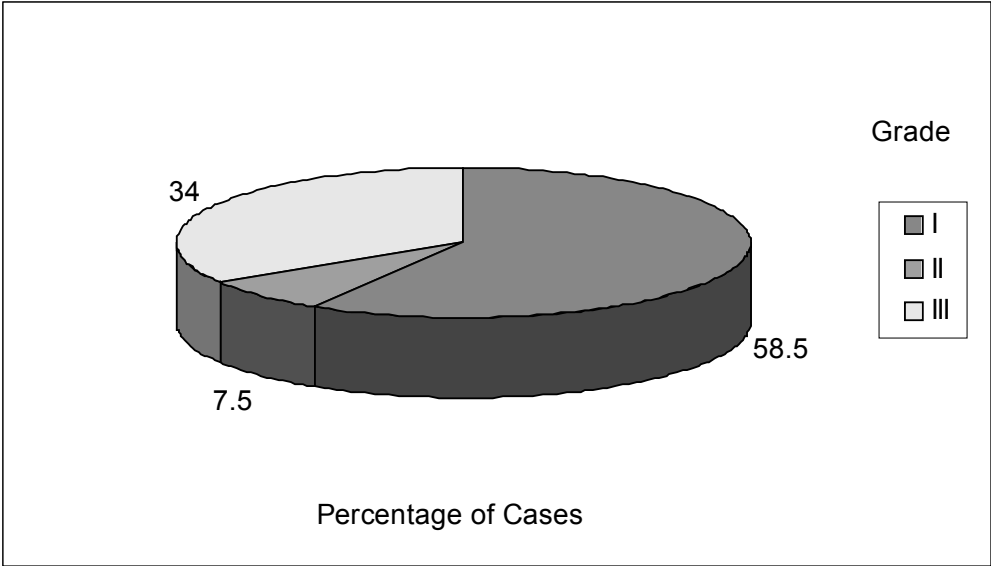
4. Distribution of cases according to the time of admission:

Time(hrs)	Number(n=53)	Percentage (%)
18.00-6.00	28	52.8
6.01-17.59	25	47.2

5. Distribution of cases according to severity:

Grade	Male	Female
1	14 45.2%	17 54.8%
2	3 75%	1 25%
3	13 72.2%	5 27.8%

PERCENTAGE DISTRIBUTION BY GRADE



6. Distribution according to severity by age group

Grade	<25 yrs	26-40 yrs	>40 yrs
1	8 25.8%	17 54.8%	6 19.4%
2		3 75%	1 25%
3	6 33.3%	5 27.8%	7 38.9%

7. Frequency distribution of symptoms

Symptoms	Number of patients	Percentage (%)
1.Local pain	44	83.02
2.Local swelling	23	43.40
3.Parasthesis	22	41.51
4.Chest Pain	3	5.66
5.Sweating	4	7.55
6.Palpitations	4	7.55
7.Breathlessness	5	9.43
8.Giddiness	4	7.55
9.Redness at sting site	20	37.74
10.Vomiting	2	3.77

8. Frequency distribution of signs in Scorpion envenomated cases:

Signs	Number of patients	Percentage (%)
1.Tachycardia	10	18.87
2.Hypotension	6	11.32
3.Hypertension	6	11.32
4.Profuse sweating	3	5.66
5.Cold peripheries	4	7.55
6.Tenderness at sting site	16	30.19
7.Pulmonary edema	3	5.66

9. Significance of assessment of CK; Difference within groups

Grade	CK- Mean	CK- SD	P value
1	105.97	43.31 ^a	<0.001 ^{**}
2	212.50	190.31 ^a	
3	952.61	738.06 ^b	

Note: 1)** denotes significance at 1% level. 2) Different alphabet between grade denotes significance at 5% level. 3) Analysis by ONEWAY ANOVA.

10. Analysis of CK-MB

Grade	Mean	SD	P value
1	16.19	12.39	<0.001**
2	31.75	8.06	<0.001**
3	74.44	46.23	<0.001**

Note:** denotes significance at 1% level.

11. t-test for independent samples of group:

Variable	number	Mean	SE of Mean
Study Group	53	401.5472	80.237
Control Group	20	41.9000	4.210

Levene's Test for equality of variances: $P = <0.001^{**}$

t-test for Equality of Means: 2-Tail significance = $<0.001^{**}$

12. Time interval and Grade

Grade	Mean	SD	P value
1	1.17	0.64	<0.001**
2	3.08	1.72	<0.001**
3	4.14	1.10	<0.001**

Note: $<0.001^{**}$ denotes significance at 1% level.

13. Scorpion envenomation : Relationship between various factors

Variables	P value
Symptoms and age group	0.20447 ^{NS}
Symptoms and gender	0.44008 ^{NS}
Variation between gender	0.8091 ^{NS}
Variation between age group	0.90198 ^{NS}
Grade and time interval	<0.001**
Grade and CK	<0.001**
Grade and CKMB	<0.001**
Grade and leucocytosis	<0.001**
CK and ecg changes	<0.001**
CKMB and ecg changes	<0.001**

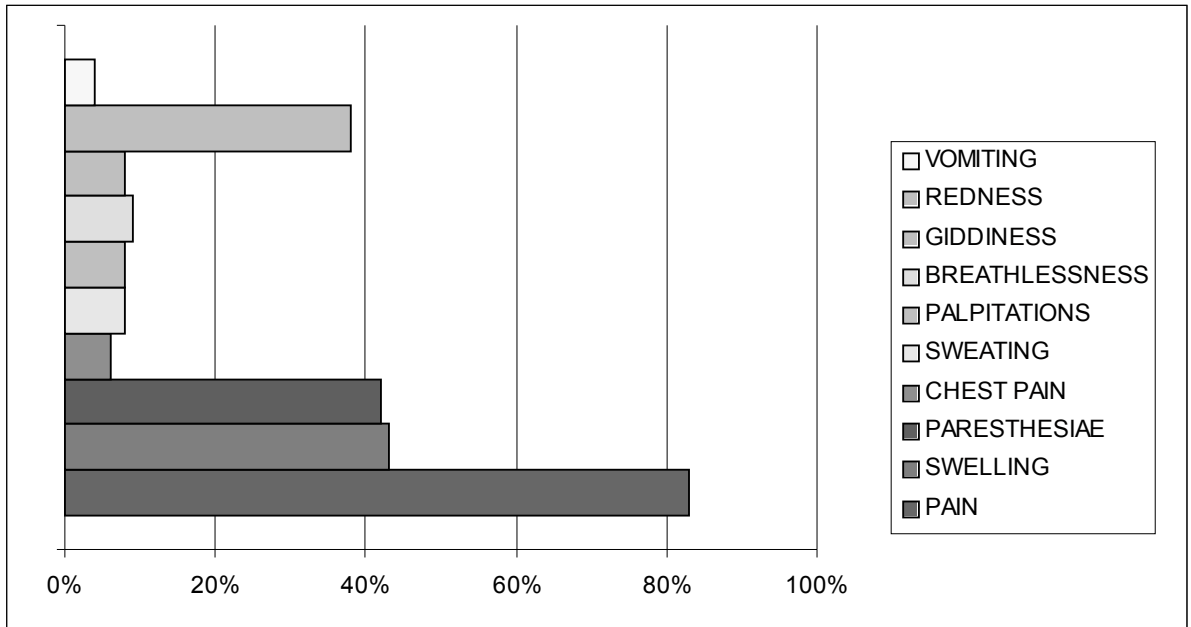
** denotes significance at 1% level

^{NS} denotes Not Significant at 5% level

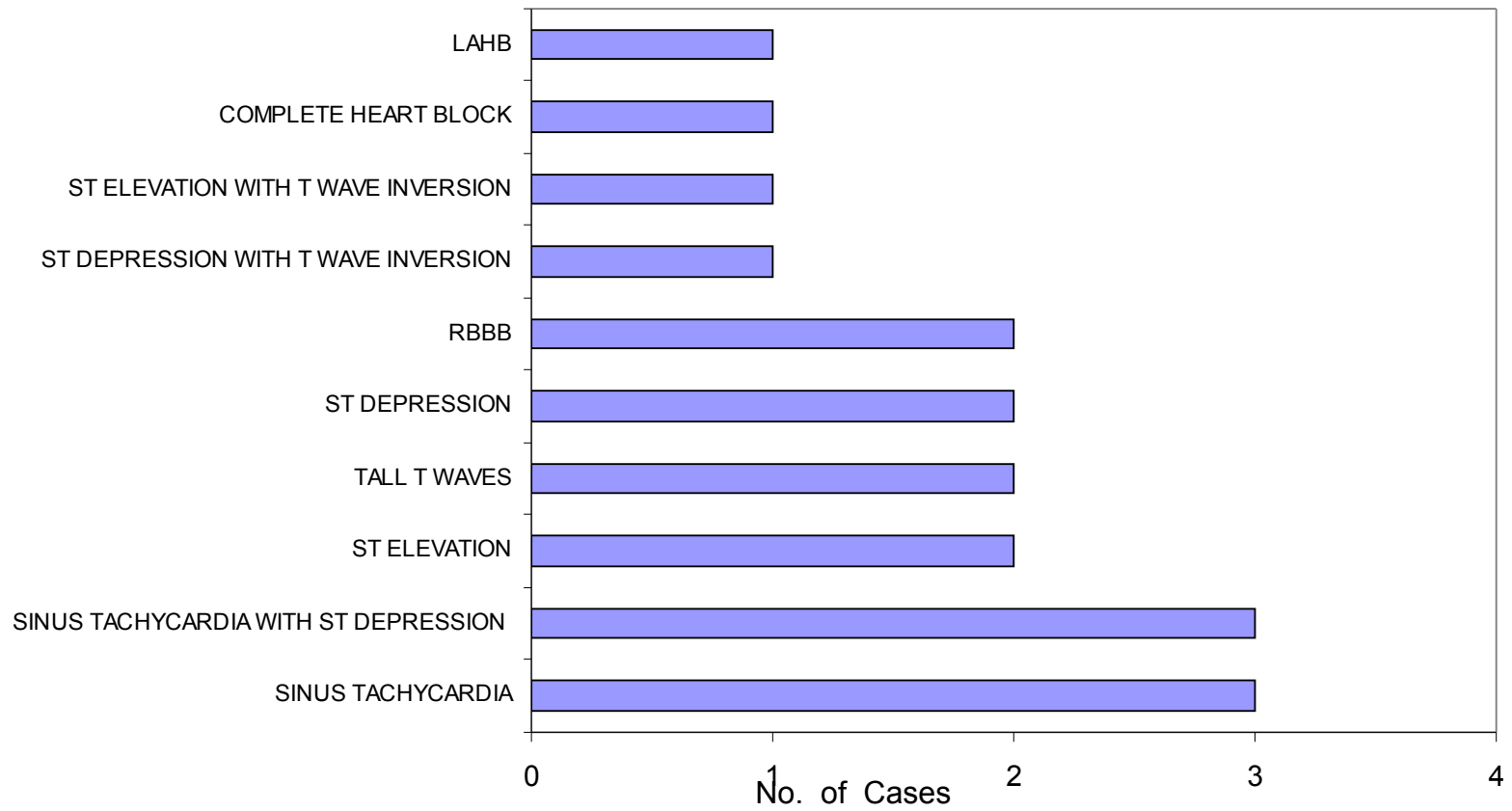
14. ECG changes seen in scorpion sting cases:

ECG ABNORMALITIES	NUMBER (n=18)
Sinus Tachycardia	3
Sinus Tachycardia with ST depression	3
ST Elevation	2
ST Depression	2
ST Depression with T wave inversion	2
Right bundle branch block	2
Tall 'T' waves	2
Left anterior fascicular block	1
Complete heart block	1

DISTRIBUTION OF SYMPTOMS



ECG CHANGES IN SCORPION STING



DISCUSSION

Fifty three patients fit the inclusion criteria for the time period studied. Thirty patients (56.2%) were male and twenty three (43.8%) were female. The age range was 13 years-62 years. Majority of the patients were in the age group of twenty-six to forty years (49.3%) . Eighteen patients (24.7%) were below 25 years of age and nineteen patients (26%) were above the age of forty years. There was no significant difference in the gender distribution and the age distribution of the patients by statistical analysis. In Tunisia⁴⁶, Egypt⁴⁷, Saudi Arabia⁴⁸, Argentina⁴⁹ and Brazil⁵⁰, epidemiological studies showed that most scorpion stings were seen in males, while in a study in turkey⁵¹ it was predominantly seen in females. In epidemiological studies done in different regions of Morocco, male preponderance of scorpion sting was seen in southwest regions and high incidence of scorpion stings in females in the rest of the regions^{51,52}. The analysis of data shows that in the present study there were more males than females both in total cases and in the age group data during the study period. This shows that male- female distribution varies according to regions .The higher incidence of males in this study could be due to the fact that some of the men work in places with poor lighting and improper storage facilities which makes it ideal for the scorpions to hide.

In the present study, the majority of the patients were in the age group of 21-40 years. Fifteen of the patients were in the age group of 21-30 years, 17

were in the age group of 31-40 years. In a ten year retrospective study of scorpion stings in Saudi Arabia which included both adults and children, seventy-three patients of the patients were thirty years or younger.⁵³ In the study carried out by K. Radha Krishnamurthy et al. in G.G.H, Kurnool, India, out of the twenty five patients of scorpion sting studied, the highest incidence was found to be in the age group of 13 to 30 years. The male to female ratio was 2:1. In this study the ratio was 1.2:1. Both show a higher incidence in males.⁵⁴

Of the fifty three patients, 31 patients (58.5%) had grade one envenomation. Four patients(7.5%) were classified as grade two and eighteen patients(34%) fitted the criteria for grade three envenomation.

In the one year period, from first week of July 2005 to the last week of June 2006, maximum number of patients were admitted in the months of May to October. The highest number of admissions was recorded in the month of August. The study from Kurnool G.G.H showed the incidence of scorpion stings was high between July and December.⁵⁴ The study from Saudi Arabia⁵³ states that the six months from May through October are responsible for 75% of the ER visits. In another study from Saudi Arabia by Mahaba, the frequency was highest in the summer months from June to September¹⁰. Similar incidence has been reported from Brazil, Egypt, Morocco and Turkey.^{47,49,52,55} Scorpion stings increase dramatically in summer months and are lowest in winter.³ This

study also shows the incidence to be higher in summer months when compared to the winter months. This is due to the fact that scorpions are intolerant to high temperatures and so live under ruins and stones to protect themselves from heat during summer months.

Twenty-eight patients (52.8%) were admitted to the ward in the time period 18.00 hrs to 06.00 hrs. Twenty-five patients (47.2%) were admitted in the time period 6.00 hrs to 18.00 hrs. In the study carried out at Kurnool Medical College, Kurnool, India, 72% of scorpion stings occurred during day at work, while the rest took place at night as the subjects were sleeping on the floor.⁵⁴ In the Saudi Arabian study, 59% of patients presented to the Emergency Room between the hours of 8pm and 2 am.⁵³ This shows the nocturnal predatory pattern of the scorpion. In another study by Mahaba HMA, most of the stings (60%) occurred at night.¹⁰

All the patients presented with stings on exposed areas of the body—upper or the lower extremities. Thirty-four patients (64%) presented with scorpion sting in the upper extremity while the rest had sting (36%) in the lower extremity. Epidemiological studies have shown that the ratio of patients affected in the extremities (hand, arm, thigh, leg and foot) is 86% in Saudi Arabia, 83% in Argentina and 85% in Egypt. Scorpion sting was mostly seen in the upper limbs in Morocco and Brazil,^{47,48,49,50,52} similar results were obtained in the present study. The same pattern was seen in a study from Turkey.⁵⁵ The

reason for the high ratio of scorpion sting in extremities is considered to be due to the socioeconomic structure depending on agriculture in rural area, wearing sandals in warm season, walking barefoot, lifting up stones in an uncontrolled manner, cleaning old racks with bare hands, shaking the hands during sleep or resting to move away scorpions. Sting in the head, neck and other sites mostly happened at sleep or resting because of putting on clothes without checking and also not controlling bed mattresses.⁵⁵ Scorpion stings are primarily due to accidental contact with the scorpion.³ Scorpions become active at night for their own protection against humans.¹⁰ According to the study by Ken Dittrich et al., the lower limb stings comprised the majority and the incidence of toxicity did not vary significantly in relation to the location of the sting⁵³. The study by Mahaba on scorpion sting in Saudi Arabia recorded stings on the foot to be the most common site of occurrence.¹⁰ Closer proximity of the sting site to the head and torso results in venom absorption into the central circulation and a quicker onset of symptoms.

The patients in the present study were not able to identify the colour of the scorpion. None of the patients in the present study presented with multiple stings.

Local pain was the commonest symptom on presentation in this study. Forty-four patients (83%) presented with pain at the sting site during admission. Twenty-three patients (43%) presented with swelling

at the sting site. Twenty-two patients (41%) presented with parasthesias like tingling sensation at the sting site. Redness was present at the sting site in approximately 20% of the patients. The other symptoms were sweating, palpitations, breathlessness, giddiness, chest pain and vomiting in the frequency of 7.55%, 7.55%, 9.43%, 7.55%, 5.66% and 3.77% respectively. Cardiovascular and autonomic symptoms dominated the clinical presentation in this study. The table below contrasts the findings in the present study with other studies.

Authors	Clinical presentations observed in the study	Year
Ken Dittrich et al., Saudi Arabia	Pain (92%), Radiation of pain(7%), Redness (51%),swelling(28%),Tenderness(12%)	1995
Ozkan O; kat I., Turkey	Intense pain (98.7%), Hyperemia (88.8%), Swelling (54.6%), burning(19.7%), numbness and itching.	2005
Mahaba M.A., Saudi Arabia	Pain(98.3%), vomiting, sweating, restlessness, tachycardia, hypertension	1997
K.Radha Krishna Murthy, India	Sweating(100%), palpitations(80%),chest pain (50%), breathlessness (90%), cough (50%), restlessness(50%), Salivation(90%),nausea(30%),vomiting(30%),abdominal pain (40%), headache (10%), convulsions (5%), blurred vision(15%)	1999

Scorpion venom is a powerful stimulant of the autonomic nervous system. Its effect has been described as a “sympathetic storm”.⁵⁶ Scorpion venom acts by two mechanisms:1) peripheral action through stimulation of the postganglionic elements of both components of the autonomic system and the adrenal gland with significant catecholamine release;2) central sympathetic action and a reflex mechanism through the carotid sinus or carotid body;3) a direct stimulant effect on the heart.⁵⁷

The Clinical presentation of scorpion sting is broad and has been aptly described by Neale as” scorpion sting syndrome”.

On examination, ten patients (18%) had tachycardia, six patients (12%) presented with hypotension. An equal number of patients presented with hypertension. Three patients (6%) had profuse sweating on examination. Four patients (8%) had cold peripheries on admission. Three of the fifty-three cases (6%) had features suggestive of pulmonary edema on admission. Sixteen patients (30%) had sting site tenderness on examination.

Tachycardia was the commonest finding among the patients in presentation to the toxicology ward. The patients who presented with systemic toxicity were treated with Prazosin. The patients who presented with hypertension became normotensive during the course of their stay in the hospital.

A 18 year old patient who presented with pulmonary edema, type 1 respiratory failure and ECG suggestive of myocarditis was immediately treated with antifailure measures- back rest , ionotropic support with dopamine and mechanical ventilation with PEEP for respiratory support. Carnitine was added for its cardioprotective action. The pulmonary edema resolved over 2 days. His general condition improved and he was extubated. The echocardiogram after stabilization revealed a normal cardiac status. He was discharged a week after admission.

The following table gives the signs observed in other studies.

Authors	Clinical presentations observed in the study	Year of study
OzkanO.; Kat I., Turkey	Dry mouth(8.6%), thirst(1.3%), sweating(5.3%), hypotension(3.9%),Hypertension(1.3%), tachycardia(0.7%), dyspnoea(1.3%),Cyanosis(0.7%)	2005
K.Radha Krishna murthy	Sweating(100%),cold clammy skin(100%), tachycardia(80%), bradycardia (80%), gallop rhythm(70%), systolic murmur(20%),pulmonary edema(40%),hypertension(20%)	1999
Ken Dittrich et al., Saudi Arabia	Abnormal vital signs (111/434), Hypertension (75/111), tachycardia(19/111),hypertension With tachycardia(13/111), Hypotension(1/111), nausea and vomiting(14/111), abdominal pain (4/111), diarrhea (1/111), seizure (1/111), anxiety (18/111), drowsiness(6/111), hyperventilation(6/111)	1995

By the Pearson's Chi- Square test, there was no statistical significance (P value >0.05) in the difference in local symptoms with respect to age group and gender in this study. There was no statistical significance in the signs with respect to age group and gender in this study.

Electrocardiographic abnormalities were detected in eighteen of the fifty-three patients admitted with scorpion envenomation (34%). Out of the eighteen patients with E.C.G. abnormalities, thirteen patients were male and three were female.

The commonest abnormality observed in this study was sinus tachycardia which occurred in six patients. Three of those patients presented with sinus tachycardia alone, while three had sinus tachycardia associated with ST depression. The second commonest in frequency was ST elevation which was observed in two patients. Tall 'T' waves were noted in two patients with ECG changes. An equal number of cases had ST depression. Two of the scorpion sting cases had right bundle branch block. One patient had complete heart block and another patient had Left anterior hemi block.

In a study in G.G.H., Kurnool, India, ECG changes were studied in 25 scorpion sting patients (age range:13 to 57 years),sinus tachycardia was the commonest abnormality noted. This is similar to the present study. It was noted in 80% of patients. Sinus bradycardia was noted in 10%. Supraventricular tachycardia was present inn 8%. ST depression and ST elevation in 55% and

10% of the patients studied in kurnool. 'T' wave inversion was found in 50% of the patients. Tall 'T' waves in 20%. This study too demonstrates the increased frequency of ST and 'T' wave changes in scorpion envenomation indicating myocarditis.

Gueron et al.,²⁷ hypothesized that catecholamine storm post envenomation may cause cardiac dysfunction by catecholamine – induced hypoxia and death might result from myocarditis and congestive cardiac failure.¹⁹ Some authors suggested that cardiac dysfunction in scorpion envenomation may be due to a direct effect of scorpion venom evoking the so called scorpionic myocarditis characterized by non-specific ultra-structural changes. Noura et al. showed the presence of right and left ventricular dysfunction after scorpion envenomation providing further augmentation to the hypothesis of scorpionic myocarditis.⁵⁸

In a study carried out by Ajay kumar R, M Jayarajah et al. In Sri Ramachandra Medical College and Research Institute, Chennai, nine cases were studied (mean age-42.6 years). On presentation all of them had tachycardia, 7 had diaphoresis, 6 had severe hypertension, 2 had persistent chest discomfort and 2 had palpitations. These patients were found to have typical clinical and electrocardiographic features of severe myocarditis and cardiogenic shock. One patient with myocarditis showed acute ST elevation in

lateral leads mimicking acute myocardial infarction. Other ECG changes noted were Tall t waves, pseudo infarct Q waves and QT prolongation.⁵⁹

A 55 yr old male patient admitted during the period of present study with bradycardia, dyspnoea and palpitations. His heart rate on admission was found to be 40/min. ECG showed features of complete heart block. He was immediately transferred to the Intensive cardiac care unit and was treated there. The echocardiogram showed a good LV ejection fraction of 68%. Hence he was not put on temporary pacemaker. He was treated symptomatically and discharged with advice to follow up regularly.

All the patients with ECG changes in this study were found to have elevated serum levels of creatine kinase and creatine kinase isoenzyme-MB. Statistical analysis showed it to be significant at 1% level. This indicates the presence of myocarditis in these patients of the study group. ECG changes produced by scorpion sting are found to persist up to 12 days before normalizing. In studies done in pediatric age group in JIPMER, by S.Das , P.Nalini et al.,⁶⁰ ECG changes were observed in 63% of the envenomated children. fifty percent of the children in the study were diagnosed to have myocarditis ;of these in four children the presentation was subclinical. ECG changes were found to be a sensitive indicator of myocarditis. Sixty –nine percent of the children with myocarditis had left ventricular dysfunction as

shown by echocardiography. In those children who came for follow up, the left ventricular function was found to be reversed to normal.

Three patients out of the fifty-three patients in this study had pulmonary edema. All three of them recovered. One patient required ventilatory support.

A study was done at the King Edward Memorial Hospital, Bombay, India, by D R Karnad⁴⁴ to assess the haemodynamic patterns in patients with scorpion envenomation. Eight patients with *Mesobuthus tamulus* stings who were admitted to the intensive care unit were studied, (mean age-25.9 years). From the study it was concluded that two hemodynamic patterns were observed⁴⁶ a predominantly vascular effect and⁴⁷ a predominantly myocardial effect. One patient in the study had intense vasoconstriction and tachycardia which caused hypertension. The cardiac output, pulmonary artery pressure, pulmonary wedge pressure, and right atrial pressures were normal. The author has concluded that hypertension and tachycardia may represent the mildest form of cardiovascular involvement in scorpion envenomation. The author has used captopril and has found it to be effective within one hour of oral administration. The predominant myocardial dysfunction resulting in acute left ventricular failure was observed in the rest of the patients in the study. These patients either presented as pulmonary edema if the hydration status was good or hypovolemic shock if there was dehydration.

In the present study, 12% of patients had hypertension and another 12% had hypotension. There was no significant relationship between the abnormal clinical signs and age group and gender. The echocardiography demonstrated a decreased ejection fraction in those patients with pulmonary edema. While some of the patients with abnormal ECG indicative of myocarditis maintained good ejection fraction.

The patients in this study were graded according to the clinical presentation and the ECG abnormalities . The majority had grade one envenomation-58.5%, 7.5% had grade two envenomation. Thirty four patients had grade three scorpion envenomation. There was no statistical significance between age groups and gender according to this study with respect to grade.

The serum Creatine Kinase levels of all the scorpion envenomed patients was found to be high compared to the controls. On applying the t-test , there was statistical significance in the difference between the serum CPK levels of the cases and controls. The serum CPK levels of grade three patients were found to be significantly higher than those with grade one or grade two envenomation .

In the study by Ajay kumar et al⁵⁹., they have found serum CPK to be markedly elevated in all cases with myocarditis. Two out of nine cases developed features of acute respiratory distress syndrome without features of myocarditis.

The mean serum CK-MB levels of grade one, grade two and grade three patients were 16.19, 31.75 and 74.44 respectively showing statistical significance in the difference in the serum levels of the enzyme on applying the Kruskal Wallis 1-way Anova. The mean levels of serum CK-MB in all three grades of scorpion envenomated cases were found to be significantly higher than that of controls.

In this study there was statistical significance in the relation between the serum levels of patients and the electrocardiographic manifestations. Those with ECG changes were found to have high levels of serum CK and serum CK-MB.

In a study by Abdel-Raheim A.M et al.,⁶⁴ on the significance of assessment of serum Troponin I and Interleukin-8 in scorpion envenomed children in Upper Egypt, the authors documented that all the envenomed victims showed significantly higher mean values of CPK,CPK-MB and IL-8 on admission in comparison to control group. cTnI was not detectable in the sera of control group s well as patients with mild envenomation. Adams et al., stated that the increases incTnI don't occur despite severe acute or chronic muscle injury even when level of creatine phosphokinase and CPK-MB isoenzyme are increased unless cardiac injury is present. Troponin I could not be estimated in our study due to technical reasons. The authors have concluded that cTnI is the most specific marker for diagnosis of myocardial injury.

The mean leucocyte count of the study group in this study was found to be significantly higher than the mean of the control group. In those patients who had leucocytosis, the polymorphonuclear cell count was high. Similar observation was also made in a study by D R Karnad in King Edward Memorial Hospital,⁴⁴ All the patients in his study group were found to have leucocytosis. The same observation was also made in a study on scorpion sting in Tunisia.⁴⁶

There was hyperglycemia (B.glucose>200mg/dl) noted in ten out of the 53 patients. This is due to the excessive catecholamine release. The B.sugar decreased to normal levels on subsequent testing. The unopposed action of scorpion venom toxins that cause alpha receptor stimulation lead to suppression of insulin secretion, hyperglycemia, hyperkalemia , freefatty acids and freeradicals accumulation injurious to the myocardium.In a study by K. Radha Krishna murthy et al., they had recorded hyperglycemia in 40%of their study subjects.⁵⁴

The time interval between the scorpion sting and admission to the hospital was found to influence the severity of clinical manifestations. There was statistical significance in the time interval between the grade of severity and the time taken for hospital admission. In the study at kurnool, India, the authors have noted the increasing severity of clinical manifestations as the time

delay between sting and admission is increased.⁵⁴ In the study by Ken Dittrich et al. , the average time delay was not more than 2hrs.⁵³

The patients in the study group were symptomatically managed with analgesics, local infiltration of lidocaine, prazosin and antibiotics. The patients were given anxiolytics-diazepam/alprazolam if it was needed. Serial blood pressures were taken in those presenting with hypertension.

The patients did not require antihypertensive medications. Patients who presented with shock were resuscitated with intravenous fluids and inotropic agents . One patient with pulmonary edema and type1 respiratory failure required mechanical ventilation. Anti venom was not given for any patient. There was no mortality during the period of study due to scorpion envenomation.

Ken Dittrich et al. have noted that with grade1 and grade envenomation , pain management is the main stay of therapy .Local analgesia, systemic analgesia ,application of ice at the sting site were all found to be useful. Agents such as paracetamol, NSAID's are useful in recommended doses. Patients can be discharged safely after one hour if they do not fall in to one of the high risk categories and their vital signs are within normal limits. Patients with tachycardia or hypertension should be observed until vital signs return to normal. Since systemic toxicity usually within six hours of the sting, there is no need to retain the patient greater than this time period unless there is risk of

serious toxicity. Grades 3 and 4 envenomation require full supportive measures as necessary. All these patients should be admitted to the hospital and followed in an intensive care setting until their condition stabilizes.⁵³

The use of the following drugs are controversial with studies showing conflicting reports regarding their benefit: lytic cocktail, morphine, steroids (excepting type1 hypersensitivity to antivenin), nifedipine, ACE inhibitors.^{3,44,53}

SUMMARY

1. In this study, the incidence of scorpion sting in males(56.6%) was found to be higher than females.
2. The incidence of scorpion envenomation was found to be maximum in the age group of 31-40 years (33%) and 21-30 years (29%). This indicates the risk of exposure to the scorpion sting at work place and during household chores.
3. More patients presented to the Poison center in the night (53%) than in the morning. This is in line with the predatory pattern of the scorpions and the risk of disturbing scorpion homes in the darkness of the night.
4. Fifty –nine percent of the patients presented with Grade 1 envenomation. Seven percent with Grade2 and thirty four percent with Grade3 envenomation.
5. Hand was the commonest site of sting in this study. Most of the scorpion stings were accidental and occurred indoors.
6. Pain (83%) and Tachycardia (19%) were the commonest presenting symptom and sign respectively.

7. Sinus tachycardia (6%) was the commonest ECG abnormality seen in the study.
8. There was no significant difference in clinical presentation with respect to age group and gender.(P value=0.20447)
9. The patients who presented late to the emergency room after scorpion sting were found to have greater morbidity.(P value<0.001)
10. There was statistical significance in the relationship between ECG change and biochemical markers CPK and CPK-MB.
11. Patients with Grade 1 envenomation treated with local infiltration of lidocaine at the pain site, anxiolytics , antibiotics and observed. Those with Grade 3 envenomation required oxygen and managed with intravenous fluids and inotropic agents for shock. One of the three patients with pulmonary edema required mechanical ventilation.
12. The transient hyperglycemia and hypertension observed in patients with severe envenomation resolved in 48 hours.

CONCLUSION

Scorpion sting is common in tropical countries like India. Although majority of the stings are harmless. They have been found to cause significant morbidity, especially in children. Fatalities in both adults and children have also been reported from various studies around the globe.

There is no report of the actual cases of scorpion sting in India because most of the scorpion stings occur in the rural areas and go unreported. Scorpion envenomation in adults needs to be studied to identify the high risk groups and to assess the morbidity caused it.

In this study eighteen out of 53 cases had ECG changes. Three of the patients presented with pulmonary edema. There was no mortality due to scorpion sting in the study period.

There was significant correlation between the time delay and severity of envenomation. This indicates a need for immediate medical care following scorpion sting.

Follow this study it is seen that patients were stung by the scorpions due to their lack of knowledge about scorpions and due to their carelessness, like putting their hands in to scorpion homes. People living in regions where scorpion stings are common must be educated to be careful while cleaning /

searching probable scorpion homes. They must be educated to clean homes or search at work places in bright day light or in artificial light.

Follow up studies are required to assess the long term complications of scorpion stings.

PROFORMA

Name : Date /Time:

Age /Sex : I.P.No.

Circum Stances of Exposure :

Time of Exposure :

Location : Urban/Rural
Home/Office

C/F : Site of bite
Pain/numbness
giddiness/breathlessness

O/E : PR
BP
RR
CVS
RS
CNS
Signs of Perip. Circul. Failure

Past h/o : DM/HT/IHD

Investigation : TC Urine Analysis
DC ECG:On Admn.
ESR
HB% On discharge
Urea Others:
Sugar ECHO:
CR Enzymes:
elect CPK
CPK MB

Specialist opinion :

Treatment :

Condition at discharge :

ABBREVIATIONS

1. ECG : Electrocardiogram
2. CK : Creatine Kinase
3. CK-MB : Creatine Kinase MB
4. CPK : Creatine Phosphokinase

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