







## Department of Plastic Surgery

### **Sugarcane Crusher Injuries of the Hand : Madness to Method.**



# PROBLEM STATEMENT

**A characteristic clinical presentation of  
crush injury hand**

**Severity of injuries varying from simple  
skin lacerations to composite irreparable  
tissue loss or amputated digits.**



# Appearances can be Deceptive !





# Appearances can be Deceptive !





## SUGARCANE CRUSHING MACHINE INJURIES-MECHANISM OF INJURY, CLASSIFICATION & MANAGEMENT.

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**SUMMARY:** Sugarcane crushing machine injuries are common throughout India. Based on the observation on 53 sugarcane machine injuries to the hand over a period of 2 years, the mechanism of injury has been elucidated. A classification has been proposed and treatment guidelines have been given.

### INTRODUCTION

Sugarcane crushing machine injuries are seen only in India and are not discussed in any standard text books<sup>1</sup>. These injuries have a characteristic pattern recognizable of the trauma caused by the serrated steel rollers of this machine. Apart from these power rollers, atypical injuries can be caused by the open gears and the drive-belt of the machine. We have studied fifty typical and three atypical injuries and followed them for 2 years.

The typical clinical features of these injuries are as follows:

1. Area proximal to the level of the thumb is never injured.

The injury occurs only distal to the level of the thumb. This is because the thumb is abducted while feeding the sugarcane into the rollers. The thumb

abuts over the guard and prevents the hand from being drawn in any further.

2. The thumb is rarely injured.

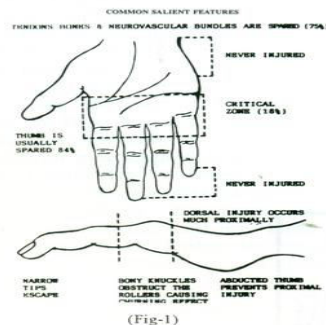
The thumb is spared in over 84% cases and even when injured it has only skin lacerations or cuts.

3. The finger tips are never injured.

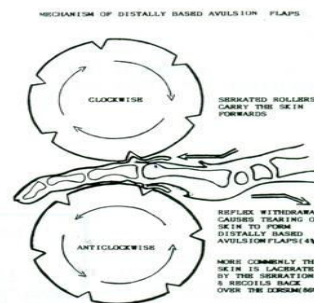
The soft pulp is easily compressed and passes uninjured through the rollers. The pulp or the nail bed may only be contused.

4. There is a critical zone of maximum injury.

The critical zone of maximum injury where damage to neurovascular bundle occurs is between the distal palmar crease and the proximal interphalangeal joint crease. Damage to the neurovascular bundles needs to be checked in this particular region. Severe injury occurs in this zone



(Fig-1)



(Fig-2)

Surprising  
Paucity  
of  
Literature

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## CLASSIFICATION

Few classifications exist for similar injuries.<sup>3</sup> We have proposed the following classification for the sugar cane crush injuries.

- Minor injury - abrasions or lacerations of the skin only, with no injury to the deeper structures.
- Moderate injury - Skin lacerations with denuded or lacerated tendons or fractures.
- Severe injury - In addition to the above skin avulsion, loss of skin, degloved flaps or injury to the neurovascular bundle.



# Discrepancies



**Need for devising a  
METHOD  
TO THE  
MADNESS**



# Hand : Anatomical Marvel



Bones  
Joints  
Ligaments  
Tendons  
Muscles  
Nerves

*eOrthopod.com*  
© MMG 2011



Adjustable  
Gap



# CLASSIFICATION SYSTEM

CLASS OF INJURY	SKIN	TENDON	BONE
I	Longitudinal Lacerations	Longitudinal Lacerations	Single bone fracture
II	Degloving	Disruption	Fracture of TWO bones and/or single joint movement
III	Loss	Loss	Fractures of more than TWO bones/bone loss/2 joints
IV	Amputation/ Neurovascular compromise/Thumb involvement Mangled hand		

# CLASS I



Type of Injury	Clinical Presentation
CLASS I	<p>Skin and Soft tissue - Multiple longitudinal lacerations</p> <p>Tendons – Longitudinal lacerations</p> <p>Bones – Single bone fracture</p>



# CLASS II

Type of Injury	Clinical Presentation
CLASS II	<p>Skin and Soft tissue - Degloving</p> <p>Tendons – Disruption</p> <p>Bones – Fracture of TWO bones and/or single joint involvement</p>



# CLASS III

Type of Injury	Clinical Presentation
CLASS	Skin and Soft tissue – LOSS
III	Tendons – LOSS
	Bones – Fractures of more than TWO bones/bone loss/2 joints





# CLASS IV

Type of Injury	Clinical Presentation
<b>CLASS</b>  <b>IV</b>	Traumatic Amputations of fingers / neurovascular impairment of the hand /  Involvement of all 5 digits of the hand / Mangled Hand presentation.







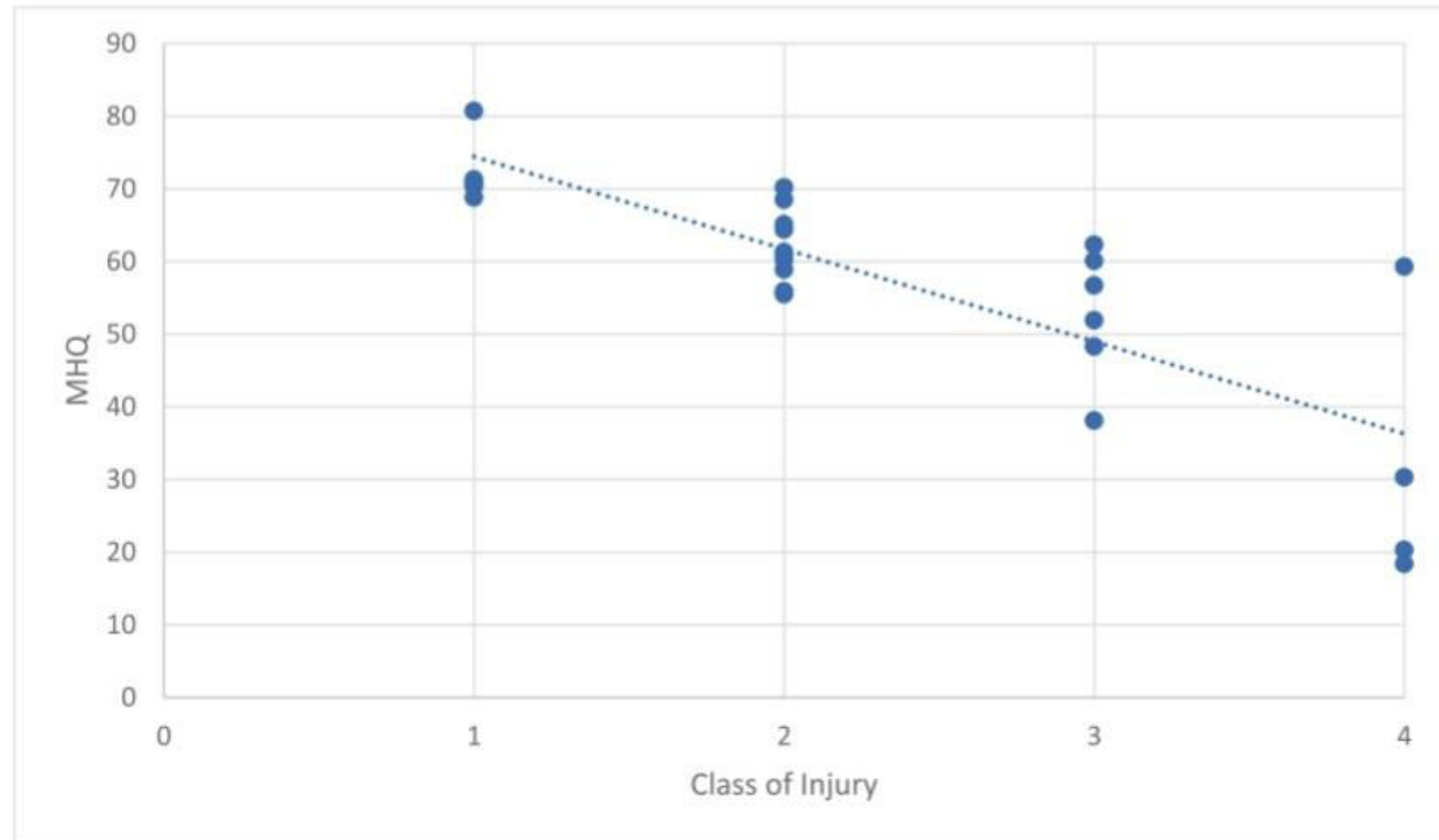
**Table 2.** Demographic and Clinical Data

Patient No.	Age (years)	Gender	Work experience (years)	Previous history of injury	Injury to dominant hand	Mechanism of retrieval of hand	Class of injury	MHQ
	41	Male	15	No	Yes	Roller reversal	II	68.5
	28	Male	4	No	Yes	Roller reversal	II	65.1
	31	Male	6	No	Yes	Roller reversal	III	0*
	36	Male	7	No	Yes	Roller reversal	II	60.9
	26	Male	4	No	Yes	Roller reversal	IV	59.3
	13	Male	<1 year	No	Yes	Pulled hand free	III	38.1
	45	Male	15	No	Yes	Roller reversal	III	62.3
	32	Male	3.5	No	Yes	Roller reversal	II	58.9
	30	Male	5	No	Yes	Roller reversal	II	55.5
	42	Male	9	Yes	Yes	Loosened plates	I	71.3
	32	Male	8	No	Yes	Roller reversal	III	60.1
	17	Female	<1 year	No	Yes	Roller reversal	II	0*
	30	Female	7	No	Yes	Loosened plates	I	70.8
	22	Female	3	No	Yes	Roller reversal	IV	30.3
	32	Female	5	No	Yes	Roller reversal	II	64.4
	27	Male	5	No	Yes	Roller reversal	III	0*
	37	Male	8	No	Yes	Pulled hand free	IV	18.4
	33	Male	7	Yes	Yes	Loosened plates	II	60.3
	20	Male	4	No	Yes	Roller reversal	III	56.7
	34	Male	8	No	Yes	Loosened plates	I	80.7
	32	Male	11	No	Yes	Roller reversal	II	55.9
	30	Female	7	No	Yes	Roller reversal	III	0*
	75	Male	56	Yes	Yes	Loosened plates	I	68.8
	19	Male	<1 year	No	Yes	Pulled hand free	IV	20.3
	40	Male	17	No	No	Loosened plates	I	0*
	32	Male	5	No	Yes	Roller reversal	II	70.2
	31	Male	6	No	Yes	Pulled hand free	III	48.3
	43	Male	12	No	Yes	Loosened plates	I	70.3
	51	Female	19	No	Yes	Roller reversal	III	51.9
	32	Male	5	No	Yes	Roller reversal	II	61.3

\*Patient lost to follow up.



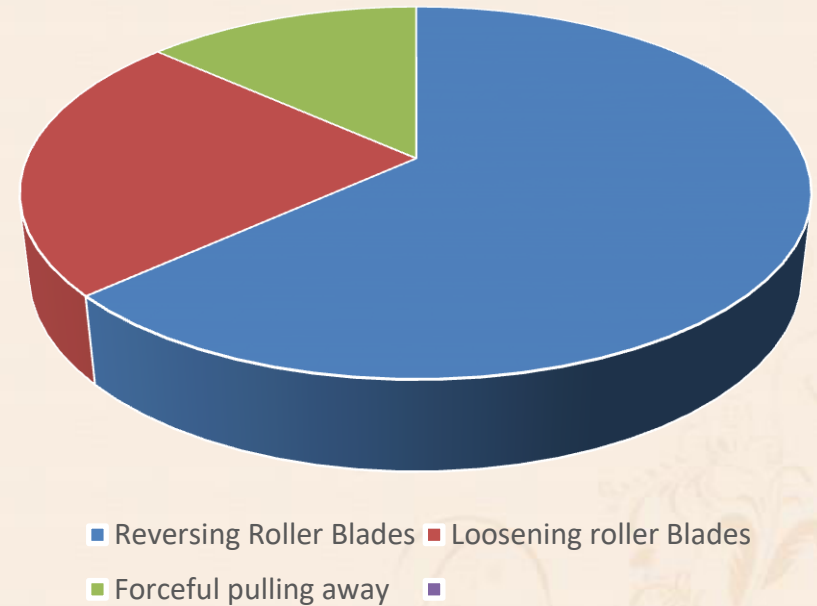




Statistical analysis of correlation between the MHQ and class of injury.

Nineteen patients out of 30 (63.3 %) retrieved the crushed hand by reversing the roller blades, 7 patients loosened the rollers to free the hand (23.3%) and four patients (13.4%) gave history of pulling the hand forcefully to get it out of the machine.

Method of Crushed Hand Retrieval





## Relation Between Method Of Retrieving Hand And Return To Hand Function

• Type I or Type II injuries

Loosened the roller plate

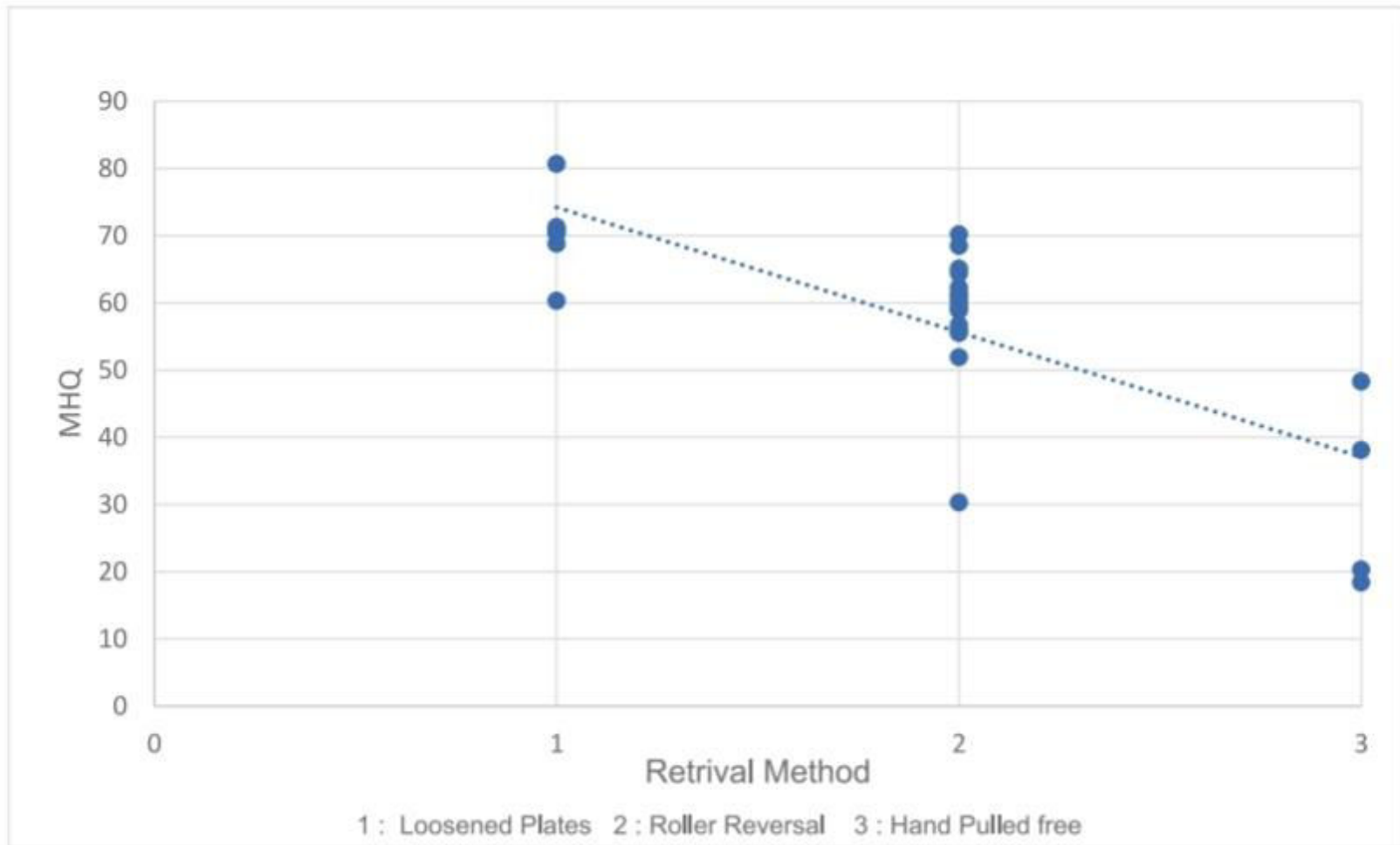
Reversing the rollers

Retrieved the hand using force

• Type II to Type IV injuries

• Type III & Type IV injuries

# THE STATS DON'T LIE



Statistical correlation between the method of hand retrieval and MHQ.

# Why this Classification?

- 1) Per Primum appropriate management
- 2) Enormous Impact on hand function and on quality of life.
- 3) Patient and Surgeon as partners and stakeholders during management





## Original Article

The Journal of Hand Surgery (Asian-Pacific Volume) • DOI: 10.1142/S2424835522500382

### A Proposed Classification for Sugarcane Crusher Injuries of the Hand and Its Correlation with Patient Rated Outcome Scores at 6 Months

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**Background:** Crush injuries of the hand sustained from sugarcane juice extracting machines have a unique mechanism of injury and clinical presentation. The severity of the injury can vary from simple skin lacerations to mangled of the hand. We devised a classification for these injuries based on the severity that has helped us with the management. The aim of this study is to determine whether the classification correlates with patient rated outcome score at 6 months.

**Methods:** We prospectively studied 30 consecutive patients with a sugarcane crusher injury of the hand. The patients were classified into Class I, II, III or IV based on our classification and managed accordingly. Patient outcomes were assessed at 6 months after the injury, using the Michigan Hand Outcomes Questionnaire (MHQ). Spearman's rank correlation test was used to analyse the correlation between the different classes of hand injury and functional outcomes at 6 months following injury (measured using MHQ).

**Results:** The study included 6 patients (20%) with Class I injury, 11 patients (36.6%) with Class II, 9 patients (30%) with Class III and 4 patients (13.4%) with Class IV injury. The mean MHQ scores at 6-month follow-up were 72.3% in Class I, 62.1% in Class II, 52.9% in Class III and 32% in Class IV injuries. An inversely proportional association between the severity grade as per the classification and MHQ scores was noted.

**Conclusion:** Our proposed classification of sugarcane crusher injuries of the hand correlates well with the MHQ score. The use of the classification can help with management and predicting prognosis. In addition, wider use will permit comparison of outcomes between different centres.

**Level of Evidence:** Level IV (Therapeutic)

**Keywords:** Occupational injuries, Sugarcane crusher injuries, Mangled hand, Classification, Treatment algorithm

## INTRODUCTION

A typical sugarcane juice extracting machine consists of two grooved metal rollers that are spun by a low power motor (Fig. 1). Sugarcane stalks are fed into the gap between the rollers and the extracted juice is collected in a vessel below the rollers. The stalks are passed two to three times between the rollers to extract as much juice as possible and the gap between the rollers is progressively decreased between successive passes. A crush injury to the hand occurs while guiding the cane through the rollers or while washing the machine.<sup>1</sup> Modern machines should have safety guards to protect hands from getting

Received: Jul. 16, 2021; Accepted: Dec. 23, 2021

Published online: MMM. DD, YYYY

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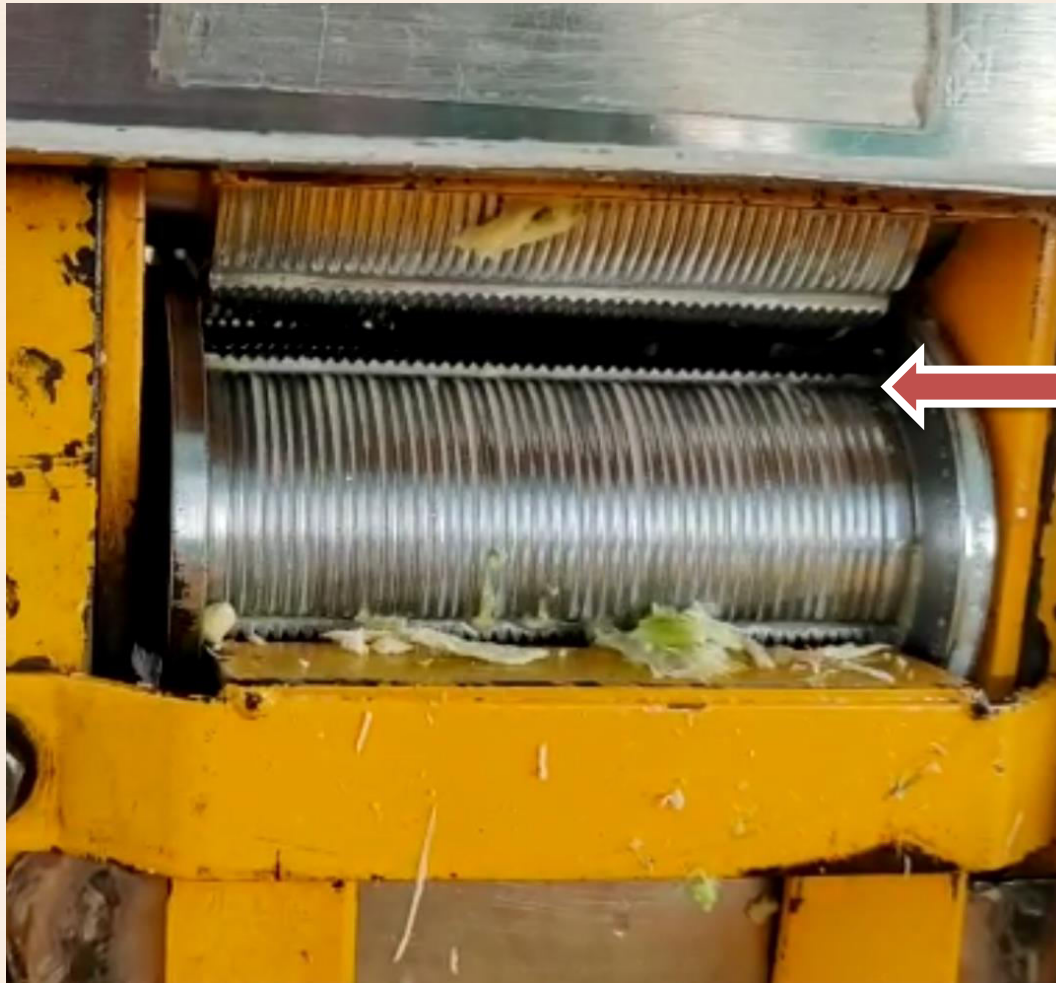
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# The Recent Advance We DON'T Need !

DPU



SHARP  
TEETH

**Because loss of hand function equals loss of means  
of livelihood.**

**Save the Working Hand!**