

Danger in Every Squeeze: Occupational Risks of Sugarcane Juice Machines

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ABSTRACT

Introduction: Occupational injuries continue to be one of the major causes of morbidity and mortality in most parts of the world including India. A recent study conducted by the US Department of Labour found that 23% of all work-related injuries involved hands or fingers, making hand injuries “the most frequent preventable injuries” Sugarcane juice vendors come under the bracket of ‘at risk’ group, especially in the summer season when the demand of cane juice in India, resulting in high chances of hand injury. With the help of this study, we could understand demographic and contributory facts in a better way and hence formulate preventive and therapeutic strategies

Material and methods: We present retrospective data on 20 cases of hand crush injury caused by sugarcane machine usage from May 2021 to April 2023. The hospital records were used to extract information regarding the patient’s profile, type of injury, time of presentation, etc.

Results: Among all male patients, 75% were between 20 and 30 years of age. Forty percent (8 cases) presented within 8 hours of the injury, while 10% (2 cases) presented within 4 hours. Ten cases (50%) were managed by primary suturing and splinting, while three cases (15%) required fracture fixation. Involvement of the thumb is extremely rare, though it was seen in one of our cases, which had a mangled hand.

Conclusion: This occupational injury must be addressed by prevention and surgical intervention. This study helped us understand the demographic and contributory facts related to sugarcane crushers in a better way and hence formulate preventive and therapeutic strategies for the same.

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INTRODUCTION

India is still a developing country with majority of rural population still dependent on agriculture as their prime occupation for their earning. Besides creating bumper production records in crops, India also boasts

of being the second largest producer of sugarcane, Brazil being the first. The scorching Indian summer synchronizes well with harvest of sugarcane and thus its utilization in its most common edible form as ‘cane juice’. Sugarcane juice crushers mostly belong to low socio-economic status group and usually are found with their stalls roadside. The juice production process utilized by them are hazardous and places them at high risk for hand injuries.¹

In India, the most common machines utilized for this purpose are either mechanical (hand-driven) or by electrical motors (Figures 1a to c), the latter most commonly used and also most commonly attributed to debilitating hand injuries. The hurriedness to fulfil the demands of customers or carelessness during cleaning of machines while

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Figure 1(a to c): Motor driven sugarcane machine

the power is still on, are the two directly recognized factors for crush injuries. The indirect factors can be faulty machine designs, less or no awareness towards safety protocols and long working hours which blunts the mind away from concentrating.^{2,3} The presentation of these injuries can be as subtle as simple laceration to traumatic amputation of digits.^{4,5}

MECHANISM AND PATTERN OF INJURY

Entrapment of hand, both while carelessly passing the sugarcane between moving irregular surfaces of roller blades of machine (Figures 2 a, and b)

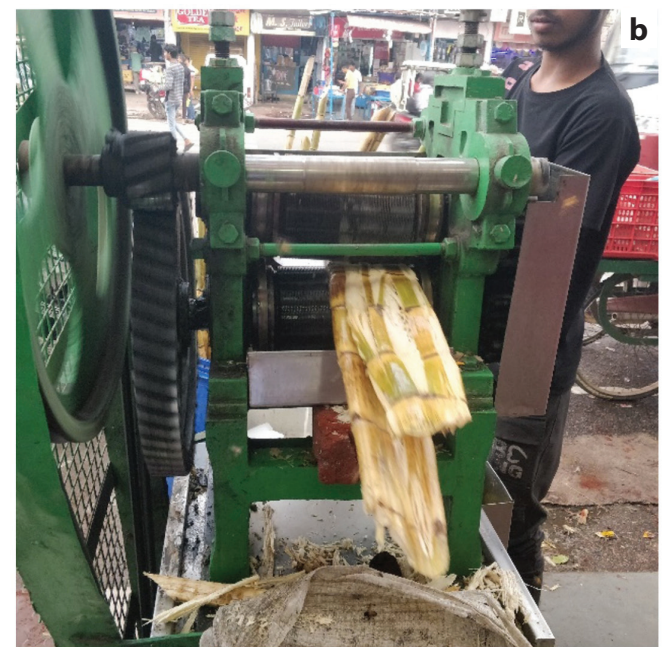


Figure 2(a & b): Entry and exit of sugarcane through the machine



Figure 3: Laceration on volar aspect of hand



Figure 4: Soft tissue avulsion along with underlying extensor tendon apparatus damage and fracture of underlying phalanges

or while cleaning the machine bare hand or with cloth are attributed to cause crush injury as stated above.⁶ These injuries have a recognizable pattern of trauma caused by serrated steel rollers of the machine.⁷ The fingers gets hooked in the serrated blades and are pulled first followed by the hand, creating mixed pattern of crush injuries consisting of lacerations (Figure 3), fractures (Figure 4), soft tissue avulsion (Figures 5a, and b), joint capsule damage and sometimes mangled limb (Figure 6). The drive belt of the machine and open gears can sometimes too can cause such injuries. There is a characteristic longitudinal split in extensor expansion along its whole length and usually extends to metacarpophalangeal joint (Figure 7) Usually flexor tendons are found in continuity with extensive damage to flexor tendon sheath at the volar laceration region (Figure 8).⁸

MATERIAL AND METHODS

The study presents data on sugarcane crush injury



Figure 5(a,b): Clinical and radiological evidence of fracture at PIPJ Index finger



Figure 6: Mangled hand involving thumb (rarely involved in sugarcane crush injury)



Figure 7: Longitudinal split in extensor expansion of digits



Figure 8: Flexor tendons and sheath damaged

Table 1: Data tabulation

S. no of patients	Age (years)	Sex (M/F)	Dominant hand	Presentation time (hours)	Digits involved	Surgical Procedure
1.	25	M	Right	6	2nd,3rd,4th,5th	Tendon repair
2.	27	M	Right	4	2nd,3rd,4th	Tendon repair
3.	24	M	Right	10	2nd,3rd,4th,5th	Tendon repair
4.	29	M	Right	8	2nd,3rd,4th	Tendon repair + fixation
5.	35	M	Right	6	2nd,3rd,4th,5th	Suturing + splinting
6.	26	M	Left	6	2nd,3rd,4th,5th	Suturing + splinting
7.	25	M	Right	6	2nd,3rd,4th	Suturing + splinting
8.	45	M	Right	10	2nd,3rd,4th,5th	Tendon repair
9.	28	M	Right	6	1st,2nd,3rd,4th, 5th	Debridement + Tendon repair + fixation + flap cover
10.	32	M	Right	8	2nd,3rd,4th	Suturing + splinting
11.	30	M	Right	8	2nd,3rd,4th,5th	Tendon repair
12.	38	M	Right	4	2nd,3rd,4th,5th	Suturing + splinting
13.	29	M	Right	8	2nd,3rd,4th	Suturing + splinting
14.	24	M	Right	6	2nd,3rd,4th,5th	Tendon repair
15.	26	M	Right	8	2nd,3rd,4th	Suturing + splinting
16.	30	M	Right	6	2nd,3rd,4th,5th	Suturing + splinting
17.	24	M	Left	8	2nd,3rd,4th	Tendon repair + fixation
18.	44	M	Right	10	2nd,3rd,4th,5th	Suturing + splinting
19.	29	M	Right	6	2nd,3rd,4th	Tendon repair
20.	27	M	Right	8	2nd,3rd,4th	Suturing + splinting
21.	30	M	Right	6	2nd,3rd,4th	Suturing + splinting
22.	27	M	Right	6	2nd,3rd,4th	Suturing + splinting
23.	31	M	Right	8	2nd,3rd,4th	Suturing + splinting
24.	28	M	Right	6	2nd,3rd,4th	Tendon repair
25.	35	M	Right	4	2nd,3rd,4th	Tendon repair + fixation
26.	30	M	Right	8	2nd,3rd,4th	Suturing + splinting
27.	32	M	Right	6	2nd,3rd,4th	Suturing + splinting
28.	28	M	Right	6	2nd,3rd,4th,5th	Tendon repair + fixation
29.	27	M	Right	6	2nd,3rd,4th	Tendon repair + fixation
30.	30	M	Right	6	2nd,3rd,4th	Suturing + splinting

cases presented to Emergency/Casualty at our institute from May 2021 to April 2023. Besides the demographic profile of the patient like age and sex attributes, other features like type of injury, hand dominance, need of hospital admission, time interval to presentation and most common digit/digits involved were recorded and tabulated (Table 1).

This is a type of retrospective observational study conducted at our hospital, which is one of the leading trauma case centres in North India. All patients satisfying the inclusion criteria were included in the study.

Inclusion criteria- Patient with hand injuries due to sugarcane crushing machine

Exclusion criteria- Crush injury of hand due any other cause

INITIAL MANAGEMENT

The primary assessment and management which is of prime importance in any trauma case was done on the lines of “Airway Breathing Circulation” on immediate presentation of the patient in casualty. After life-threatening injuries were ruled out and the patient being stabilized, a detailed history and clinical examination were carried out about the hand injury. All these patients were administered analgesics, antibiotics and a shot of tetanus prophylaxis. Before wheeling the patient to OT, a radiological evaluation was done of the injured part.

In the Emergency OT, the wound was examined to note the depth and extent of injury. Open wounds were washed thoroughly with normal saline and povidone solution to remove the adhered foreign bodies like splinters, cloth pieces, etc. If only clean lacerations were present, suturing was done. Splinting of the wrist and hand was done on fracture suspicion. Decisions on further management like tendon repair, fracture fixation, soft tissue/skin cover, digital amputation etc., as required are taken and executed after obtaining due consent.

STATISTICAL ANALYSIS

The data obtained from the study was tabulated in MS Excel sheet and analyzed using the Statistical Package for Social Sciences (SPSS) Windows, Version 16.

RESULTS

The following results were obtained from our study-

1) **Gender-** Males were found to be most commonly

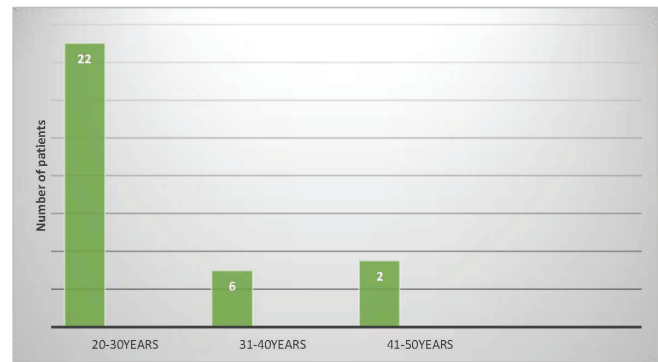


Chart 1: Age distribution in study patients

affected. All the cases in our study were males.

- 2) **Age-** Nearly 75% (15 cases) of patients belonged to the age group of 20 to 30 years, followed by 2 cases in the 31 to 40 years age group. 41 to 50 years age group comprised 15% of all the cases in our study (Chart 1).
- 3) **Hand Dominance-** In 90% of cases right hand was dominant and the same was involved. Hill *et al.* found that the incidence of crush injury in the right and left hand was 51.8 and 45.4%, respectively.⁹ The incidence of a crush injury to right and left hand in another study by Murtuza *et al.*, was found to be 39 and 36% whereas both limbs were injured in 11% cases.¹⁰ There were no cases in our study involving both of the limbs.
- 4) **Time of Presentation-** 6 patients (30%) presented within 6 hours of injury whereas 12 patients (60%) presented after 6 hours of injury. As per study outcomes of hand crush injuries by Hill *et al.*, half of the patients presented within 2 hours of injury, whereas in our study none of the patients came to us within 2 hours period (Chart 2).

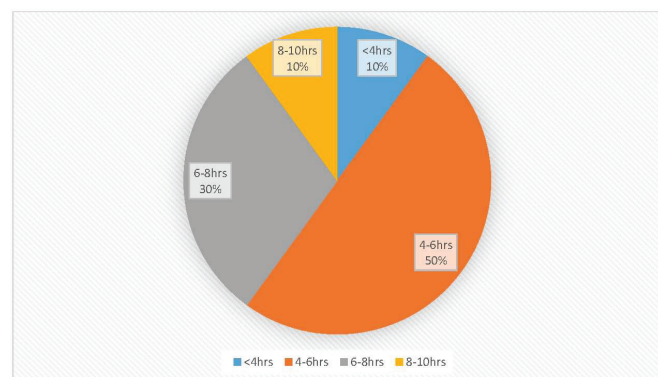


Chart 2: Time of presentation of patients post injury

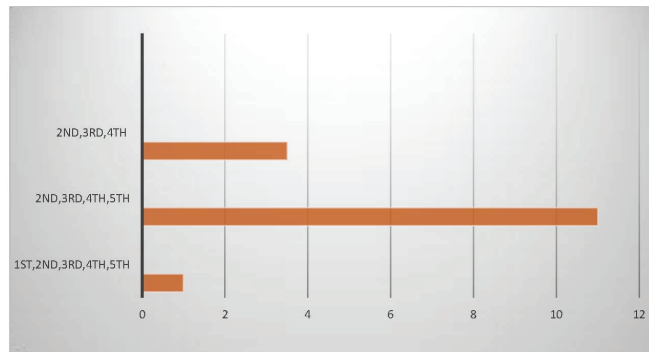


Chart 3-Involvement of digits

- 5) *Digits involved*- Nearly 55% of cases had involvement of 2nd, 3rd, 4th and 5th digits, while the little finger was spared in 40% of cases. A study conducted by Rohini *et al.* reported the incidence of multiple-digit involvement in nearly 32% of cases of hand injuries.¹¹ Though the thumb is characteristically spared in such cases, we had a single case of mangled upper extremity involving all of the digits (Chart 3).
- 6) *Operative intervention*- In our study, nearly 50% of cases were managed by skin suturing and splintage, while 10% of the cases suffered extensor tendon rupture along with a fracture of interphalangeal joints which had to be managed by tendon repair and K wire fixation. In 7 cases (35%), only tendon repair and skin suturing had been done (Chart 4). Splinting was done in all of the cases. For the single mangled hand case, thorough debridement of wound was done along with splintage. After 24 hours, it was reassessed for digital vascularity. Except middle and ring finger, rest of the fingers showed necrotic changes which were subsequently amputated with due consent. Fracture fixation

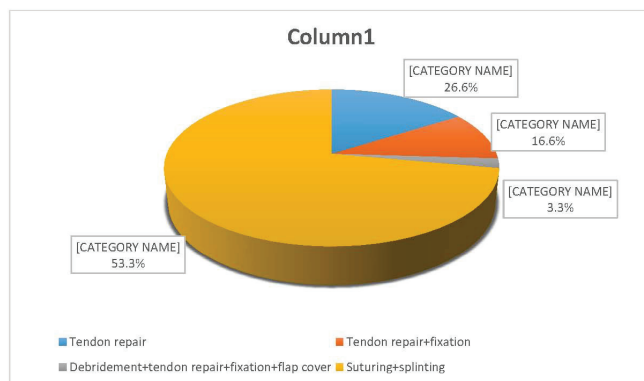


Chart 4: Surgical intervention done

and tendon repair were done with a flap cover to be planned in a subsequent sitting.

DISCUSSION

Sugarcane crushing injuries are common throughout India and going by various studies and data published before, it definitely has a seasonal incidence. Harvest of sugarcane is carried out during summer and spring season and thus its utilization. The pattern of injuries encountered creates unique challenges for reconstruction. The area proximal to the level of thumb is rarely injured. This happens because of thumb abducts while the cane is fed into rollers. The sucking of hand further into the machine is prevented as the thumb abuts over the guard. Between the distal palmar crease and proximal interphalangeal joint crease, there occurs a critical zone of maximum injury. This is where damage to neurovascular bundles occurs and hence should be kept in mind during assessment.¹² Early and thorough debridement of the wound along with intravenous antibiotics should be provided on presentation. The decision regarding fracture fixation, tendon repair, and soft tissue cover should be undertaken after the determination of salvageability, or else amputation should be advocated to the patient. Moreover, to attain near-normal hand functioning strict splinting (post-operatively) followed by a dedicated physiotherapy regimen should be planned.

Preventive measures have to be formulated to prevent such injuries. The patients seemed to be unaware of safety protocols and attributed to such mishaps as destiny. The risk of such injuries tends to increase while working with faulty machines. Wearing gloves reduced the risk by 60%.¹³ The government should provide local repair shops to upkeep the machinery and also provide modifications to address safety. All these measures are secondary, the primary being finding ways to tackle unawareness of safety protocols, identifying high-risk workers and disseminating proper knowledge about machine usage.¹⁴

CONCLUSION

Occupational injuries have become more common owing to booming industrialization and hand is the most commonly involved in such injuries. Proper and timely intervention if not carried out, results in

profound impairment in hand functions. Most of the time, these patients are of a low socioeconomic group and the sole earning members of their family. Awareness regarding proper usage and care of sugarcane machines is of utmost importance. The sugarcane machine vendors have to be made aware that occupational safety is the right of each one of them and not an entitlement for a few.

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