Abstract

Background: Snake bite is a neglected tropical disease. More than 50% of death due to snake bite in the world occurs in India. Acute kidney injury (AKI) is the cause of morbidity and mortality in viper bite. The compartment syndrome is a rare manifestation of snake bite. There is paucity of data on the role of fasciotomy in viper bite.

Methods: A prospective observational study was done in patients admitted to a tertiary care hospital in south India, with snake bite-associated acute kidney injury, from March 2018 to March 2020.

Results: Sixteen % of patients underwent fasciotomy following snake bite. We compared the renal outcome of 21 patients, who had undergone fasciotomy following snake bite, with 65 patients with dialysis-requiring acute kidney injury following snake bite. The patients in the fasciotomy group had a lower peak serum creatinine (5.3 mg/dl), needed less number of dialysis sessions (3.9) and were on lesser number of days (6.1) on dialysis following snake bite, when compared with the group not needing fasciotomy.

Conclusion: In snake bite patients presenting with compartment syndrome, fasciotomy should be considered in view of favourable renal outcome.

Key words: Compartment syndrome, Fasciotomy, Renal outcome, Snake bite

Introduction

Snake bite is an occupational hazard of rural Indian population. In India about 0.5% of deaths is due to snake envenomation each year, mostly in young individuals.1 Russel’s viper is the most common cause of mortality due to snake bite in south India.2

The presenting symptoms of Russel’s viper bite are cellulitis (96.7%), regional lymphadenopathy (89.5%), and bleeding manifestations (23.8%).3 Local manifestations are more severe in Russel’s viper bite including swelling, bleeding, blistering, necrosis and sometimes, severe swelling and
pain leading to compartment syndrome. The development of cellulitis is one of the risk factors for acute kidney injury.\textsuperscript{2} Fasciotomy may be needed to reduce tissue pressure in some cases of viper bite. There is risk of fasciotomy, for the victim due to the combination of consumption coagulopathy, thrombocytopenia, and enhanced fibrinolysis.\textsuperscript{4} We aimed to study the renal outcome of viper bite victim, who had undergone fasciotomy to reduce intra compartmental pressure.

**Methods**

This is a prospective observational study done in a tertiary care hospital, Government Mohankumaramangalam Medical College Hospital, Salem from March 2018 to March 2020. The study was approved by the Institutional ethics committee (GMMKMCH/2623/IEC/01/2016 -63).

We included all snake bite patients in the age group of 15 to 70 years developing acute kidney injury, by elevation in serum creatinine of at least by 0.3 mg/dl within 48 hours or 1.5 times the reference creatinine by Kidney Disease Improving Global Outcome (KDIGO) criteria. The snake bite patients with pre-existing chronic kidney disease, with no cellulitis and with pure neurotoxic envenomation were excluded.

All patients underwent the following investigations: 20-minute whole blood clotting time, complete blood count, blood urea, serum creatinine, urine analysis and prothrombin time. The creatinine phosphokinase and lactate dehydrogenase estimation were done in selected patients. The patients who developed AKI underwent ultrasound abdomen. The patients were treated with intravenous (IV) fluids and IV antibiotics. Anti-snake venom (ASV) was given according to local symptoms or systemic envenomation in the form of coagulopathy or neurotoxicity. Some patients with features of clinical compartment syndrome in the form of pain on passive movement, pallor, pulseless limb, hypoesthesia over the territory of sensory nerve passing through the compartment underwent fasciotomy, after adequate antivenin administration and correction of coagulopathy according to the surgeon’s clinical decision. Intra-compartmental pressure was not measured.

Early fasciotomy was defined as those who had undergone fasciotomy within 36 hours of bite, and late fasciotomy between 36 to 72 hours of bite. Patients who had undergone fasciotomy less than 72 hours after snake bite and developed renal failure, were compared to those patients with similar age and who had similar bite-to-ASV time and developed AKI, for renal outcome in the form of peak creatinine, oliguria (defined as less than 500ml/day) and duration of dialysis requirement. The AKI patients, managed conservatively were excluded from the final analysis.

The continuous variables were described as Mean ± standard deviation and categorical variables were described in %. Fisher’s exact test was used for categorical variables. The statistical analysis was done using one-way ANOVA test (SPSS software). The P value < 0.05 was considered statistically significant.

**Results**

After obtaining informed written consent, the clinical details of 186 patients including 68(37%) females with snake bite AKI due to hemotoxic envenomation were collected. Among 186 patients, 47 patients with AKI were managed conservatively and 139 (75%) patients needed renal replacement therapy in the form of peritoneal dialysis or haemodialysis. Fasciotomy was done in 29(16%) patients.

Among the dialysis-requiring renal failure, 107(77%) patients were oliguric. Fasciotomy was done in 5 out of 47 patients with AKI managed conservatively and 24 (17%) out of 139 patients with dialysis-requiring AKI.

In the final analysis, 3 patients with bite-to-fasciotomy interval of more than 5 days were excluded. The remaining 21 patients including 5 females with dialysis-requiring snake bite AKI, who underwent fasciotomy were matched with those who did not need fasciotomy following snake bite AKI, with similar age and bite-to-ASV time.

After matching, 86 patients including 30(35%) females with dialysis-requiring snake bite-AKI were stratified into two groups and compared.

Group 1 underwent fasciotomy in less than 72 hours following snake bite – 21

Group 2 who did not undergo fasciotomy following snake bite – 65
The patients were in the age range of 15 to 70 years. The time delay in initiation of ASV after bite was similar in both groups in the range of 1 to 16 hours. The total dose of ASV received by the participants were a minimum of 10 vials and a maximum of 45 vials during the study period. The total dose of ASV received by the snake bite victims was significantly more in those who had developed compartment syndrome needing fasciotomy (Table 1).

**Table 1: Comparison of Age of the patient, Dose and Timing of ASV**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>Mean ± Standard deviation</td>
<td>F Stat</td>
<td>P-value</td>
</tr>
<tr>
<td>Time delay in ASV initiation (hours)</td>
<td>4.9 ± 3.8</td>
<td>5.2 ± 4.2</td>
<td>0.08</td>
</tr>
<tr>
<td>Total number of ASV vials given</td>
<td>31.5 ± 7.4</td>
<td>26.1 ± 7.1</td>
<td>8.93</td>
</tr>
</tbody>
</table>

ASV – anti-snake venom

**Comparison of renal outcome**

In the fasciotomy group, significantly a greater number of patients presented with non-oliguric AKI (43%) following snake bite (Table 2).

**Table 2: Fasciotomy and Oliguric renal failure.**

<table>
<thead>
<tr>
<th>Group</th>
<th>Oliguric AKI</th>
<th>Non-oliguric AKI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasciotomy</td>
<td>12</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>No Fasciotomy</td>
<td>53</td>
<td>12</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>21</td>
<td>86</td>
</tr>
</tbody>
</table>

P-value = 0.04, AKI – acute kidney injury

The peak creatinine in the dialysis-requiring AKI patient following snake bite, who have undergone fasciotomy was significantly less. The number of days on dialysis and the number of dialysis sessions needed by the AKI patients following snake bite who have undergone fasciotomy were also significantly less (Table 3).

**Table 3: Fasciotomy and Peak of serum creatinine and Dialysis vintage**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± standard deviation</td>
<td>F Stat</td>
<td>P-value</td>
</tr>
<tr>
<td>Peak serum creatinine mg/dl</td>
<td>5.3 ± 2.5</td>
<td>6.9 ± 2.5</td>
<td>6.98</td>
</tr>
<tr>
<td>No of days on dialysis</td>
<td>6.1 ± 3.9</td>
<td>10 ± 6.9</td>
<td>6.30</td>
</tr>
<tr>
<td>No of sessions of dialysis</td>
<td>3.9 ± 2.2</td>
<td>5.9 ± 3.2</td>
<td>6.81</td>
</tr>
</tbody>
</table>

**Early vs Late Fasciotomy and Renal outcome**

Early fasciotomy was done in 12 patients and 9 patients underwent late fasciotomy. In the early fasciotomy group, even though patients had low peak serum creatinine and needed a lesser number of dialysis sessions, when compared to those who underwent fasciotomy more than 36 hours after bite, it was not significant (Table 4). This may be due to low number of patients in both groups.

**Table 4: Early vs Late fasciotomy and Renal outcome.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Early fasciotomy</th>
<th>Late fasciotomy</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± standard deviation</td>
<td>F Stat</td>
<td>P-value</td>
</tr>
<tr>
<td>Peak serum creatinine mg/dl</td>
<td>4.5 ± 2.5</td>
<td>6.3 ± 2.4</td>
<td>2.69</td>
</tr>
<tr>
<td>No of days on dialysis</td>
<td>5.1 ± 2.5</td>
<td>7.2 ± 5.1</td>
<td>1.59</td>
</tr>
<tr>
<td>No of sessions of dialysis</td>
<td>3.4 ± 1.5</td>
<td>4.7 ± 3.7</td>
<td>1.80</td>
</tr>
</tbody>
</table>
Discussion

In India, snake bite is commonly due to Russell’s viper or Echis carinatus, which causes AKI. The causes of AKI following snakebite are due to many factors including hypotension, haemolysis, rhabdomyolysis, disseminated intravascular coagulation and direct cytotoxicity.\(^5,7\)

Snake envenomation mimics compartment syndrome.\(^8\) However, true muscle compartment syndrome following snakebite is quite rare. The detection of arterial pulses by palpation or doppler ultrasound probes, does not exclude intra compartmental ischaemia.\(^4\) In compartment syndrome, pulselessness is seen only at a late stage associated with vascular injury. The sensitive sign is loss of two-point discrimination.\(^9\) The most reliable test is to measure intra compartmental pressure (ICP) directly through a cannula introduced into the compartment and connected to a pressure transducer or manometer. Normal resting muscle pressure is less than 8 mmHg and pain and paraesthesia appear at 20 to 30mmHg. If pressure is more than 30 mmHg, fasciotomy is indicated.\(^10\) In patients with hypotension, muscle damage from compartment syndrome can occur at ICP of 20 mmHg for 6 hours.

According to Toschlog EA et al, the proportion of patients needing fasciotomy following snake bite was 3.4% to 13% of hospitalized patients.\(^11\) According to Tanen DA et al, administration of adequate doses of antivenom reduces compartment pressure in animal experiments and eliminate the need for fasciotomy.\(^12\) Antivenom administration is indicated in all cases of compartment syndrome and fasciotomy should be performed in cases where aggressive antivenom therapy fails to correct impaired tissue perfusion.\(^13\) The fasciotomy has its own complication. The complications of fasciotomy include soft tissue infection, swollen limb, tethered scar, and venous insufficiency due to poor calf muscle function.\(^14,15\)

Renal outcome

According to Chawla LS et al, predictors of long-term poor renal outcome following AKI include advanced age, presence of diabetes, low serum albumin levels, and severity of AKI, as assessed by serum creatinine levels during hospitalization. In their study each 1 mg/dl rise in serum creatinine, increases the Odds of reaching CKD stage 4, by 50%.\(^16\) In addition to the severity of AKI, the duration of AKI is also an important prognostic determinant of long-term outcome. According to Mehta S et al, the duration of AKI was independently associated with long-term mortality, cardiovascular (CV) events, and development of incident CKD Stage 3.\(^17\)

The increased pressure in the subcutaneous and sub-fascial compartments in limb is associated with venom sequestration. In our study, the reduced compartment pressure after fasciotomy, causes less sequestration of toxin and less local damage, leading to less inflammatory mediator release and it may be the factor for less severe renal failure, in the form of lower peak serum creatinine and shorter duration of dialysis dependency following snake bite AKI presenting with compartment syndrome.

Conclusion

Fasciotomy was needed in 16% of viper bite victims. The patients who had undergone fasciotomy, needed more anti-snake venom following snake bite. The peak creatinine and duration of dialysis dependency were less, in those who underwent fasciotomy following snake bite. In view of favourable renal outcome, early fasciotomy should be judiciously considered in viper bite victims with compartment syndrome, after adequate ASV administration.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical clearance: The study was approved by the Institutional ethics committee.

References


