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Steroid Use in Tourniquet Paralysis

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ABSTRACT
Introduction: *Tourniquet paralysis is an infrequent but devastating complication and a real nightmare for a treating orthopaedic surgeon. Most likely this is due to a neuropraxia. . Mechanical pressure seems more important in the injury than distal ischaemia*
Methods: *90 patients were studied in Government Hospital Miraj over six month interval and the patients were followed fortnightly up till 3 months of surgery. 8 cases of tourniquet palsy were studied.*
These patients were followed up for nerve healing and functional recovery. All patients of nerve injury were treated with intravenous Dexamethasone 8mg twice a day for 3 days, and this gradually being tapered off. All patients were given vitamins for a month.
Results: *All the cases had tourniquet time more than an hour.*
6 cases (75%) were associated with Esmarch bandage. Females were affected more than males. 6/8 (75%). Upper limb was more involved than lower limb. 5/8 (62%). The average time for recovery in our study after giving steroids was 4 weeks.
Conclusions: *One must not forget the remote possibility of a nerve paralysis after a tourniquet application. A pneumatic tourniquet is preferred as compared to an Esmarch bandage. Steroids are certainly helpful in reducing the average recovery time. Almost all cases of tourniquet paralysis have a complete recovery.*
Keywords: *Tourniquet, Esmarch, Steroids, Palsy.*

INTRODUCTION

Tourniquet paralysis is an infrequent but devastating complication and a real nightmare for a treating orthopaedic surgeon. Most likely this is due to a neuropraxia. Nerve injuries associated with tourniquet use have been reported by quite a few. [1,2,3,4]. A survey of surgeons in the Australian Orthopaedic Association thirty years ago reported the incidence of nerve palsy to be 1 in 5000 and 1 in 13000, after upper limb and lower limb tourniquet use respectively [5]. This incidence of nerve injury is probably underestimated as the data provided for this survey was voluntary, and electro diagnostic testing was not routinely performed. Mechanical pressure seems more important in the injury than distal ischaemia[6]. Compression of the nerve causes micro vascular congestion and oedema, causing inadequate tissue perfusion and axonal degeneration [7]. Esmarch bandages can generate pressures in excess of 1000 mmHg immediately under the tourniquet [8]. Excessive continuous compression times cause a higher likelihood of neuropathy and delayed recovery of function [3]. The duration of tourniquet application is proportionate to quadriceps dysfunction following tourniquet-controlled knee surgery [9].While some degree of pain and muscle necrosis may be involved, delayed recovery may be the result of a slowly resolving axonal compression syndrome caused by the pneumatic tourniquet. Axonal injury induces muscle weakness, loss of sensation and leads to adaptive responses and neuropathic pain, but nerve regeneration following crush injury occurs at 3-4 mm per day [10].

METHODS

A total of 90 patients were studied in Government Hospital Miraj over six month interval and the patients were followed fortnightly up till 3 months of surgery. In 45 of these patients a pneumatic tourniquet was applied and in the remaining 45 an Esmarch bandage was used as a tourniquet. The age group ranged from 7 years to 75 years. All patients were studied as regards to operating time (time of tourniquet application), side and whether upper or lower limb.

The nerve injury patients were followed up for nerve healing and functional recovery (as given below) and each of these patients was given a disability percentage at various stages of follow up.

Functional recovery in the upper extremity was studied under the following parameters.

Lifting overhead	☐
Touching Nose	☐
Eating	☐
Combing	☐
Shirt	☐
Ablution glass	☐
Drinking glass	☐
Buttoning	☐
Tie Nara Dhoti	☐
Writing	☐

Each of these headings was awarded a disability percentage from a scale from 1-9

In addition hand grip strength (Maximum 20% disability), pinch grip strength (Maximum 10 % disability), opposition (8% disability) and sensory loss (Maximum 30 % disability) were also studied.

Functional recovery in the lower extremity was studied under the following parameters.

Plane surface ▭
Slope ▭
Stairs ▭
Both legs ▭
Affected leg ▭
Squat ▭
Cross legged ▭
Kneeling ▭
Turns ▭

Each of these headings was awarded a disability percentage from a scale from 1-9

In addition sensory loss was also studied and awarded an extra percentage from a scale of 1-10.

All patients of nerve palsy were treated with intravenous Dexamethasone 8mg twice a day for 3 days, and this gradually being tapered off. All patients were given injections of multivitamin while admitted followed by multivitamin tablets for a month after discharge.

RESULTS

Out of these 57 were males (63%) and 33 were females (37%). 64 patients (71.1%) were of lower extremity fractures and 26 patients (28.8%) were of upper extremity. Left side was involved in 5 (62%) patients and was more than the right side – which was involved in 3 patients (38%).

During the entire duration of the study we encountered 8 tourniquet paralysis; 6 of which were given Esmarch bandage (75%) and 2 whilst the use of a pneumatic tourniquet (25%)

All the cases of tourniquet paralysis that we encountered had a tourniquet time more than an hour.6 cases (75%) were associated with Esmarch elastic bandage. Females were affected more than males. 6/8 (75%).Upper limb was more involved than lower limb. 5/8 (62%). The average time for recovery in our study after giving steroids was 4 weeks.

Table 1. The chart of the patients who suffered from tourniquet induced paralysis

No	Age	Co morbidities	Type of tourniquet	Operating time	Average time of recovery of nerve injury	Disability percentage immediately post operatively	Residual Disability percentage at 3 months
1	7	Nil	Esmarch	1.5 hrs	3 weeks	55	0
2	24	Nil	Esmarch	2 hrs	3 weeks	42	4
3	55	Diabetes	Pneumatic	2.5 hrs	7 weeks	44	30
4	13	Nil	Esmarch	1 hr	4 weeks	40	0
5	50	Hypertension	Esmarch	2 hrs	4 weeks	45	0
6	23	Nil	Pneumatic	1.5 hrs	3 weeks	40	5
7	36	Diabetes	Esmarch	2 hrs	6 weeks	32	10
8	22	Nil	Esmarch	1.5 hrs	3 weeks	30	0

Figure 1 and 2: The 2 week follow up of a tourniquet paralysis of a 13 year old girl who suffered a left forearm fracture after 1 hour application of tourniquet.

Figure 3, 4 and 5. 3 week follow up of the same girl with slightly better grasp function

Figure 6. A 6 week follow up of the same girl showing full recovery of the left hand. Unfortunately she fractured her right hand this time and was admitted for the same.

Figure 7. A similar such case of a 24 year old man who was operated for elbow fracture. He showed recovery in 3 weeks.

DISCUSSION

Tourniquet paralysis is certainly linked with time. The time duration in the patients we studied ranged from 30 minutes to a maximum of 2.5 hours. All the cases of tourniquet paralysis that we encountered had a tourniquet time more than an hour.

Females were affected more than males. 6/8 (75%).

Esmarch bandage is more likely a culprit than Pneumatic tourniquet. 6 cases (75%) were associated with Esmarch bandage. This is probably due to the fact as we don't have much control over the pressure applied while applying an Esmarch bandage. Besides Esmarch bandages generate more pressures than pneumatic tourniquets. (96)

Upper limb was more involved than lower limb. 5/8 (62%). This is probably because the nerves of the upper limb are more superficial and more susceptible to injury.

Majority of the patients healed by the end of three months follow up. Only one particular diabetic patient had a residual disability of 30% at the end of 3 months. Diabetic patients on an average take longer time to heal as compared to normal patients.

The use of steroid significantly reduces the average time taken to heal. On average this time is three to six months [20]. The average time for recovery in our study after giving steroids was 4 weeks.

The two most common causes of these nerve injuries are: mechanical stress on the nerves under the cuff or at its edges and anoxia or ischemia of nerves under or distal to the cuff, which leads to a slowing or cessation of both sensory and motor nerve conduction. Pressure is more responsible for nerve damage than ischaemia.

Persons with flaccid, loose skin (e.g., the elderly), or persons with large amounts of subcutaneous tissue on cone - shaped limbs are subject to nerve and tissue injury from a shearing force mechanically created by an improperly fitting cuff. Most often, shearing occurs at the proximal edge of the cuff. Risk of shearing - related injury may be reduced by selecting a contoured cuff (which fits the limb taper) and a matching limb protection sleeve.

Preventive Measures

Because tourniquet - related neural injury has been linked to mechanical rather than ischemic factors, mechanical stress merits the most focus for preventing nerve injury. It is recommended that the minimum tourniquet pressure that is necessary to obtain a stable, bloodless field be employed in all circumstances. Safety measures to prevent nerve injury and pressure - induced complications can be summarized as follows:

- Never use a tourniquet for more than the recommended period of time.
- Make sure that the pressure display accurately reflects the pressure within the cuff bladder. Some nerve palsies may be secondary to faulty pressure gauges causing excessive tourniquet inflation pressures.
- Use only the minimal effective pressure required to reliably maintain arterial occlusion throughout the procedure.
- Use a cuff that properly fits the extremity and has the maximum bladder width possible.
- Use a limb protection sleeve that matches the selected cuff.
- Apply the cuff to the limb with care and attention, according to the manufacturer's instructions.
- Apply the cuff at the proper location on the limb. Application of the cuff over the peroneal nerve (the knee or ankle) or the ulnar nerve (the elbow) may produce nerve/bone impingement resulting in nerve damage or paralysis.

In addition, do not permit the tourniquet to slip or twist during limb manipulation. Do not pinch or kink the connecting tubing. Avoid wrinkling of loose, flaccid tissue and/or padding under the cuff by using the proper limb protection sleeve for the cuff, or 2 layer tubular stockinettes which is stretched and applies light compression to the limb when applied.

Review of literature

More than 50 cases of tourniquet paralysis have been reported unto now.[11,14,17,19,21,22] However majority of these have been caused by rubber tubing or elastic bandage. Approximately 20 or so cases have been reported with a Pneumatic tourniquet [14, 15, and 16]

The radial nerve is the most vulnerable, but the ulnar and median are also often damaged. Damage to musculoskeletal nerve is rare.

Nerve lesions heal spontaneously in three to six months [20] and are only exceptionally permanent. [19]

Digital Pressure is regarded as a cause [11, 15, and 22] as compared to ischaemia. [12].

Spiegel and Lewin (1945) surgically explored three cases of tourniquet paralysis. They noted that at the

site of compression the nerve diameter was reduced to one half or one quarter of normal. In addition scarring and neuromata were found.

The significance of exsanguiation remains unclear.

Over two hours is not recommended as tissues start to suffer from acidosis after that time. [18]

The pressure recommended for a pneumatic cuff applied to upper arm is 250 millimetres of mercury in adults and 200 millimetres in children. [13]

CONCLUSIONS

One must not forget the remote possibility of a nerve paralysis after a tourniquet application.

A pneumatic tourniquet is preferred as compared to an Esmarch bandage.

Steroids are certainly helpful in reducing the average recovery time.

Almost all cases of tourniquet paralysis have a complete recovery.

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