ASSOCIATED INJURIES AND COMPLICATIONS OF STAB WOUNDS OF THE SPINAL CORD

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THIS review follows on an earlier series (Lipschitz and Block, 1962). At that stage 130 cases of stab wounds of the spinal cord were discussed and these occurred over a period of $4\frac{1}{2}$ years, viz. 1955-1959. In the following eight years, because of improved socio-economic conditions amongst the Africans living in and around Johannesburg our figures have decreased and only a further 122 cases have been collected, making a total of 252 all in all. In this group there were no less than 86 associated injuries. These stab wounds of the spine have on occasion been inflicted with the deliberate intention of making the patient paraplegic but more recently this means of 'getting even' with a fellow-gangster has been replaced by more sophisticated methods. The majority of our stab wounds of the spine occur as the result of generalised stabbing. Our hospital, which in the pre-1960's used to admit over 5,000 cases of generalised stabbing a year, now admits less than 2,500 stab wound cases annually. As most of these stab wounds are haphazardly inflicted, the chances are that a certain number will penetrate into the spinal column and destroy or damage the cord. The weapon, as stated previously, can be any sharp instrument which is long enough and strong enough to be effective. Knives of every shape and description were by far the commonest though we have also encountered such weapons as sharpened screw-drivers and bicycle spokes. Very often the patient does not know what weapon was used as many of the stab wounds are inflicted into his back and the victim is taken by surprise. The weapon is usually withdrawn but sometimes such force is used that the knife which enters the vertebral body is embedded so tightly in the bone that either the stabber is unable to withdraw the knife or in trying to do so the handle of the weapon snaps off, leaving the blade or portion of the blade behind.

As many of these stabs which damage the cord are haphazardly aimed, it is obvious that other organs will be injured in transit of the sharp point through the body towards the spinal cord. Furthermore, where the stab wound is inflicted during a fight, these patients may naturally sustain multiple injuries. These other injuries may be due to the related stab wound, other stab wounds or various blunt trauma such as kicks, being hit with various blunt instruments, etc. These associated injuries are often as severe if not more dangerous than the actual stab wound causing the paraplegia.

Head Injuries. No less than 12 of our patients on admission were unconscious due to associated head injuries. Even in the presence of a mid-line stab—let alone one further afield—the diagnosis of a spinal injury is most difficult because the paresis or paralysis of the limbs may be due to the head injury or spinal injury or both. This poses a problem since the patients are unconscious and unable to give a history or co-operate with a detailed examination.

Where the spinal cord has been cut it has often been noted that these patients have a 'cold nose' and 'warm feet' due to vaso-dilatation of the lower limbs which is not a common finding in primary head injuries. Secondly, should the lesion be such that bladder control is affected, then in spinal injuries the patient has a dribbling overflowing incontinence; whereas in head injuries the incontinence is similar to that which we find in a normal infant, *i.e.* as soon as the bladder is full he spills over and then completely empties his bladder. The greatest diagnostic difficulty occurs in those patients who have a bilateral midline injury over the sagittal sinus in the region of the motor cortex. Here, one will get the equivalent of a paraplegia but as stated above, though these patients become incontinent it is usually of the automatic infant type rather than the continuous dribbling overflow incontinence of the spinal injury. We have had three such patients who on admission have been mistaken for cases of spinal trauma.

X-ray of the spine does not help greatly as the majority of stab wounds to the spine do not give a positive X-ray picture since the knife often passes between the laminae rather than through them, especially if the stab is in an upward direction. Even in the cases where a fracture of the lamina has been found at operation the fracture was often not visible on standard radiographs.

Cutting of Major Vessels in the Neck in High Cervical Stabs.—Any of the carotid arteries, or more rarely, the vertebral artery, may be cut by the weapon. The artery may be completely severed or just nicked causing a small lateral opening. This leads to extensive bleeding and haematoma formation in the neck. Often because of the tension of the tissues, the smallness of the opening of the entrance wound in the vessel and the haematoma formation, the patient will stop bleeding. On the other hand the patient may haemorrhage to death via the external wound or into the thoracic cavity.

In cases where the vessel is totally severed, and the patient survives, the patient has to rely on cross-circulation of the circle of Willis to maintain the blood supply to the ipsilateral side of the brain. In this instance the following may occur:

- (a) The cross-circulation is adequate, in which case the artery can be safely ligated in the neck and the patient treated as in the case of carotid ligation in certain types of cerebral aneurysm (Lipschitz and Hagen, 1964). This occurred in one case.
- (b) The carotid circulation from the contra-lateral side will be insufficient in which case the patient will develop a hemiparesis in addition to his spinal cord para- or tetraplegia. This occurred in two cases: in one of them the cerebral oedema resulting from anoxia to the hemisphere was so great that the patient died of cerebral compression from a swollen, insufficiently oxygenated hemisphere. The treatment here, where possible, is to restore the artery and thus the continuity of the blood supply, though usually by the time the patient arrives at the hospital the damage to the hemisphere is irreversible.

Should these patients be shocked, then the drop in blood pressure may be enough in itself to prevent the contra-lateral carotid artery from supplying the ipsi-lateral hemisphere with blood. Accordingly shock must be actively and rapidly treated.

Where the laceration to the artery is small a haematoma forms and may seal off the hole. After a few weeks the vessel may completely heal or an aneurysm may form. One case in this series developed an aneurysm of the carotid artery which was dealt with surgically.

Discussion with our pathologists in our medico-legal laboratories (Kemp, personal communication) revealed that they have had quite a number of deaths due to the cutting of the carotid and one patient died after cutting of the vertebral artery. In this last case death was not instantaneous as the patient lived for two days, only to die of anoxia of the vital structures in the posterior fossa. The circulation through the circle of Willis appeared to be inadequate leading to anoxia and oedema of the vital centres.

Injuries to the Brachial Plexus. This can cause a serious dilemma, for here, the knife in transit may pass through the brachial plexus and the patient may be left with a lower motor type monoplegia superimposed on his para- or tetraplegia. The diagnosis can be most difficult and it is quite possible that we have missed such injuries in some of the cases in our series. One case sustained an injury to his brachial plexus giving him a marked flaccid monoplegia. Further penetration of the knife caused a partial tetrapegia. He recovered rapidly from his partial tetraplegia but since he had no recovery from his brachial plexus lesion it was decided to explore his neck. At operation, the roots of the brachial plexus were found to be severed. In this patient the limb remained permanently flaccid. Electromyography confirmed a lower motor neurone lesion. However, very often in a stab wound of the cord the knife may cut one root inside of the bony confines of the canal. In order to diagnose a lesion of the brachial plexus with confidence, in a case in which there is a tetraplegia, there must be evidence of a lower motor neurone involvement of at least two or more roots, cords or nerves.

4. Injury to Trachea and Oesophagus. These usually occur in multiple stab wounds in the neck and though in this series there are no stab wounds of the oesophagus, a case of such an injury has been seen by our medico-legal pathologist colleagues. In that case the patient died of mediastinitis following a stab wound into his neck.

Extensive emphysema may follow stab wounds of the trachea associated with paraplegia. This emphysema may be marked, extending over large areas of the body. We have three such cases and two required low tracheostomy.

5. Stab Wounds of the Thoracic Cage. Very often in stab wounds of the lower cervical and upper dorsal region, the thoracic cage is penetrated. When this occurs, the lung, the heart, the pericardium, any of the vessels in the thoracic cage, the oesophagus or trachea or even the thoracic duct may be cut.

- (a) *Stab Wounds of the Lung:* This can lead to pneumothorax or even haemo-pneumothorax or haemothorax. This occurred in no less than 18 of our cases. Should the patient develop marked haemothorax or pneumothorax or haemo-pneumothorax this will further impede oxygenation of the patient. It can be easily understood, how much more desperate the position will become in the case of a tetra- or high paraplegic patient, who is relying only on diaphragmatic and accessory muscles for

respiration. As all stab wounds of the spine should have full X-ray studies, an X-ray of the chest will diagnose the above condition immediately. The above condition must obviously be treated as soon as possible and as actively as possible if the patient is to survive.

In traumatic pneumothorax the patient may develop marked spreading surgical emphysema. This surgical emphysema, however, usually settles within a few days. Occasionally the haemo-pneumothorax may go on and become septic or the blood may clot and become organised. These complications can be avoided by early recognition and treatment of the condition.

- (b) *Damage to Major Vessels in the Thoracic Cavity:* Following a stab wound of the cord, haemorrhage can arise from either the aorta, the pulmonary artery or the veins draining into the heart. However, the commonest cause is usually due to bleeding, from intercostal vessels or the internal mammary arteries. These must be treated on their merits and the diagnosis is made by clinical and radiological means. Some of our cases in this series fell among the 18 described in Section (a), *viz.* stab wounds of the lung.
- (c) *Stab Wounds into the Heart:* A patient had two stab wounds, one into the heart and another which damaged his cord. On arrival at our hospital he was found to have a marked cardiac tamponade. The hole in the heart was sutured and the second stab which entered the cord rendered him partially paraplegic. He recovered from both injuries sufficiently to return to his former occupation. He was indeed fortunate. One case was stabbed twice—once into the cord which caused partial damage—and the other stab must have gone among the great vessels in his neck. Though there was no bleeding from any major vessel, 40 hours after the injury he suddenly developed a dense hemiparesis. On angiography it was found that his middle cerebral artery failed to fill and it was surmised that the stab into the upper neck must have damaged one of his great vessels or some part of his heart leading to thrombus formation and embolism to his brain. We have seen this pathology, unrelated to paraplegia, in stabs in the region of the great vessels in the neck or in the region of the heart. This has been shown at post-mortem to be due to bruising of the heart or great vessels leading to thrombus formation which embolises.

Stab wounds of the heart, occurring in paraplegia, are usually due to a second stab very often not associated with the one causing the paraplegia.

- (d) *Chylothorax:* We have seen one case where the lateral stab wound of the neck ended in a high thoracic paraplegia. This patient developed a chylothorax which dried up after a few days of intercostal drainage.
- (e) *Rupture of the Diaphragm:* In a case of a stab wound of the spine, as the result of the diaphragm being lacerated, the stomach and colon were found on X-ray to be in the right side of the chest. This was corrected by means of diaphragmatic suture. This injury may not be immediately recognisable and may only be found weeks or even months after the injury.

6. Abdominal Injuries (16 cases). One unfortunate individual had a stab wound which involved the lung, spleen, stomach, small bowel in addition to his cord injury. Almost any organ in the abdomen can be affected by a stab wound and any major vessel can be cut. In one case the stab wound in the mid-line posteriorly went between the laminae through the cord, through the vertebral body and the point impinged against the aorta anteriorly. Retro-peritoneal haemorrhage is also not an uncommon finding where one of the lumbar arteries or veins has been cut. This often leads to paralytic ileus and gastric dilatation, which if not recognised early may lead to a fatal outcome.

The diagnosis of intra-abdominal injuries is extremely difficult as the abdominal muscles following stab wound of the cord may be rigid, and the patient does not complain of abdominal pain. One has to rely on such secondary symptoms and signs such as shifting dullness and developing shock. The peritoneal cavity may have to be tapped to ascertain whether or not it contains free blood. One case who had a malarial spleen suffered a rupture of this organ as the result of a kick following on the stab wound to his spine.

Most surgeons, however, routinely carry out laparotomy in any stab wound of the abdomen, while others prefer to wait and watch for more evidence of visceral penetration—this latter delay may be dangerous.

In this series we have not seen a stab wound of the bladder in association with paraplegia. On the other hand five patients were admitted with stab wounds of the kidney. The diagnosis of this is dependent on the finding of blood in the urine. In all cases of stab wounds in the region of the kidney the urine must be carefully examined.

7. Injuries of the Limbs. As stated before, these persons who have been stabbed, especially where there has been gang warfare, may also be severely beaten and injured. One particular case, after being stabbed, was thrown out of a car and sustained a compound fractured femur. Another, as a result of a beating received a fracture of the humerus in the same fight in which he was rendered paraplegic. Similarly, other bones may be fractured in association with stab wounds but to go into all these injuries would be far beyond the scope of this paper as the computations and permutations of this are vast.

8. Injuries to the Vertebral Column. Firstly the knife may fracture a lamina or may become deeply embedded in the actual body of the vertebra and may even pass right through the body. The knife is often so deeply embedded that the assailant is unable to withdraw it. We have in fact had five cases where the handle has broken off. Very often, after formal exploration and laminectomy, only by brute force and the use of garage instruments such as 'vice-grips' were we able to withdraw the blade.

Sometimes the point of the blade breaks off and remains embedded in the patient. We have had four such cases. One patient who had suffered a stab wound of the mid-thoracic spine, complained that every time he leaned down to touch his toes, his legs felt weak and a shock-like wave travelled down them. On X-ray of the spine the blade was found embedded in the body of the fifth thoracic vertebra and at laminectomy it was found that the blade of the knife had gone right through the cord in the mid-line. The tip of the knife had then broken off and remained *in situ* deeply embedded in the bone with the posterior

portion thrusting backwards and impinging on the cord. Fortunately, that portion of the blade which was left behind was in a vertical direction, and after removal the patient made an uninterrupted recovery except for a band of anaesthesia around his waist.

Sepsis is an added associated complication and in this series two chronic Brodie's ulcers developed where the knife had become embedded in the body

FIGS. 1 and 2

AP and lateral of spine, showing Brodie's abscess after laminectomy and removal of knife blade.

and in one of these cases the patient arrived at the hospital with an abscess high up in his left buttock. He had had a stab wound of the spine five months previously (Figs. 1 and 2). On examination there was the abscess described, a small healed scar over D11/12 near the midline and a mild weakness of his left foot associated with a partial anaesthesia. X-ray showed an embedded, broken-off knife point in the body of D11. This was removed and the abscess healed. However, he developed a small Brodie's abscess of the body of the vertebra which responded only to lengthy bed rest and the use of antibiotics.

Two cases developed chronic epidural granulomata as a result of their stab wounds. These patients presented a history of a stab wound and a slowly progressive paraplegia over a few weeks. At operation the epidural granuloma was found and these patients responded to decompression and antibiotics.

Four patients developed gross meningitis; one of them died. At post-

mortem an epidural abscess was found to be the cause of his meningitis. This abscess was due to a stab wound of the spine.

Another local injury that is not uncommon is that of CSF leak. This occurs as a result of a stab wound that has been inadequately sutured and in this series there were no less than nine such cases. Their treatment is very simple—a debridement of the muscles and skin with resuture is carried out and the patient placed on antibiotics.

CONCLUSIONS

In stab wounds of the spinal cord the wounds may be multiple and the person may have additional diverse injuries. It is therefore the duty of any medical practitioner examining a stab of the spine to remember that the signs and symptoms presented by the patient are not necessarily due to the stab wound alone but may be due to associated injuries. A very careful examination has to be carried out especially where a small weapon has been used, as the entrance wound may be so tiny as almost to defy detection. In one case of a stab wound of the spine, the entrance wound was found only on lifting the arm and looking in the axillary hair where the small entrance wound measuring 3 mm. in diameter was found—the stab wound being due to a sharpened bicycle spoke. This patient also had a haemo-pneumothorax. Furthermore, the practitioner must be aware that the paraplegia may mask many of the signs and symptoms of the associated injuries that one may find in a stab wound of the spinal cord.

SUMMARY

86 associated injuries and associated complications in 252 stab wounds of the spinal cord are described. The main problem is to be aware of these injuries and to recognise them in the presence of a totally or partially paralysed patient. This is especially so because these associated lesions may not necessarily be due to the stab causing the spinal cord trauma but due to other injuries inflicted at the same time.

RÉSUMÉ

86 lésions associées ainsi que leurs complications dans 252 atteintes médullaires par armes blanches sont décrites. Le problème principal est celui de la reconnaissance de ces lésions et de pouvoir les reconnaître chez un malade totalement ou partiellement paralysé. Ceci spécialement parce que ces lésions associées peuvent ne pas être, nécessairement, dues à la blessure médullaire, mais à d'autres lésions subies en même temps.

ZUSAMMENFASSUNG

86 assoziierte Verletzungen und Komplikationen in 252 Stickverletzungen des Rückenmarks werden beschrieben. Das Hauptproblem ist die Diagnose diesser Nebenverletzungen im total oder partiell gelähmten Patienten. Dies ist umso wichtiger, als die assoziierten Verletzungen abgesehen von der Rückenmarksverletzung gleichzeitig erfolgen können.

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