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Coup and contrecoup head injuries: Predictors of outcome

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Abstract : Coup and contrecoup contusions comprise a group of focal brain injuries. The pathogenesis of the two are different, the outcome in the two would therefore be expected to be different. However there are no studies in literature comparing outcome in coup-contrecoup injuries. At NIMHANS, Bangalore, two hundred and ninety eight consecutive cases presenting with coup and contrecoup injuries over a 2-year period were retrospectively analyzed. They were divided into three groups: Coup injuries with intraparenchymal injury (n = 129), contrecoup injuries (n = 84) and coup-contrecoup injuries (n = 85). The groups were comparable with respect to age and GCS. Site of primary impact was determined by clinical and CT scan criteria. The mortality rates in each group were compared with respect to age, GCS and CT pattern. Significance was calculated using the chi –square test. There was a statistically significant difference in mortality between patients with coup injuries and patients with contrecoup ($p< 0.005$) and coup-contrecoup injuries ($p<0.001$). There was no significant difference in mortality between contrecoup and coup-contrecoup injuries ($p = 0.1$). Mortality in patients aged less that 60 years and patients with GCS > 8 was significantly higher in patients with contrecoup and coup-contrecoup injuries. Presence of a contrecoup component on CT scan may portend a worse outcome in head injuries and may warrant closer monitoring and more aggressive management of these patients.

Keywords: coup, contrecoup, contusion

INTRODUCTION

Focal brain injuries are found in approximately one half of all the patients with severe brain injuries and are responsible for nearly two-thirds of the deaths associated with head injury[1,2,3]. Coup and contrecoup injuries comprise a group of focal brain injuries. The pathogenesis of the two is different, with coup injury occurring under the impact point while contrecoup injuries occur at areas distant from the point of impact as a result of shock waves travelling across the brain causing stress/ cavitation effects[4]. The outcome in the two therefore would be expected to be different. However there are no studies in literature comparing outcome in coup and contrecoup injuries

Outcome after head injuries continues to be an evolving science, with various factors being implicated. It has generally been accepted that the neurological status and age of the patient are the two most important factors in prediction of outcome[5,6,7,8]. It is increasingly evident that the pattern of structural brain injury as visualized by computed tomography (CT) and the depth and duration of ischemia are also important factors[8,9]. Although the pattern of injury on CT scan has been studied, outcome in relation to coup and contrecoup injuries is not known. The presence of a contrecoup injury implies a more severe primary impact, and therefore an injury more diffuse, than focal. We hypothesized that patients with contrecoup injuries would have a worse outcome because of the diffuse nature of injury.

With CT scan it is possible to precisely delineate the type, location and severity in the majority of head injured patients and to determine whether injuries are coup or contrecoup. The present study was undertaken to study the outcome in coup and contrecoup brain injuries.

MATERIALS AND METHODS

A retrospective study of 298 patients with head injuries who presented to NIMHANS was carried out. The case records were studied with respect to age, sex, mode of injury, Glasgow coma score (GCS), pupillary asymmetry and focal neurological deficits, at admission and at discharge. Patients with systemic injuries and polytrauma were excluded from the study.

CT scans which showed unequivocal evidence of coup, coup-contrecoup and contrecoup injuries were reviewed.

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The clinical parameters used to determine coup versus contrecoup contusions were the presence of scalp lacerations, scalp bogginess or obvious fractures. Imaging parameters noted on the CT were subgaleal haematoma, fracture and the presence of underlying haematoma or contusion. The injuries were classified into 3 groups: Coup injuries with intraparenchymal injury (n = 129), contrecoup injuries (n = 84) and coup-contrecoup injuries (n = 85).

Outcome measured in this study was mortality during the same hospital admission. Using the Chi square test, the mortality rates were compared across the groups and then correlated with the GCS and age and conclusions were made based on the "p" value.

RESULTS

The age of the patients ranged from 4 months to 78 years with an average age of 39.5 years. There was no significant difference amongst the three groups with respect to average age, although patients with coup injuries tended to be younger. Road traffic accident was the commonest mode of injury (53.1%), followed by fall (28.9%) and assault (10.4%). In 7.5% the cause was undetermined. The mean GCS of the entire study population was 9, and there was no difference of GCS in all three groups.

CT pattern of injury : Based on the criteria, 129 patients (43.3%) had coup injury with parenchymal injury, 84 (28.2%) had significant contrecoup injuries and 85 (28.5%) patients had significant coup and contrecoup injuries (Table 1).

Coup injuries: The most common coup injury was depressed fracture with contusion (n = 61); followed by extradural hematoma (EDH) with contusion (n = 16).

Coup-contrecoup injuries: Patients with these injuries had a coup injury on one side with a distant contrecoup injury. Patient with bilateral contusions (n = 39) and EDH with contusion (n = 30) formed the majority in this group.

Contrecoup injuries: Patients in this group had an insignificant coup injury such as a linear fracture or subgaleal haematoms, but had a significant intracranial isolated contrecoup injury. Patients with contusions distant from the site of primary impact were the dominant group (n = 37).

Table 1: Pattern of injuries

Type of lesion	Percentage	
I. Coup (with parenchymal) injuries (n = 129)		
Depressed fracture with SDH	1	0.2%
Depressed fracture with contusion	61	15.3%
Depressed fracture with EDH with intradural lesion	4	1.0%
EDH with SDH	1	0.2%
EDH with contusion	16	4.02%
EDH with SDH + contusion	1	0.2%
Acute SDH	12	3.0%
Acute SDH +Contusion	11	2.7%
Contusion	22	5.5%
II. Coup – contrecoup injuries (n = 85)		
Bilateral contusions	39	45.8%
EDH with contrecoup contusion	30	35.3%
SDH with contrecoup contusion	10	11.8%
Contusion with contrecoup SDH	3	3.5%
Depressed fracture with contrecoup Contusion	3	3.5%
III. Contrecoup injuries (n = 84)		
Acute SDH	23	27.3%
Contusions	37	44.0%
Acute SDH with contusion	24	28.7%

Management: All patients were clinically assessed and were operated depending on the size of the lesion and mass effect as demonstrated in the CT scan. Patients in good neurological condition with small lesion were managed conservatively. Some patients with significant injuries but with very poor GCS and absent brainstem reflexes were not operated. Patients with severe head injuries were ventilated.

Comparison of mortality in the three groups (Table 2): Outcome was best in the group with coup injuries. Coup injuries with parenchymal injuries had a significantly lower mortality than both coup-contrecoup injuries ($p<0.005$) and contrecoup injuries ($p<0.001$). The addition of a contrecoup component to the injury increased the mortality rate, particularly when the injury was purely contrecoup. However, the difference (between coup-contrecoup and pure contrecoup injuries) was not statistically significant ($p = 0.1$).

FACTORS INFLUENCING MORTALITY

Age: The predominant age group was less than 40 years. Patients aged over 60 years were the minority, in all three groups. Patients with coup injuries in the age

Table 2: Outcome and mortality for all groups

	Coup with Parenchymal (n = 129)	Coup-contrecoup (n = 85)	Contre-coup (n = 84)	P value
I.Outcome				
Improved	93(72.1%)	47(55.3%)	39(46.5%)	
Same	15(11.6%)	10(11.7%)	7(8.3%)	
Dead	21(16.4%)	28(33%)	37(44.1%)	<0.001
II.Mortality				
1. GCS				
3-8	39.1%	42.5%	38.6%	NS
9-12	6.6%	19%	28.5%	<0.05
13-15	0%	12.5%	8.3%	<0.02
2. Age(yrs)				
≤ 40 yrs	13.4%	36.3%	43.9%	<0.001
41-60 yrs	4.1%	30%	35.4%	<0.001
> 60 yrs	62.5%	75%	58.3%	NS

(NS - Not Significant)

groups of < 40 years and 41-60 years, had significantly lower mortality rates than their counterparts with contrecoup injuries (p<0.001). Patients aged 60 years and above had similar mortality rates in all groups, with the difference between them being statistically insignificant. Mortality in patients with coup-contrecoup and contrecoup injuries was similar across all age groups (p = 0.1).

GCS: There was statistically significant difference in two groups in patients with moderate and mild head injury p value <0.05 and <0.02 respectively. However there was no significant difference in mortality in all three groups for severe head injury.

DISCUSSION

The Glasgow coma score has been extensively tested as a means of rapidly assessing a patient with head injury and making an early and accurate prediction of outcome[6,7]. However the GCS is not an absolute predictor as there are patients with poor scores who may improve as also patients with good scores who may not show expected improvement. As many as 4% to 40% of patients with GCS less than 9 may have a good outcome. This suggests the participation of other factors in influencing outcome after head injury. Marshall et al have related outcome to the diagnostic categories on CT scan[8]. The mortality rates according to CT scan classification are also variable. Mortality rates of upto 10% were found in patients with diffuse injury type I and upto 40% in patients with evacuated mass lesions. Other factors such as a raised intracranial pressure also have been shown to be associated with a poor prognosis[7,8]. However, few if any authors have dealt on the role of coup versus contrecoup injuries in influencing outcome. There are no studies specifically comparing outcomes in coup and contrecoup injuries available in literature.

In this study the mean GCS and age were comparable in all three groups, though the patients in only coup contusions were younger.

Mortality rates varied significantly among the three groups, being 16.4% in patients with coup injuries with intraparenchymal injury, compared to 33% in those with coup-contrecoup injuries and 44% in those with contrecoup injuries. This implies that the addition of the contrecoup component of the injury significantly increases the mortality rate in patients with head injuries. However the mortality is higher irrespective of presence of contrecoup injuries when the age of patient is more than 60 years, the GCS is less than 8 and if patient also has acute subdural haematoma. The highest mortality in this study was found in patients with acute subdural haematomas when they occurred in isolation, either as a part of coup or contrecoup mechanisms. The mortality rate in this study is almost exactly the same as found in the series of Gennarelli et al[2].

Lobato et al found the highest mortality for patients with bilateral contusions (58%)[9]. In this study patients with bilateral contusions had a mortality of 33%. In contrast to the study by Kotwica et al, this study found that patients with acute subdural haematomas with associated contusions had a better outcome than acute subdural haematomas alone[10]. This is also contrary to the findings of Seelig et al who found no difference in outcome for patients with or without associated contusions[11].

Age was a significant determining factor in outcome. Patients in the age group over 60 years had the worst outcomes. The overall mortality of patients aged 40 years or less was 14%, aged 41-60 was 18.4% and patients aged more than 60 years was 55%. Jayakumar et al found contrecoup injuries in 9.6% of their 650 patients[12]. In this study comprising of cases of only contrecoup injuries, the mortality was 41% in patients less than 40 years and 67% in patients more than 40 years of age. Mortality for bilateral contusions was 79% in this study[12]. Comparable figures in the present study, for patients less than 40 years were 43.9% and for

patients more than 40 years was 35.4%, for contrecoup injuries. However patients above 60 years with contrecoup injuries, in this study had a mortality of 58.3%. Amongst patients 40 years or less, the highest mortalities were for patient with acute subdural haematomas, whether coup or contrecoup.

The study by Lobato et al suggested that patients with coup contrecoup injuries or bilateral injuries fare worse than other groups of patients[9]. The study by Generalli et al was a large, multicenter trial conducted across seven centers which found that lesion type was a significant factor determining outcome but it did not correlate outcomes in patients with unilateral versus bilateral injuries[2]. The present study also showed a poorer prognosis in patients with coup - contrecoup injuries as compared to those with only coup injuries.

Various other authors have shown that epidural haematomas and acute subdural haematomas associated with contusions or other intradural haematomas carry a worse outcome than either one alone. This suggests that the further the spread of he shock wave through the brain, the more the damage and the worse the outcome.

CONCLUSION

Though a number of studies are available on outcome prediction after head injury, very few studies have analyzed the role of coup injuries versus contrecoup injuries in influencing outcome. The present study shows that the presence of contrecoup contusions, with or without coup contusions, is associated with a poor prognosis across all GCS and age categories. However, age more than 60 years, GCS $\geq$ 8, and presence of acute SDH on CT scan was uniformly associated with a poor outcome.

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