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Non-metallic and metallic craniocerebral missile injuries : Varied outcome

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Abstract: We studied the comparative outcome related to 694 non-metallic and metallic craniocerebral missile injuries who lived at 2 hours and beyond the time of injury in a retrospective and prospective analysis in the Department of Neurosurgery at Sher-I-Kashmir Institute of Medical Sciences (SKIMS) Kashmir, India, over a period of 21 years from September 1988 to March, 2010. The study revealed an overall mortality of 32.70% (227 out of 694). A total of 664 adults and 30 children (mostly teenagers) were studied. The 79.1% (549 out of 694) patients were metallic missile injuries whereas 20.8% (145 out of 694) patients were non-metallic missile injuries. The non-metallic missile injury group mostly (72.4% i.e.; 105 out of 145) had low GCS score and overall worse prognosis with zero good-recovery, 47.5% disabilities and 52.4% mortality as compared to the metallic missile injury group. The non-metallic group comprised of 60% (18 out of 30) children with one death. Non-metallic missile injuries accounted for 10.95% (76 out of 694 patients) of total deaths. Predictors of poor outcome were low admission GCS score, non-metallic penetrating injury due to tear-gas cartridges, rubber bullets and stone-bullets, perforating metallic missile injuries and delayed and maltransportation. Most complications in non-metallic missile injuries were infective and had poor outcome. The common non-metallic missiles used were stone bullets (balls) fired by Gulail (modified catapult) or slingshot, red rubber bullets, plastic tear gas shells and cartridges, wooden (pulped mulberry stem) and card-board wads used in shotguns. The stone pelting, throwing stone projectiles (stone-bullets) by Gulail and manually has become a common way to inflict head injuries in Kashmir. The non-metallic missiles are not less-lethal and have high disabling, killing and infective potential.

Keywords: Craniocerebral, Missile injuries, Metallic, Non-metallic, Outcome

INTRODUCTION

The history of non-metallic projectiles dates back to the era of Pre-Christian Roman wars and before, in the form of stone-bullets thrown by catapults[1]. The emergence of modern 'stone-bullets or projectiles' fired at a high speed through small y-shaped light wooden and rubber (or leather) catapults (locally called Gulail) or stone slingshots is one of the most unsafe weapon to cause head injuries in Kashmir, India. A missile is a projectile of either a high velocity {muzzle velocity > 2000 Ft/sec} or a low velocity {muzzle velocity < 1000 Ft/sec}[2]. Projectiles are pellets fired from a shotgun, bullets from rifles, machine-guns, carbines, automatic guns and shrapnels and splinters by exploding bombs, mines and grenades. The non-metallic missiles have not proved less lethal as expected by the various Regimes of different countries and should not be considered as safe alternative defence weapons to control violence. In fact the non-metallic plastic, rubber, wax, stones and wooden missiles have proved more dangerous and fatal to control mobs and protesters[3,4,5,6,7]. Gunshot wounds of head are common in military personnel in war zones but for the past few decades civilian population around the world has become vulnerable to such injuries due to civil wars, regional conflicts, militancy, terrorism and military-related operations[8]. The rubber bullets were first used in 1970 by British Forces in Northern Ireland and were replaced by plastic bullets in 1972 by the British authorities. However these non-metallic missiles proved lethal causing more serious injuries and deaths. The first plastic bullet was made of PVC, 89 mm long, 38 mm in diameter and weighed equal to a rubber bullet i.e. 142 gm and had low muzzle velocity[5,7]. A high velocity primary metallic missile deposits its kinetic energy on the skull, it fragments or mushrooms (deforms) with the fracture of the bone, thereby indriving number of small bone pieces (secondary missiles) as non-metallic missiles into brain tissue furthering damage. The tear gas was first used in the World War I in August 1914 by the French army as lachrymatory irritant gas in small amounts of 19 cm^3 ethyl bromoacetate in 26 mm sized grenades. Later Germans used xylyl bromide gas in large scale[9,10,11].

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However the tear-gas shells and cartridges made of white hard plastic (non-metallic) containers used in Kashmir, India are to be aimed below the waist of protesters but unfortunately injuries were caused in the head which proved fatal. While non-metallic objects like card-board and mulberry wood are commonly being used in shotguns[8]. Craniocerebral missile wounds have been classified by Cushing in World War I and Matson in World War II[12,13]. Skull X-rays and plain CT-scan are the investigative tools, latter being the only primary and practical diagnostic tool. Metallic scatter can compromise the quality of a CT-scan. Angiography is procedure of choice in patients with sylvian fissure hematomas and when missile trajectory is detected close to either middle cerebral artery complex or sylvian fissure[14,15]. However, MRI is contraindicated in metallic missile injuries but can be performed on patients of non-metallic craniocerebral missile injuries if one is sure about the nature of injury. In World War I Harvey Cushing reduced operative mortality of penetrating brain injuries from 56% to 28% in 3 months by aggressively and meticulously debriding all devitalized tissue, removing metal and bone fragments with good closure[12]. Similar low mortality of 9.7% was reported by Hammon in 1971 from the Vietnam War, in 2187 patients[16].

MATERIAL AND METHODS

The Neurosurgical Centre of Sher-i-Kashmir Institute of Medical Sciences (SKIMS), Kashmir, India, caters 6 million ethnic, non-migratory Kashmiri population, as a single centre in whole valley of Kashmir. The study, outcome related to 694 craniocerebral metallic and non-metallic missile injuries who lived at 2 hours and beyond the time of injury was carried out in the Department of Neurosurgery at Sher-I-Kashmir Institute of Medical Sciences (SKIMS) Kashmir, India, over a period of 21 years from September 1988 to March, 2010. Adults as well as children (18 years and below) and both sexes were involved. Craniocerebral Injuries were due to high velocity metallic and low muzzle velocity non-metallic missiles. The type of missile, metallic or non-metallic, causing injury was recorded according to history, imaging and clinical and/or intraoperative findings. There was no field-resuscitation or airway control taken care-of (by the laymen who brought most of the patients to the hospital). So hospital-resuscitation was the first but delayed measure in the resuscitation process of such patients. No post-mortem study was carried out in any case. After initial resuscitation, all patients were assessed by admission Glasgow Coma Scale (GCS) score[17] and then subjected to X-ray chest, skull and plain CT brain. Patients were triaged in CT room, investigated and managed surgically and conservatively. Surgical procedures were undertaken after complete assessment of base-line investigations. The ventriculostomies for intracranial pressure monitoring was carried out in many operative and some non-operative patients. Complications were managed accordingly and as required. The type of missile injury (metallic or non-metallic), age and sex analysed whereas survival, mortality and functional outcome were evaluated by Glasgow Outcome Scale (GOS) score[18]. The Analysis of Variance was applied where-ever possible.

RESULTS

Age and Gender : A total of 694 patients of both metallic and non-metallic craniocerebral injuries of both sexes of all ages were involved. Most of the patients were adults and only 4.3% (30 out of 694) were children. Males were 43.80% (304 out of 694) and the females were 51.87% (360 out of 694) patients. Out of 304 males 74.0% (225 out of 304) patients had metallic and 25.9% (79 out of 304) non-metallic missile injury, similarly more females, 86.6% (312 out of 360), had metallic rather than 13.3% (48 out of 360) non-metallic missile injuries of the head. However 60% (18 out of 30) children had non-metallic craniocerebral missile injuries and most of these were stone projectiles and tear-gas shell hits (Table 1).

Imaging: X-ray skull demonstrated bone defects, fractures, pneumocephalus and intact or fragmented metallic missiles but not the non-metallic missiles (Figs 1, 2, 3). Plain CAT-scan head, performed in all patients showed full extent of the cranial and intracranial injury. The non-metallic missiles like rubber bullets, tear-gas cartridges, stones, wood and gravel are not seen directly in x-rays and CT-scans for their low density.

Table 1: Outcome related to age and sex

Outcome	Adults		Children	Total
	Male	Female	(<18 years)	
Survival				
a) Metallic missiles	118	271	9	398
b) Non-metallic	47	5	17	69
Mortality				
a) Metallic missiles	107	41	3	151
b) Non-metallic	32	43	1	76
Total	304	360	30 (4.3%)	**694**

However metallic missiles are easily detected and recognized with their sizes and shapes (Figs 4, 5, 6, 7).

Missile Type, GCS and management : Because of the high muzzle velocity of the metallic missiles the skin, bone and brain loss was more apparent and the penetrating or perforating injuries were more common (Figs 1, 2, 3). A total of 549 metallic missile injuries on analysis showed that 38.2% (210/549) patients had a GCS score of 3 – 5, 38.6% (212/549) had a GCS score of 6 – 8 and 23.1% (127/549) had 9 – 15 score. Their injuries were caused by the metal bullets, grenade, bomb and improvised explosive device (IED) blasts, shrapnels, bolts, splinters and pellets used by shotgun etc (Figs. 1, 2, 3, 7). Almost 84% (461/549) patients were operated upon using standard surgical approaches with a survival of 62.4% (343/549) and a mortality of 21.4% (118/549). While 16% (88/549) patients of metallic missile injuries were conservatively managed, revealing a survival of 10% (55/549) and a mortality of 6% (33/549). Thus metallic group had a total survival of 72.4% (398/549) and total mortality 27.5% (151/549). The non-metallic missiles have a low muzzle velocity so most of the injuries were penetrating or blunt, leaving the bone fractured over a large area of contused and lacerated brain and torn dura before getting themselves lodged into the brain (Fig 4) or falling down (Figs 5, 6). The non-metallic missile injuries had lower GCS score of 3 – 5 in 72.4%

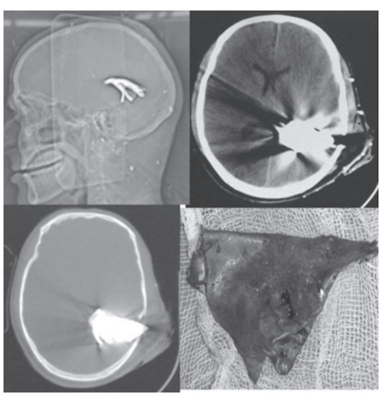

Fig 1: X-ray and plain CT head showing large metallic (steel) shrapnel of 70 mm length recovered from brain.

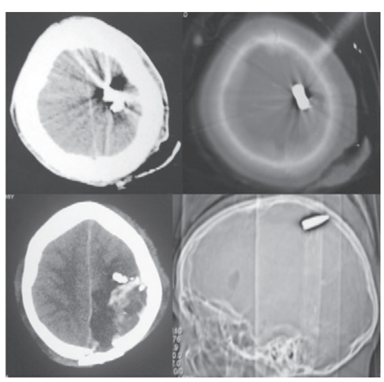

Fig 2: X-ray skull showing metallic bullet entry defect in left frontal area and fracture of left parietal bone also shown on the plain CT brain.

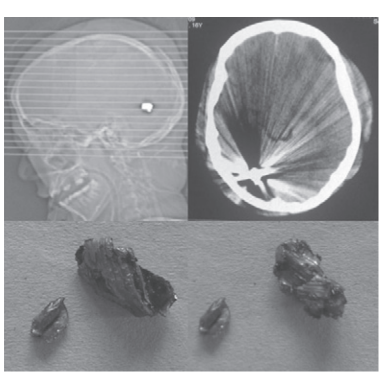

Fig 3: The deformed and mushroomed splinters removed from the occipital lobe of a blast-injury patient seen in X-ray skull and plain cranial CT.

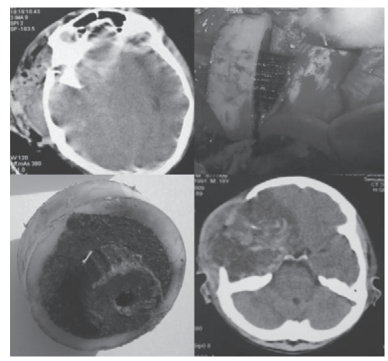

Fig 4: Pre- and post-operative CT brain in a case of non-metallic missile injury showing white plastic tear gas shell (51 mm diameter) in brain and after removal.

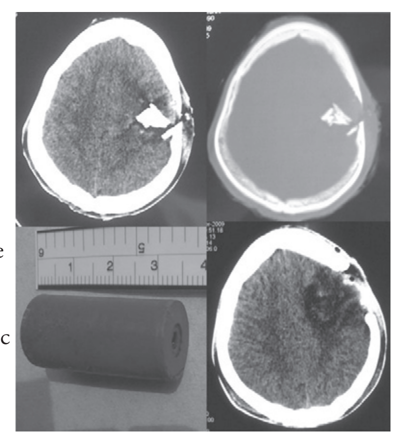

Fig 5: Plain CT brain showing in-driven bone fragments within the brain parenchyma caused by a non-metallic missile, a red rubber bullet (> 35 mm long and14 mm diameter).

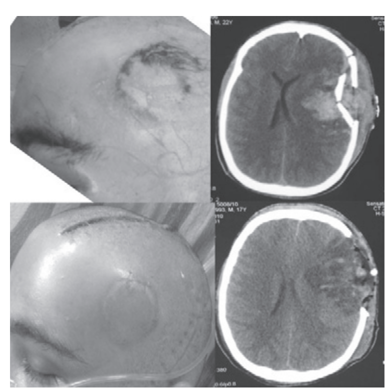

Fig 6: Pre- and post-operative clinical photo and CTbrain in a patient of non-metallic missile (tear-gas shell) injury showing 5 cm x 5 cm circular scalp tear in the left fronto-parietal region overlying fracture, dural tear, brain laceration and contusion.

(105/145) patients, 6 – 8 score in 26.8% (39/145) and only 0.6% (1/145) patient had a GCS score of 9 – 15 (Table 2). These injuries were caused by non-metallic projectiles (Figs 4, 5, 6, 7) as follows:

a)	Stone-bullets fired from a Gulail (Modified Catapult)	=	61 patients
b)	Red Rubber bullets	=	52 patients
c)	Tear-Gas shells or Cartridges	=	25 patients
d)	Wooden wads used in Shotguns	=	05 patients
e)	Cardboard wads used in Shotguns	=	02 patients
	Total	**=**	**145**

A total of 85% (124/145) non-metallic missile injuries were operated upon with a survival of 42% (61/145) and mortality of 43.4% (63/145). The conservative treatment was given to 14.8% (21/145) patients with a survival of 5.5% (8/145) and mortality of 9% (13/145) patients. The overall survival of non-metallic group was 47.5% (69/145) and a mortality of 52.4% (76/145) patients.

INTRACRANIAL PRESSURE (ICP) MONITORING

Intracranial pressure (ICP) monitoring was performed in 207 patients, of which 14.0% (29 out of 207) were conservatively managed metallic and 52.1% (108 out of 207) postoperative metallic missile injuries. The monitoring was performed in 30.4% (63 out of 207) postoperative and 3.3% (7 out of 207) conservatively managed non-metallic missile injuries. Monitoring devices were placed either in ventricular system or within the intraparenchymal cavities created after evacuation of blood-clots. Postoperatively, ICP monitoring was conducted on 171 (out of 207) patients and 36 (out of 207) patients from conservatively managed group. This included 168 (out of 207) patients from admission GCS score 3-5 group and 39 (out of207) from GCS score 6-15 group. An ICP of more than 20mmHg in any patient was treated either by therapeutic drainage of CSF or by decongestants.

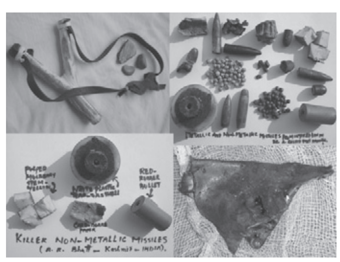

Fig 7: Metallic bullets [longest > 30 mm, 16 gm], shrapnels, splinters, pellets, bolts (heaviest > 26 gm) and non-metallic red rubber-bullets, (35 mm long and 14 mm diameter) white plastic tear-gas shells (largest 51 mm diameter), stone-bullets with a catapult, card-board wads and yellow pulped mulberry-stem missiles removed from brain.

SURGICAL & CONSERVATIVE TREATMENT

All patients required wound cleaning and repair of scalp or skin but only 585 patients, who required haemostasis, debridement of devitalised brain, repair of dura and skin, evacuation of clots and removal of accessible and visible missiles and bone fragments, were selected for surgery. A total of 109 patients, who were haemodynamically unstable, had coagulopathy, some were admission GCS score 3 with bilateral fixed and dilated pupils, or had any GCS score with no gross dural tear even in presence of in-driven bone and metal, plastic, wooden or rubber pieces, no clots or midline shift visualised on CT-scan, were not operated. This conservative group had 42.2% (46 out of 109) mortality. The most practiced operative procedure in cases of metallic missile injuries was, "standard" procedure and the commonly performed procedure on the non-metallic missile injuries was "radical" but the "minimal" operative procedure was the least exercised. A surgical mortality of 30.9% (181 out

Table 2: Correlation between type of missile, GCS, type of treatment and outcome

GCS	METALLIC MISSILES				NON-METALLIC MISSILES				Total
	Operative Survival	Conservative Mortality	Operative Survival	Conservative Mortality	Survival	Mortality	Survival	Mortality	
3–5	81	69	37	23	33	53	7	12	315
6–8	135	49	18	10	27	10	1	1	251
9–12	90	0	0	0	1	0	0	0	91
13–15	37	0	0	0	0	0	0	0	37
	343	118	55	33	61	63	8	13	
	461 (83.9%)		88 (16%)		124 (85.5%)		21 (14.4%)		694
	549				145				

P value < 0.0001

of 585) for all procedures and missile-types was observed. The intraoperative ultrasonography was used to locate and sometimes finger used (as much as missile-track allowed) to palpate the missiles and bone. All hairs, skin, debris, and dirt was removed by saline irrigation and rest of the procedure completed after water tight dural closure. No attempts were made, to chase or palpate any in-driven inaccessible bone and missile fragments, to avoid any insult to normal and uninjured brain. The missiles recovered from brain tissue were of different sizes, shapes, weights and material (metallic and non-metallic) like metal bolts, pellets, bullets, shrapnels, splinters, stone balls, rubber bullets, yellow wooden-pieces of pulped mulberry stem and cardboard pieces. Some rubber and metal bullets, plastic tear-gas shells and pellets were intact but others deformed, mushroomed and fragmented. The non-metallic missile of largest size was that of a tear-gas cartridge lodged in the brain measuring 51 mm in dia (Figs 4, 7). A red rubber bullet measured 35 mm in length and 14 mm in diameter and the stone balls (bullets) recovered were 20 to 35 gm in weight (Figs 5, 7). The longest metallic missile recovered was 15 gm steel shrapnel 70 mm in length. A long bullet of more than 30mm length, 16 gm in weight and 14 mm in diameter. Heaviest missile was a mushroomed bolt, 26 gm in weight. Smallest pellet was less than 1 gm in weight (Figs 1, 7).

COMPLICATIONS

A total of 550 complications were observed in 694 patients with 32.7% (227 out of 694) deaths. It was remarkable to note that the non-metallic missile injuries were probably the dirtiest type of injuries with a high complication rate where 145 patients had 287 complications and most of these infective proving fatal in 52.4% (76 patients out of 145). Three patients had orbito-cerebral penetrating injuries and 2 of these were due to non-metallic missiles (one due to tear-gas shell and other because of rubber-bullet). The wound infections, CSF fistulas, meningitis, brain abscess, hydrocephalus, DIC and seizures were all common in the non-metallic missile injuries. It was observed that metallic missile injuries with 549 patients developed 263 complications and causing 27.5% (151 out of 549) deaths, the brain swelling and midline shift being the most common and fatal (173 complications with 134 deaths). A patient of metallic missile injury with pseudoaneurysm developed a rare complication of trigeminal neuralgia (Table 3). Meningitis occurred 33 times with 6 deaths in non-metallic missile injuries, similar to brain abscesses and CSF-fistulas.

FUNCTIONAL OUTCOME

The currently used and widely accepted Glasgow Outcome

Table 3: Metallic and non-metallic missile injuries complications and mortality

Complications	Metallic Missile Injuries		Non-metallic Missile Injuries		Total
	Complications	Deaths	Complications	Deaths	
Wound Infections	54	15	83	24	137
Brain Swelling with Midline Shift	173	134	56	22	229
Meningitis	11	0	33	6	44
CSF – Fistulas	7	0	43	12	50
Brain Abscess	5	1	16	3	21
Hydrocephalus	4	0	22	0	26
Pseudoaneurysms (V n Neuralgia*)	1*	0	2	1	3
Carotico - Cavernous Fistula+	1+	1	0	0	1
Disseminated Intravascular Coagulation (DIC)	2	0	17	8	19
Seizures and Cortical Atrophy	5	0	15	0	20
Total	**263**	**151**	**287** complications in 145 patients	**76**	**550**

* One patient with pseudoaneurysm developed Trigeminal (5^{th} N) Neuralgia.
+ One of the 3 blind patients who had penetrating orbital and brain injuries.

Scale – GOS[18] was applied to assess the recovery, disability and death of patients (Table 4). A total of 67.2% (467 out of 694) patients survived and 32.7% (227 out of 694) died. Good outcome was observed in 37.6% (176 out of 467) of all survived patients. Analysis of metallic missile injuries showed that out of 549 cases 27.5% (151 out of 549) died, 40.4% (222 out of 549) were disabled and 32.0% (176 out of 549) showed good recovery. While all the GCS score 3 – 5 patients died in the metallic missile injury group, no death occurred in the GCS score group 9 – 15. Comparatively the non-metallic missile injuries had comparatively more 52.4% (76 out of 145) deaths as well as disabilities 47.5% (69 out of 145) but no good recovery. Most of the deaths i.e. 38.6% occurred in the GCS score 3–5 group. However GCS score 9–15 group had no mortality.

DISCUSSION

The non-metallic missile injuries are probably the most contaminated penetrating injuries due to the nature of the non-metallic substances like rubber, plastic, wood, stone, gravel, card-board etc harbouring microbes. The kinetic energy which a metal foreign body gains after detonation imparts enormous heat to the metal literally sterilizing it but the cavitation that leads to suction of air contaminates the brain. Given this, the speed with which a non-metallic missile hits, covering a large cranial vault surface, shatters the bone with high indriving energy causing damage to the larger area of the brain that leads to morbidity and mortality. Kobayashi and Mellen have raised a question about a rubber bullet (non-metallic missiles) of 30 gm weight and 40 mm diameter being safe when actually it hits and kills[3,5]. In a comparative study Laurence reported more serious skull and brain injuries due to rubber bullets (non-metallic missiles) in 99 people compared to 90 patients struck by plastic bullets[7].

Analysis at SKIMS showed that out of 694 patients, males had 32.4% metallic and 11.3% non-metallic missile injuries, females had 44.9% metallic and 6.9% non-metallic missile injuries, while children had 1.7% metallic and 2.5% non-metallic missile injuries (Table 1). The 61 females, teenagers and children were injured by stone-bullets weighing 20 to 35 gm fired from Gulails (Fig 7). Mahajna et al reported 61% blunt and 39% penetrating injuries caused by rubber bullets in Israeli-Arab conflict with 151 casualties[4]. Sherman et al noted that 70% of elderly patients died but the young group of 21-40 years had only 15% mortality[19].

Level of consciousness has a significant influence on the mortality as revealed at SKIMS Kashmir. Of 315 patients with GCS score 3–5 mortality was 55.9% with 37.1% in metallic and 17.7% in non-metallic missile injuries. But GCS 6 – 8 group had only 21.5% mortality with 13.5% in metallic and 7.9% in non-metallic missile injuries. No mortality was observed in GCS score 9–15 (Table 4). Clark et al showed that all 33 patients of gunshot wounds with GCS score of 3 and 4 were not considered for surgery and had high mortality[20]. A study of series of gunshot wounds in civilians were analysed by some workers and correlated level of consciousness based on GCS score with mortality. The results revealed that patients with GCS score 3–5 had 94% and GCS score 6-8 had 59% mortality. Their series showed a mortality of 15% in GCS score 9-12 and 3% in GCS score 13-15[21-28].

Intracranial pressure (ICP) monitoring is used to determine cerebral perfusion pressure in some patients. A series of many authors shows that all those patients who had mean ICP 62 mmHg died and mean ICP 31 mmHg lived. ICP is thought to be the only second to GCS scoring as the predictor of outcome[19,21,22,29,30,31,32,33]. The analysis at SKIMS, Kashmir showed that a total of

Table 4: Glasgow outcome scale scoring related to Type of missile and GCS score

GCS Score	METALLIC MISSILES						NON-METALLIC MISSILES						Total
	Good Recovery	Moderate Disability	Severe Disability	Vegetative State	Deaths	Total	Good Recovery	Moderate Disability	Severe Disability	Vegetative State	Deaths	Total	
3 – 5	4	11	63	15	117	210	0	4	18	27	56	105	315
6 – 8	87	67	21	3	34	212	0	1	7	11	20	39	251
9 – 12	52	28	10	0	0	90	0	0	1	0	0	1	91
13 –15	33	4	0	0	0	37	0	0	0	0	0	0	37
Total	176	110	94	18	151	549 (79.1%)	0	5	26	38	76	145 (20.8%)	694

P value < 0.00005

207 patients, 171 postoperatively (52.1% metallic and 30.4% non-metallic missile injuries) and 36 conservatively managed (3.3% non-metallic and 14% metallic missile injuries), were subjected to ICP monitoring. The monitoring devices were placed in ventricular system and intraparenchymal cavities, created after clot evacuation. The admission GCS score of 168 patients was 3-5 (only 105 survived) and 39 had admission GCS score 6-15, all of these survived. An ICP of more than 20 mmHg was controlled by therapeutic drainage of CSF and decongestants.

Surgical outcome at SKIMS Kashmir, revealed an operative mortality of 21.4% for metallic missile injuries while non-metallic missile injuries had 43.4% deaths (Table 2). Grahm et al, had an operative mortality of 23% and overall mortality of those admitted was 63%[21]. Stone et al used post resucitation GCS score plus haemodynamic stability as the primary criteria for surgery, with 21% mortality[34]. Kaufman et al had 55% mortality with standard approaches[22]. Raimondi et al had 16% mortality with the conservative approach[35].

The SKIMS analysis revealed a high infective potential of tear-gas cartridges/shells. The size of a blasted and mushroomed tear-gas shell measures 51 mm in diameter. The brain infections (meningitis and brain abscesses) were most common type of complications in the non-metallic missile type of brain injury and resulted in 52.4% mortality (76 deaths out of 145 patients with 287 complications). While scalp wounds were major source of infection to bone and brain in both the metallic and non-metallic groups but more responsible factors for delayed brain and wound infections were intraparenchymal rubber bullets, plastic tear-gas shells, stone balls or bullets, wooden (pulped-mulberry) and cardboard wads (non-metallic missiles), pneumocephalus, intraparenchymal hairs, skin undetected by imaging, delay in wound debridement and closure. However Cowel EM revealed tear gas cartridges used by French in 1914 as small as 26 mm filled with ethyl bromo acetate gas and Germans in 1915 using xylyl bromide gas. The British Forces also applied these skills of warfare to induce irritation and lachrymation in enemy soldiers but there were no casualties. The gases used were benzyl bromide, ethyl iodo acetate, bromo acetone, mono bromo methyl ethyl ketone and acrolein[9,11,36]. Authors have reported complications like post debridement infections, retained bone fragments, sinus injury and cerebrospinal fluid (CSF) leaks related to each other[19,24,25,31,37,38]. The Infective potential of bone fragments was shown by Martin et al in Vietnam war[39]. Levy reported 85% mortality in disseminated intravascular coagulation (DIC) in a study[40].

At SKIMS all those missiles or fragments whether metallic or non-metallic which were accessible could be removed without damaging the normal brain. The largest steel shrapnel measured 70 mm in length and heaviest bolt weighing 26 gm of metallic origin were removed. The largest non-metallic missiles removed were plastic tear gas shells of 51 mm dia, red-rubber bullets of 35 mm length, stone bullets of 20 to 35 gm weight and wads (Figs 1, 3, 4, 5, 7). Kluger has reported recovery of bolts weighing 25 g from brain tissue in terrorist bombing[41]. Millar et al reported rubber bullet injuries to the head and neck most frequent and severe in a series of 90 cases[42]. Kobayashi and Mellen (2009) removed a rubber bullet of 40 mm in dia weighing 30 gm from a patient[3].

OUTCOME

The study at SKIMS observed that children and teenagers mostly had non-metallic missile injuries like stones, rubber bullets, tear-gas shells etc. and survived with disabilities (Table 1). Around 50% males died of metallic missile injuries while most females died of non-metallic missile injuries. The metallic missiles had 27.5% mortality, 40.4% disabilities (including persistent vegetative state) and 32% good recovery. Comparatively non-metallic missiles had no good recovery, 52.2% death rate and 47.5% disabilities and vegetative state. Millar et al showed rubber bullets causing permanent disabilities in 17 patients out 90 patients[6]. Nagib et al, Grahm et al, Levi et al and Aldrich et al showed that assessment of GCS score 3–5 patients with Glasgow Outcome Scale (GOS) revealed 90% mortality , 3% persistent vegetative state , 5% severe disability , 2% moderate disability and only 0.2% good outcome[21,24,25,33].

To conclude, the presently used non-metallic missiles as alternative defence weapons to keep angry mobs, protesters and dangerous criminals at bay with non-fatal and simple injuries in reality are very fatal and lethal weapons by observations and statistics.

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