



## MOBILE PHONE BATTERY BLAST CAUSING COLONIC PERFORATION

## Surgery

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## ABSTRACT

Blast trauma is multidimensional injury; the type of the blast injury may lead to different systems involvement as it often combines blast, penetrating blunt, and burn mechanisms in the same casualty. Primary blast injuries are caused by the interaction of the blast wave with the body and are therefore a type of non-penetrating trauma. They are more common in war, terrorism and cooking, but cell phone blast injuries are of late increasingly common causing variety of injuries involving different parts, organs, systems of the person with short term and long term effects on that person, family and community. These injuries pose unique triage, diagnostic and management challenges. Cell phone blast injuries are more common in Asia producing non-branded replacement batteries with attractive low price. In the literature, there are mainly facial burn cases due to mobile phone battery explosion. On the other hand, there are very few cases of mobile battery blast causing colonic perforation after explosion which this case elucidates. We aim to highlight potential hazard of lithium ion battery injuries and its implications on immediate care and surgical management.

## KEYWORDS

lithium battery, blast injury, colonic perforation

“The blast wave is a shot without a bullet, a slash without a sword. It is present everywhere within its range. Blast would be as dreaded a weapon as chemical warfare, if its range, when explosives are used were not limited to small areas. However it would be premature to believe that this situation will always remain the same.”

## Theodor Benzinger 1950

## CASE DETAILS

15 year old male was admitted to surgery emergency, Government medical college and hospital, Chandigarh, India on 18 Feb 2012 at 10.30 am with history of abdominal trauma 3 hours back on the same day, when patient was charging his phone and the battery suddenly exploded and hit his right lower abdomen. (Figure 3)

On arrival, he had stable vitals with a complaint of sudden onset abdominal pain which was continuous and progressive, present all over the abdomen with signs of peritonitis on examination. There was a superficial skin abrasion over right lower abdomen with tattooing due to the contact of instrument itself. Haemoglobin was 9gm% with rest of the investigations being normal. Patient was taken up for surgical exploration. Intraoperatively, 1.5cm\*1.5cm colonic perforation was found with minimal contamination which was repaired primarily. Post op period was uneventful. (Figure 1,3) Patient was discharged after 7 days.

## DISCUSSION

In parallel with technological improvements, humankind encounter with

equipment/devices transforming chemical energy to electrical energy, especially batteries of automobiles and mobile phones. These gadgets have their own lifelong impact on us in case they explode and cause injury, especially the blast impact.

Lithium-ion batteries commonly used to power devices such as laptops, cell phones, smart watches, and e-cigarettes are known explosion hazards. Their utility and safety is increasingly important in view of the fossil energy consumption and CO<sub>2</sub> emission level reduction. It confines a huge amount of energy within a small volume; however, increasing the hazard potential far above the common level. Explosions involving smartphone batteries are sparsely reported. Face and eyes are particularly prone to injury while using these phones. Indiscriminate usage of cell phones makes us vulnerable to the associated risks including accidental burns and blast injuries. Low-quality products and user negligence increase the risks.<sup>1</sup>

Lithium-ion batteries may overheat during charging leading to “thermal runaway,” an unregulated increase in internal battery temperature. Exposure of the lithium-ion batteries to elevated temperatures can lead to explosion.<sup>2</sup>

The battery explosion damages tissues by 3 components: heat, acid and battery pieces. Devices like mobile phones can cause injuries due to the battery systems they contain. <sup>3</sup> Although 1.5 volt-batteries seem safe due to their small sizes, they can cause severe damages when explode. <sup>4</sup> Regardless of battery size and energy level, they should be considered as potential explosive material. <sup>5</sup>



Figure 1. Post-operative day 5- showing blast injury site



Figure 2. On follow up- Post op day 30



**Figure 3. Exploded mobile battery set**

Blast and blast injury are the respective terms used to describe the gaseous decomposition and the damage occurring in an organism that is subjected to the pressure field produced by an explosion.<sup>4</sup>The blast wave begins as a single pulse of increased pressure that rises to the peak level within a few milliseconds and then rapidly falls to a minimum pressure lower than the original atmospheric pressure following complex nonlinear physics. It is propagated outward radially from the explosion, with the sharply marginated periphery of the sphere becoming the blast, over pressure, or shock wave.<sup>4</sup>

Blast injuries are classified into four types- Primary: is caused by the direct effect of blast overpressure on tissue, Secondary: caused by flying objects that strike people, Tertiary: caused by high-energy explosions; occurs when the victim hits and strikes other object, Quaternary: burn and asphyxia, Quinary blast effect from exposure to toxic substances. In primary blast injuries, ear drum perforation and hollow viscus perforation are the most common clinical findings. Mortality is in excess of 60% in severe cases.<sup>6</sup>

The barotrauma mostly involves air-filled organs and air-liquid interfaces.<sup>5</sup>Perforation of these hollow abdominal viscera depends on the amount of the charge, proximity to the explosion, and the spatial surroundings of the explosion site. This injury should be suspected in anyone exposed to an explosion with findings suggestive of acute abdomen.<sup>7</sup>

Hollow viscous injuries include haemorrhage, petechiae, and circumferential rings of haemorrhage. The shearing effect caused by acceleration of tissues with different inertial properties may be responsible for submucosal and subserosal haemorrhages in the gut, and mesenteric injuries.<sup>4</sup>The resultant intramural oedema and with microthromboses compromise intestinal perfusion and put the intestine at risk of delayed perforation, hemoperitoneum, peritonitis, and sepsis.<sup>2,4</sup>The clinical pitfall with these injuries is a delayed presentation, with some casualties developing peritoneal signs 48 hours or more after the explosion.<sup>5</sup>Perforations may develop up to 24-48 hours later; however, delays of up to 14 days have been reported. The colon is the gastrointestinal structure most frequently affected by primary blast injury. <sup>5</sup>Slow mucin dissection between the walls layers of the bowel could be the underlying mechanism <sup>8</sup>. Mesentery tears or mesenteric avulsion leading to bowel wall ischemia and eventual perforation is a more reasonable explanatory mechanism. <sup>7</sup>Delayed perforation of the colon may occur within 72 hours after the trauma. Therefore, patients exposed to significant explosive blasts should be monitored carefully for at least 48 to 72 hours, especially those with other injuries who require analgesics.<sup>9</sup>Previous studies have suggested that small bowel and colonic contusions larger than 10 mm in diameter are at high risk for delayed perforation. <sup>10</sup> The typical injury is gastrointestinal hematoma which may perforate up to 14 days after injury. <sup>11</sup>

Perhaps the single limiting issue for lithium-ion batteries is safety. Lithium-ion batteries are very sensitive to overcharge, and, at temperatures near 100°C, deleterious heat-producing side reactions inside the battery can lead to even further increases in the battery temperature. Internal short circuiting can lead to rapid temperature rises in an individual cell, and the temperature increase in one cell can propagate to other nearby cells, thus causing them to rapidly self-heat, too. Furthermore, the energy released from these reactions can be significant and dangerous. <sup>12</sup>

Various engineering strategies have been proposed to mitigate the risk, but without regulatory oversight or standardized manufacturing, there is great variation in materials and processes that produce mobile batteries.<sup>6</sup>

An understanding of the mechanism, the associated patho-physiology, clinical diagnosis and the knowledge of the recommended management of blast injury by the treating team is required to better correlate these subtle injuries may have delayed presentation due to the unique blast dynamics. The air-containing organs are extremely vulnerable to the unique primary blast effect. Familiarity with the effects that explosions exert on these organs, their consequences and treatment, together with a high index of suspicion, are crucial for medical professionals to obtain the best outcome. It's time for paradigm shift from symptom focused to mechanism of injury based assessment.

**CONCLUSION:**

This case signifies the need to increase public awareness also about the potential risks associated with cell phone use, to adopt safe practices as per recommendations from the manufacturers and to avoid counterfeit products, to avoid such accidents. Provision of providing prominent warnings with batteries and chargers on sale would help to prevent such accidents.

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