

# Problem of Imputability in Case of a Post Splenectomy Stroke Following a Traffic Accident

Marwa Boussaid<sup>1,2,3\*</sup>, Syrine Azza Manoubi<sup>2,3</sup>, Mohamed Amin Mesrati<sup>1,2,3</sup>, Hiba Limem<sup>1,2,3</sup>, Yosra Mahjoub<sup>1,2,3</sup>, Meriem Boughattas<sup>1,2,3</sup>, Randa Salem<sup>1</sup>, Abir Aissaoui<sup>1,2,3</sup>

<sup>1</sup>Faculty of Medicine of Monastir, University of Monastir, Monastir, Tunisia

<sup>2</sup>Department of Legal Medicine, Taher Sfar Teaching Hospital, 5100- Mahdia, Tunisia

<sup>3</sup>Research Laboratory LR-12-SP, Tunisia

## Abstract

The occurrence of perioperative stroke related to noncardiac, nonaortic surgery is frequently less expected than cardiovascular related one. Splenectomy could be one of these situations. The advent of post-splenectomy stroke following trauma involving third party, whether accidental or intentional, can arise several questions and be particularly challenging from legal point of view. Aim of this manuscript is to report a case of post splenectomy stroke following a traffic accident and to discuss both imputabilities of the stroke to the splenectomy and the stroke to the traffic accident. A 40-year-old male, without past medical history, was a victim of a traffic accident. Body-scan showed a Haemoperitoneum of medium abundance, a ruptured spleen and a fracture of the right humerus. An emergent splenectomy was performed. The postoperative examination revealed a Glasgow scale of 9 with anosocoria, hypotension and tachycardia. He was reanimated. A computed tomography (CT) scan, performed 6 hours after surgery, showed brain ischemia in the territory of the left middle cerebral artery (MCA) suggestive of thrombembolism with deviation of the median line and sub-falcine engagement. Few hours later, he was declared deceased.

**Keywords:** Stroke • Perioperative period • Splenic rupture • Imputability • Forensic medicine

## Introduction

Perioperative stroke is a rare complication. It can cause a high morbidity and mortality [1]. It is defined as a stroke that occurs from the peri-operative period until 30 days after surgery [2]. In most cases, it takes place after three main types of surgery: the cardiac surgery, the aorta and its major branches surgery and the neurosurgery. However, its occurrence after abdominal surgery, such as splenectomy, is less expected [3]. In fact, the risk of stroke straight after splenectomy or splenic injury is less well known [4]. The forensic expert is dealing with a difficult and thorny legal issue when post-splenectomy stroke occurs after trauma involving third party, whether accidental or intentional.

We herein report a case of a post splenectomy stroke following a traffic accident and we discuss both imputabilities of the stroke to the splenectomy and the stroke to the traffic accident.

## Case Presentation

A 40-year-old male, without past medical history, was a victim of a traffic accident (motorcyclist hit by a car). He was hospitalized in the Emergency Department. Upon admission, the patient was obtunded. During clinical examination, he presented with tachycardia, hypotension and peripheral signs of shock including coldness in the distal extremities. Glasgow coma scale was 13. Body-scan showed a Haemoperitoneum of medium abundance, a ruptured

spleen and a fracture of the right humerus. An emergent splenectomy was performed. Then, he was transferred to the Department of anesthesiology, resuscitation and intensive therapy. The examination revealed a Glasgow scale of 9 with anosocoria, hypotension and tachycardia.

A computed tomography (CT) scan, performed 6 hours after surgery, showed brain ischemia in the territory of the left middle cerebral artery (MCA) suggestive of cerebral thrombembolism with deviation of the median line, mass effect on the median structures and sub-falcine engagement (Figure 1).

Few hours later, he was declared deceased.

## Discussion

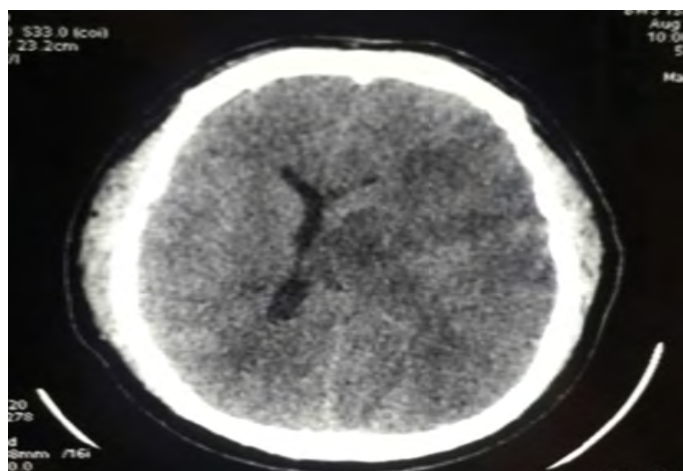
According to the World Health Organization (WHO), the stroke is defined as a result of the interruption of blood circulation in the brain, usually when a blood vessel bursts or is blocked by a clot. The supply of oxygen and nutrients is stopped, which damages the brain tissue [5]. A number of risk factors are related to an increased risk of stroke. They can be divided into changeable and unchangeable risk factors. Factors resulting from lifestyle choices and the environment are considered as changeable factors, namely hypertension, diabetes mellitus, smoking, coronary heart disease, atrial fibrillation, left ventricular hypertrophy and many others. Unchangeable risk factors include factors related to hereditary or natural processes such as age, sex and race. In fact, advanced age is considered one of the most important stroke risk factors with 95% of strokes occurring in people age 45-years and above. Men have a slightly greater risk of stroke, particularly in middle to old age [6].

In the reported case, to our knowledge the patient had neither changeable nor unchangeable risk factor related to stroke occurrence. The patient developed an immediate post-splenectomy stroke, in other words during perioperative period. It is a well-known complication after some surgery procedures. It takes place during the time extended from intraoperative period until 30 days after surgery [2]. It can be divided into two types: hemorrhagic and ischemic. It can cause serious morbidity and even mortality. The occurrence of perioperative stroke related to noncardiac and noncarotid major vascular surgery such as

\*Address for Correspondence: Marwa Boussaid, Faculty of Medicine of Monastir, University of Monastir, Monastir, Tunisia, Tel: 21692730927; E-mail: drmarwa.boussaid@outlook.fr

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**Figure 1:** Axial section of cerebral CT showing infarctus in the territory of the left middle cerebral artery.

splenectomy is less expected and overlooked than cardiovascular related one. This can be explained by the absence of modification of the blood circulation during operation based on cardiopulmonary bypass [7]. However a study carried out by Mashour et al. [8] showed a 0.1% risk of perioperative stroke after noncardiac, nonmajor-vascular, and nonneurologic surgery using a large, prospectively gathered, clinical data set in a broad surgical population. Several factors have been found as most significant favouring the occurrence of perioperative stroke. Some of these factors are listed below: age over 70, female sex, previous stroke or transient ischemic attack, hypertension, diabetes mellitus, renal insufficiency, dialysis, smoking, chronic obstructive pulmonary disease, peripheral vascular disease, cardiac disease (history of myocardial infarction within 6 months prior to surgery, atrial fibrillation, valvular cardiopathy), carotid stenosis, atherosclerosis of the ascending aorta and the discontinuation of antithrombotic therapy before surgery [1]. In this reported situation, the patient did not have any risk factor, which leads us to consider another mechanism theory. It is probable that the acute systemic inflammatory response triggered by surgery initiates or exacerbates ischemic cerebral injury [7]. Indeed, multiple cytokines have been implicated in the postoperative inflammatory response [9]. Interleukin-6 is considered to be the main mediator of the stress response after surgery [7].

In addition, postoperative endothelial dysfunction caused by general anesthetics effect is considered as an important responsible factor. In fact, vessels with endothelial dysfunction are likely to cause plaque rupture, reactive vasospasm, and thrombus formation. Nitrous oxide had been principally reported to damage endothelial function [7].

Concerning the increased risk of stroke in patients who underwent splenectomy, there have been few studies that dealt with this subject [4,10]. The authors suggested that the increased risk of stroke after splenic injury and splenectomy are probably not related to the post procedural or postoperative phenomenon. Jiun-Nong Lin et al. [4] study revealed that splenic trauma patients exhibited a 1.74-fold greater risk of stroke if they did not receive splenectomy and a 2.05-fold increased risk of stroke if they received splenectomy. In the current case, the patient presented with a severe splenic injury and a life-saving splenectomy was performed.

Many factors can increase the occurrence of vascular events in patients with splenic injury and splenectomy, including platelet activation, hypercoagulability, activation of the endothelium, and altered lipid profiles [11]. After splenectomy, immune alterations can be described, mainly increased ratio of interferon- $\gamma$  (IFN- $\gamma$ ) to interleukin-10 and significant elevation of absolute lymphocyte, CD4 T cell, and CD8 T cell counts [12]. These T lymphocytes associated with the secretion of IFN- $\gamma$  and Tumor Necrosis Factor- $\alpha$  (TNF- $\alpha$ ), have principal role in neuronal ischemic damage [13]. These phenomena play a principal role in the pathogenesis of stroke after splenectomy [4].

In the reported case, the post-splenectomy stroke can be explained by multiple mechanisms. These lesions can be attributed to the postoperative

phenomenon including the inflammatory response triggered by the surgery and general anesthetics. It can also be attributed to both acquired hypercoagulation and acquired immunologic disorder after splenectomy.

The main issue of perioperative stroke is when the original traumatic event that necessitated a surgical procedure, is involving a third party whether in an accidentally or unintentionally way. In such an event, the judge use the services of forensic experts in order to prove the relationship between the trauma and death. In this context, the relationship between the accident and death is important to prove for both the author of the accident and the victim. On the one hand, the author of the accident can be prosecuted under section 217 (involuntary homicide), according to the Tunisian Criminal Code (TCC), and can be punished by imprisonment for a term that may extend to 2 years. On the other side, according to the Tunisian law towards victims, to get fair compensation for road traffic accident, there should be a real damage associated with established and proved relationship between the damage and the trauma. This relationship is commonly known as "imputability". In some cases, proving this imputability can be a hard mission for the medical expert in the procedure that leads to indemnification in reparation of a suffered prejudice or to get fair compensation for the family of the deceased, like in the case reported here. In fact, the "imputability is defined as the essential relationship of cause and effect, the causal relationship, the correlation that have to exist between the physical damage and trauma" [14]. The principal task entrusted to the medical expert is to say whether there is damage or not, to specify it (reality of the damage), to quantify it (extent of the damage) and above all to relate it in terms of cause and effect relationship to the reported fact which is usually represented by trauma. Causality nexus between the physical damage and the trauma is not always that obvious. Its establishment is more delicate especially when there is a previous pathological condition or when there is not only one but several events involved in the occurrence of the damage.

In this situation, the main task for forensic expert is to determine what is the respective share of responsibility played by trauma (traffic accident) and the surgery (splenectomy) in the occurrence of stroke, starting from the principle that only the part of the resultant incapacity of this trauma is entitled to compensation [15]. In this context, 03 questions arise to the expert:

- 1) Would the patient develop a stroke if he was not a victim of an accident?
- 2) Would he develop a stroke if he had only the trauma without added surgery?
- 3) What was the result of the trauma and the surgery? Only the answer to the third question is possible.

Answering these questions requires applying the seven criteria of Simonin related to imputability namely [14]:

- The reality and the nature of trauma. Trauma must be real and proved through medical certificate.
- The intensity of the trauma. Indeed, to give serious injuries trauma must be intense enough. However, minimal injuries may also lead to serious lesions.
- The concordance of seat between trauma and the zone of damage. Nevertheless, in some exceptional cases, the damage may be encountered far from the original seat of trauma.
- The logical delay between the occurrence of trauma and damage according to each situation.
- The continuity of symptoms from the moment of traum until the damage appearance. However, in some situations, damage may take place after a long silent period of variable duration.
- The nature of disorder with a scientifically accepted pathogenesis;
- The novelty of appearance of lesions without having any previous pathological condition related that seat. In case of previous pathological condition, talking about aggravation instead of newly lesion would be more suitable.

## Conclusions

In summary, these are main conclusions related to this case: It is about a patient with no medical past history who had violent traffic road accident. Based on his medical records, he had splenectomy after a splenic injury. This is a major type surgery needing general anesthesia. The damage did not appear in body region concerning the trauma but far away (brain ischemia). However, and based on scientific articles review, there is an established indirectly link between splenectomy and the occurrence of stroke. Several successive events leading to stroke, which is a largely well-known disease, had taken place immediately after surgery (perioperative period). In conclusion and based on the absence of any diagnosed risk factor of stroke, the studies showing involvement of splenic injury or splenectomy in the increased occurrence risk of stroke, the severity of splenic injuries caused by the trauma leading to life-saving splenectomy, it appears that the death in the current situation would be indirectly related to reported accident.

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