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Neuropsychological Insights Into Child Survival: Possible Protective Dissociation During Prolonged Entrapment After a Turkish Earthquake

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Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Case series
Patients: Female, 6-year-old • Male, 9-year-old
Final Diagnosis: Dissociative disorder
Symptoms: Dissociation
Clinical Procedure: —
Specialty: Disaster Medicine

Objective: Unknown etiology

Background: Earthquakes and other catastrophic events can lead to conditions of being trapped under the rubble, which can cause minor-major health consequences. One of the most challenging issues in entrapment is the need to rescue people as fast as possible. A related issue for rescue forces is how long to continue searching for survivors. Indeed, sometimes victims survive longer than expected. The cases described below led us to postulate that certain adverse psychological effects of being trapped under the rubble may be beneficial for survival in such extreme situations.

Case Reports: In this article, we report 2 cases of children who were rescued from under the rubble following an earthquake in Turkey in February 2023. The children were rescued approximately 1 week after the earthquake, exhibiting symptoms that could be understood as dissociation. We present converging neuropsychological and neurophysiological scientific evidence that enabled us to propose that dissociation-related imagination together with excessive sleep may have increased vagal nerve activity. Vagal activity in turn may have helped to reduce risk of infections and inflammation, and possibly increased the chance of survival.

Conclusions: Although impossible to measure and prove in such extreme contexts, we propose a plausible psychobiological mechanism for those children's symptoms and relatively long survival under entrapment. While only a speculation, dissociation might have been protective in such conditions. We discuss the limitations of these reports and the speculative mechanisms, and provide further implications for policy.

Keywords: Children's Health Insurance Program • Earthquakes • Turkey

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Introduction

The duration of searching for survivors of Prekops earthquake entrapment is a topic of ongoing debate among rescue teams. This discourse assumes a limit on the time individuals can survive entrapment. Some search and rescue teams adhere to the "Rule of Four," which suggests that people can survive 4 minutes without oxygen, 4 days without water, and 4 weeks without food. A review of 18 earthquakes found that the average maximum rescue time was 6.8 days [1]. Agapiou [2] highlighted the critical importance of the first 48 hours following entrapment, known as the "Golden 48 h," as the most effective period for rescuing trapped survivors. This temporal aspect underscores the significance of immediate responses and team coping strategies. Liu et al [3] emphasized the value of earthquake education in enhancing individuals' awareness of earthquake risks and survival knowledge, which could be particularly beneficial for foreigners visiting earthquake-prone regions like Japan. This suggests that prior knowledge and preparedness can contribute to a proactive mindset that can influence how individuals respond to entrapment situations, potentially influencing the utilization of psychological mechanisms and protective behaviors.

In the realm of rescue operations, Ceferino [4] introduced the Earthquake Survival Chain as a framework to identify critical infrastructures and services during earthquake emergencies, emphasizing the importance of strategic planning and resource allocation in enhancing survival outcomes. This framework could provide insights into how psychological mechanisms such as dissociation and hallucination intersect with external factors to support individuals' survival during entrapment.

In addition, activity of the vagal nerve may be protective in this context. The vagal nerve is the main nerve of the parasympathetic nerve system; it has anti-inflammatory effects [5], reduces blood pressure and pain [6], and moderates stress responses. Moreover, high vagal activity predicts longer survival in many diseases [7]. All of the above factors could be of benefit during the chain of entrapment and recovery.

Case Reports

On 6 February 2023, 2 consecutive earthquakes occurring 9 hours apart (Richter scale 7.8 and 7.6) hit southeast Turkey. Those 2 earthquakes were followed by over 2000 aftershocks and caused over 50 000 deaths and thousands of injuries [8]. Several studies reported findings from this earthquake focusing on injured children. In a study on pediatric cases admitted to a hospital following this earthquake, 42% of 1246 children were admitted in the first 24 hours, and 58% were admitted within the first 3 days [9]. Another study emphasized the importance of timely treatment for children due to their unique vulnerability following an earthquake. Besides physical differences between children and adults, there is extended risk due to their psychological and emotional conditions following disasters and their difficulty communicating stress and injuries [10].

We present 2 cases of Turkish children entrapped following this earthquake and propose a plausible psychobiological explanation for their relatively long survival time, based on corroborative evidence. Given the crisis's nature and the absence of identifying information, no ethics approval was required, in line with our institute's Institutional Review Board (IRB) guidelines.

Case 1 was a 6-year-old girl found in an "air pocket" 7 days after the earthquake, with normal lab test parameters. When asked if she wanted to drink water, she replied, "No, good people came to me every day and gave me food". Case 2 was a 9-year-old boy found 9 days after the earthquake. He was cachectic, had pre-renal insufficiency, and had high creatinine levels that were later stabilized. When found, the child asked, "Why did it take you a whole day to rescue me?" In both cases it was impossible to conduct a standardized psychological assessment due to the urgent nature of the context in which physicians prioritized lifesaving procedures.

Discussion

The long-term psychological effects of such entrapment experiences on children cannot be overlooked. Prolonged exposure to stress, fear, and isolation during critical developmental stages can lead to post-traumatic stress disorder (PTSD), anxiety, depression, and attachment difficulties [11,12]. In both cases, the children were injured and isolated, which could yield stress responses, including helplessness and dissociation [13]. This often includes thought delusions and sensory illusions, as reported by the children (imagining receiving food and seeing people in Case 1, and a distorted sense of time in Case 2). In the context of earthquake entrapment, the interplay between dissociation and hallucinations as potential psychological survival mechanisms can be further elucidated by considering additional research findings.

This analysis underscores the prolonged nature of entrapment scenarios and the potential psychological toll it can take on individuals. Yet, we propose that dissociation and hallucinations could be instrumental in sustaining individuals' lives during such crises. In a qualitative study on 15 people with PTSD, 93.3% found dissociation to be helpful in relieving suffering [14].

Stress responses and hopelessness could prevail in such circumstances due to a lack of control. However, entrapment and absence of light could induce sleep, which could increase vagal nerve activity [15], resulting in reduced stress responses and hopelessness [16].

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The earthquake occurred during winter, with low temperatures measured on the day of the event (2.7°C), which could have induced partial hypothermia, resulting in bradycardia. A low heart rate and slow breathing rate increase vagal activity [17,18]. An explanation for the children's survival could be the cold temperature, possibly resulting in hypothermia, which has been found to have therapeutic effects, including neuroprotection and increased survival [19,20].

To the best of our knowledge, food and water were unavailable due to the destroyed buildings' horrific conditions, causing dehydration, as reflected by the high creatinine level (Case 2). The physical impact of dehydration, starvation, and hypothermia can have lasting effects on growth and development [21].

In entrapment situations, where individuals may experience heightened stress and anxiety, maintaining cardiovascular stability via vagal nerve activity could be crucial for preventing panic responses and conserving energy. By regulating heart rate and cardiovascular function [22], and since high vagal predicts longer survival [7], vagal nerve activity may help individuals endure the physical demands of entrapment and increase their chances of survival until rescue.

Vagal nerve stimulation has been shown to significantly affect various physiological processes, including heart rate regulation, inhibiting inflammation and modulating cognitive function [23,24]. Understanding the vagal nerve's role in these processes allows us to explore how vagal nerve activity may influence individuals' ability to survive longer periods of entrapment during earthquakes. Vagal nerve stimulation has been linked to the cholinergic anti-inflammatory pathway, which plays a role in reducing inflammation and protecting intestinal integrity [23]. Higher vagal activity reduces inflammation by a neuro-endocrine route (the HPA axis) and by a neuro-immunological route (via splenic T cells and macrophages) [5]. Increased vagal activity was found to increase antiviral immunity (NK and CD8+ cells). These could protect the children against injury-related infections and subsequent inflammation. Importantly, anti-inflammatory processes could result in an increased chance of survival [25].

Moreover, vagal nerve stimulation has been associated with improved cognitive function in aged rats [24]. In entrapment scenarios, cognitive function and mental resilience are essential for making decisions, staying calm, and conserving energy. By enhancing cognitive function through vagal nerve activation, individuals trapped in an earthquake may be better equipped to cope with the psychological challenges of their situation and maintain a sense of hope and determination.

Being children, they may use imagination, including imagining a companion, which could be an adaptive coping strategy [26-28]. Self-guided imagery also increases vagal nerve activity [29].

Additionally, the vagal nerve has been implicated in the modulation of visceral pain [30]. In entrapment scenarios, individuals may experience discomfort, pain, or injuries that can exacerbate their distress and compromise their ability to endure the situation. Regulation of pain, infection, inflammation, and stress responses by the vagal nerve could contribute to tolerating and surviving such adversity. By modulating pain through vagal nerve activity, individuals trapped in an earthquake may experience reduced suffering, allowing them to focus on survival tasks and maintain a clearer mindset during the ordeal.

Another possible mechanism includes the effects of imagery on eating. Of relevance to Case 1, studies show that viewing pictures of food increased ghrelin [31], and imagining eating reduces appetite [32]. Both could reduce agony from starvation and increase tolerance for the children's lack of food.

Conclusions

It is crucial to provide such children with appropriate psychological support, medical care, and rehabilitation, to help them cope with the trauma and mitigate potential long-term consequences. Mental health professionals, pediatricians, and social workers should work together to develop comprehensive, child-centered interventions that address the unique needs of these young survivors [33] using evidence-based methods.

In conclusion, the implications of vagal nerve activity on survival in earthquake entrapments are multifaceted. By understanding the vagus nerve's role in regulating inflammation, cognitive function, cardiovascular stability, and pain perception, we can appreciate how vagal nerve activation through self-guided imagery and sleep may offer a potential mechanism for enhancing individuals' resilience and survival prospects during prolonged entrapment in earthquake scenarios.

All the above are speculations based on 2 cases rather than a larger sample. Nevertheless, the proposed mechanisms were based on converging scientific evidence. Furthermore, the context did not enable us to perform lab tests and follow-ups to validate our proposed mechanisms. In summary, dissociation and hallucination may serve as protective mechanisms that promote survival during earthquake entrapment. The temporal dynamics of rescue operations, the role of education in preparedness, and the interplay between psychological responses and external support systems are crucial factors that contribute to a more comprehensive understanding of the complex mechanisms involved in enhancing survival outcomes during entrapment scenarios. By considering these factors, we can better appreciate the multifaceted nature of survival in such challenging circumstances and develop more effective strategies to support those who find themselves trapped in the aftermath of earthquakes.

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We suggest that search and rescue teams should consider longer durations of survival time during underground entrapment than the current estimation, possibly explained by the neurobiological mechanisms proposed above. Thus, search and rescue efforts could be extended to save more lives.

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Ethical Lrocess

The study was approved by the local ethics committee of Tel Hai College, Israel after submitting the full description of the study followed by clarifications.

Clinical Trial Registration

This research was not clinical; therefore, this section is not applicable. The writing of this article followed the CARE guidelines for reporting case reports.

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