Heart Surgery Forum 2024; 27(5): E445–E449
doi: 10.59958/hsf.6705

Case Report

A Case Report of Arrhythmia Caused by Skin Expander Implantation

Qiong Liu[1], Bing Jiang[1], Hui Jiang[1], Bin Nie[1,*]

[1]Department of Anesthesiology and Pain Medicine, Hubei Key Laboratory of Geriatric Anesthesia and Perioperative Brain Health, and Wuhan Clinical Research Center for Geriatric Anesthesia, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, 430030 Wuhan, Hubei, China

*Correspondence: BinNie2023@126.com (Bin Nie)

Submitted: 11 August 2023 Revised: 16 November 2023 Accepted: 29 November 2023 Published: 7 May 2024

Abstract

A 51-year-old female patient suffered facial burns during her youth. Following the healing of the wound, a skin expander was implanted on 7 December 2021 to address scar contracture. The preoperative electrocardiogram (ECG) indicated sinus rhythm within the normal range. Color Doppler ultrasound revealed no abnormalities. The patient had no history of hypertension, heart disease, diabetes, arrhythmia, or other cardiovascular and cerebrovascular conditions. On 16 June 2022, the skin expander was removed, and facial scar resection was performed. The routine ECG showed ventricular premature beats. During the operation, when the surgeon pulled and compressed the neck dilator, significant arrhythmia was observed, with the heart rate dropping below 50 beats per minute and frequent ventricular premature beats occurring. The surgeon promptly halted the procedure, resulting in immediate relief of the patient's pain. Subsequently, the ventricular premature beats ceased, and normal sinus rhythm was restored. Once the heart rate exceeded 60 beats per minute, the surgeon resumed the operation, but ventricular premature beats persisted. After removing the dilator, the heart rate gradually returned to normal, and no further arrhythmia occurred. The patient recovered smoothly post-operation, with stable vital signs and no reported discomfort. She safely returned to the ward. It was determined that the patient's arrhythmia was caused by the compression of the carotid sinus due to the stretching of the neck dilator.

Keywords

skin expander implantation; arrhythmia; carotid sinus syndrome

Introduction

Burn mainly refers to the tissue damage caused by high temperature gas, hydrothermal fluid, flame and steam [1]. It usually refers to the damage of skin or mucosa. In severe cases, there will be subcutaneous or submucosal tissue damage [2]. After burn, patients may have skin redness, edema and tenderness. In recent years, burn patients have paid more and more attention to the cosmetic repair of skin surface [3]. Transplantation of composite skin is an important way for clinical intervention in patients with large area burn [4]. However, the skin color, elasticity and marginal scar after treatment cannot meet the needs of patients for aesthetics. With the deepening of clinical research, the application of skin expander in the treatment of burn patients can play a good repair effect [5]. Although skin expansion has the advantage of tissue repair, there are many postoperative complications reported in recent years, which even cause the failure of the operation and fail to achieve the repair effect. Here, the authors report a case of facial burn patient receiving skin expander implantation to address scar contracture, and significant arrhythmia was observed during operation.

Case Report

The patient is a 51-year-old female of Tujia ethnic group with no reported medical history of hypertension, diabetes, heart disease, arrhythmia, or any other relevant conditions. She denies experiencing symptoms such as convulsions, chest tightness, blackouts, syncope, or any food and drug allergies.

The patient sustained facial burns 50 years ago due to a fire incident. At that time, she received initial treatment, but the details are unknown. Following the healing of the wound, a scar formed, which remained untreated for many years. She is currently admitted to the hospital due to scar contracture. On examination, a skin expander can be observed placed under the skin on the head, face, forehead, as well as the left side of the face and neck (refer to Fig. 1). Preoperative evaluation revealed a Mallampati grade II, and the patient was classified as ASA II (American Society of Anesthesiologists Physical Status Classification System). The preoperative electrocardiogram (ECG) (Fig. 2) showed sinus rhythm, ventricular premature beats, and ST segment changes on the anterior and lateral walls. Other examinations did not reveal any significant findings.

During the operation, when the surgeon removed the left side neck dilator, the patient's heart rate signif-

Fig. 1. The figure showed the mainly process of the surgery.

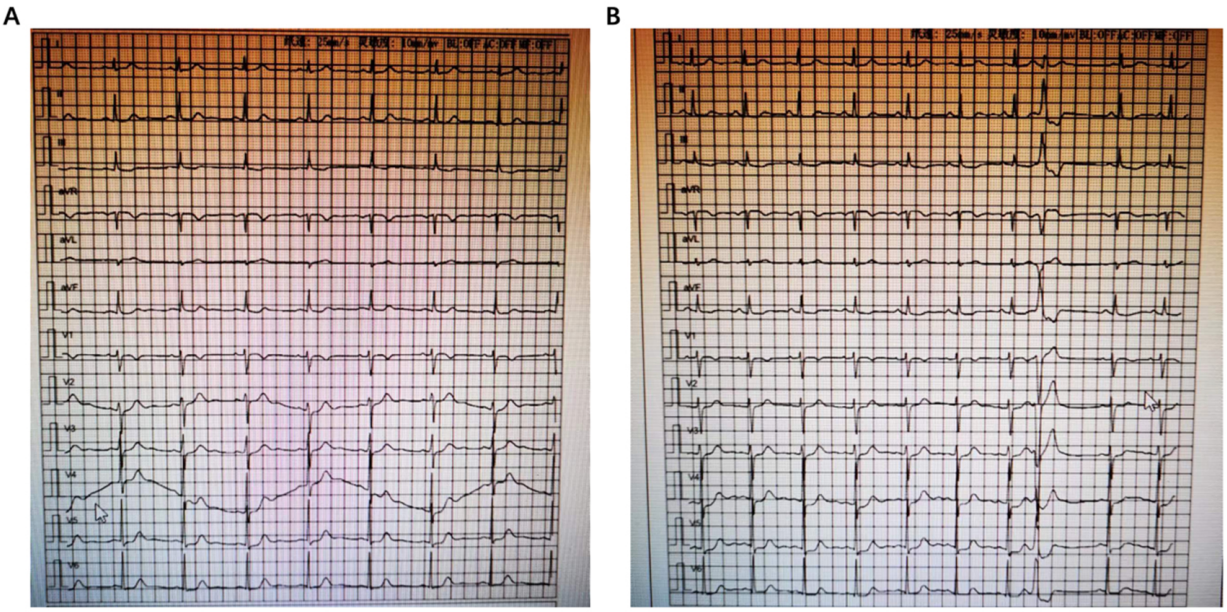

Fig. 2. The electrocardiogram (ECG) before the procedure. (A) is for the first time with a normal ECG; (B) is for the second time with ventricular premature.

icantly slowed down, reaching a minimum of 26 beats per minute, accompanied by frequent ventricular premature beats. However, there was no significant change in blood pressure. The surgeon promptly paused the operation, and the patient's heart rate gradually returned to normal. After the heart rate exceeded 60 beats per minute for 5 minutes, the surgeon proceeded with the operation, but ventricular premature beats continued to occur. Once the dilator was removed, the patient's heart rate gradually returned to normal, and no further arrhythmia was observed. Post-operation, the patient recovered smoothly, with stable vital signs, no reported discomfort, and was safely transferred back to the ward. It is believed that the arrhythmia experienced by the patient was caused by the proximity of the left cervical skin expander to the carotid sinus, resulting in arrhythmia when the carotid sinus was pulled and compressed during the operation.

Discussion

Carotid Sinus

The carotid sinus is situated at the bifurcation of the internal carotid artery, forming an enlargement known as the carotid sinus. It contains baroreceptors and is connected to the solitary tract nucleus and the dorsal vagus nucleus of the medulla oblongata through the glossopharyngeal nerve.

Stimulation of the carotid sinus baroreceptors can reflexively lead to a decrease in arterial blood pressure and a slowing of the heart rate, a condition known as carotid sinus syndrome. The carotid sinus can exhibit abnormal sensitivity to external stimuli [1].

When exposed to external stimuli, the carotid sinus can elicit various responses. Firstly, there is a significant increase in parasympathetic nerve activity, leading to a pronounced slowing of the heart rate, prolongation of the PR interval, high-degree atrioventricular block, or a combination of these effects. This results in a substantial decrease in cardiac output, potentially leading to cerebral ischemia and syncope. Secondly, due to a decrease in sympathetic nerve activity, there is systemic arterial relaxation, causing a marked drop in blood pressure and sudden reduction in cerebral blood perfusion pressure, which can also lead to syncope. In some patients, even without significant changes in heart rate and blood pressure, stimulation of the carotid sinus can cause constriction of cerebral blood vessels, resulting in cerebral ischemia and syncope. Other clinical manifestations may include restlessness, weakness, blurred vision, central blind spots, tinnitus, nausea, dizziness, followed by a brief period of fainting. Additional symptoms during syncope can include a pale face, sweating, dilated pupils, shallow breathing, clonic convulsions, incontinence, tongue biting, and recent memory loss [2].

Carotid Sinus Syndrome

Carotid sinus syndrome was first described about 65 years ago and is an important and often undiagnosed cause of syncope in the elderly [3]. Its pathophysiology is complex and some aspects are not fully understood. Timely diagnosis and treatment of this situation can improve the incidence rate of the elderly and prevent complications [4].

Carotid sinus syndrome can be diagnosed when carotid sinus massage triggers $\geq$3 second cardiac arrest, systolic blood pressure drop $\geq$50 mm Hg, or both. Diagnosis of carotid sinus syndrome requires continuous monitoring of heart rate and regular measurement of blood pressure, with symptoms reproducing during approximately 10 seconds of continuous carotid sinus massage while lying on the back and standing upright. However, in clinical practice, the duration of carotid artery pressure (3–5 seconds) is often much shorter (rather than actual massage) enough to trigger a positive response, as described below [5].

Carotid sinus syndrome is classified into four types [4]. The first type is cardiac inhibition, characterized by ventricular arrest lasting $\geq$3 seconds when the carotid sinus is stimulated. This type accounts for 60% to 80% of carotid sinus syndrome cases. Syncope in this type of patient is caused by cerebral ischemia resulting from reflex cardiac systolic dysfunction. The second type is simple blood pressure lowering, which causes a reduction in systolic blood pressure of $\geq$6.7 kPa (50 mmHg) when the carotid sinus is stimulated. This type accounts for about 5% to 11% of carotid sinus syndrome cases. Syncope in this type mainly occurs in slender individuals and is caused by cerebral ischemia due to low blood pressure. The third type is the mixed type, where both cardiac inhibition and blood pressure decrease occur upon stimulation of the carotid sinus. Diagnostic criteria for this type typically include a heart rate reduction of more than 50% and a systolic pressure drop of more than 5.3 kPa (40 mmHg) during carotid sinus massage. The mixed type accounts for approximately 30% of carotid sinus syndrome cases. The fourth type is the primary brain type. In this type, stimulation of the carotid sinus does not result in significant changes in heart rate or blood pressure. However, the patient experiences syncope or prodromal syncope symptoms, which are usually brief [6]. This type is commonly observed in patients with obstructive diseases of the carotid anterior cerebral artery and vertebral basilar artery system. It is often accompanied by symptoms of autonomic nervous dysfunction, typically triggered by sudden head rotation or tight collar. The mechanism underlying the onset of syncope in this type is unknown but may involve cerebral ischemia due to cerebral vasoconstriction. During an attack, EEG may show slow-frequency high-amplitude waves on the side of carotid sinus compression, along with twitching or spastic localized neurological signs on the opposite side.

In this particular case, the patient was under general anesthesia, making it challenging to observe the head and neck directly due to the presence of disinfection dressing. Apart from the noticeable slowing of the heart rate, no other clinical symptoms were observed. It is worth noting that in recent years, there have been few mentions of carotid sinus syndrome caused by the compression of a skin expander in case reports. This suggests that such occurrences may be relatively rare or underreported in the literature. However, it is essential to consider this potential complication and be vigilant during procedures involving the manipulation or compression of the carotid sinus area [7].

Skin Expander in the Clinical Setting

The skin expander is a unique advanced treatment method in plastic surgery [8]. Its principle is to implant a skin soft tissue dilator under normal skin soft tissue adjacent to the lesion. By intermittently injecting liquid into the expansion capsule, the dilator capacity is increased, causing it to exert pressure on the surface skin soft tissue. Through the local action of the expansion mechanism, the division and proliferation of tissues and epidermal cells and the widening of cell gaps increase the skin area [9]. After removing the expansion capsule, the newly added skin soft tissue can be used for tissue repair and organ reconstruction.

Currently, skin and soft tissue expansion surgery is commonly used for various types of scars, particularly those resulting from burns. It is also the preferred method for re-

pairing postburn deformities in many cases [10]. In situations where patients have extensive postburn deformities and limited donor sites, skin and soft tissue expansion can be employed to pre-expand the available donor area. This not only increases the amount of available donor tissue but also allows for direct suturing of the expanded skin. The expanded skin can be utilized for both full thickness and medium thickness skin grafts, resulting in improved quality of life compared to conventional skin grafts. Skin expansion has shown excellent results in ear and nose reconstruction procedures. The breast is another commonly treated area, where skin expanders can be used to create a prefabricated space for breast prostheses. Furthermore, skin and soft tissue expansion can be combined with traditional skin flap transplantation and skin tube transfer techniques to increase the size of the donor flap and reduce deformities at the donor site, leading to improved treatment outcomes.

Progress Made in the Treatment of Facial Defects Using Tissue Expansion

Posttraumatic soft-tissue injuries of the face are often the most lasting sequelae of facial burn. The disfigurement of post-burn scarring lies in both their physical deformity and psychosocial ramifications [11]. Extensive facial burn scars are a tragedy for patients and often pose a great challenge to surgeons because of the high esthetic and functional demands [12].

The advantage of the neck region as a similar adjacent tissue is that it has the appropriate color, texture, and skin thickness to achieve facial expression. Therefore, providing expanded flaps for facial reconstruction is an ideal donor site. In the past few decades, non-expanding cervical facial rotary flaps have been widely used for the reconstruction of facial defects. Therefore, theoretically, an expanded neck flap can provide a larger flap to reconstruct facial defects. Significant progress has been made in the treatment of facial defects using tissue expansion, and various reconstruction techniques for transferring expanded cervical flaps have been developed. The progressiveness of neck expanded flap is easy to design and implement [13].

Until now, the choice of reconstruction techniques has generally been based on the surgeon's experience and preferences. Standardizing preoperative evaluation, location of dilators, and expansion and reconstruction techniques will improve the efficacy of expanded cervical flaps. According to the characteristics of defects (shape, size, and location), there are five different reconstruction techniques available for different types of deformities. If the deformity is not a typical geometric shape (trapezoidal or fan shaped), normal skin near the defect can be removed to help design an expanded cervical flap. For patients with healthy neck skin, these five techniques are suitable for all types of facial defects except for the nose and forehead. Delayed surgery is a reliable method to increase the blood supply of random flaps, which is crucial to improving the survival ability of the expanded flap transferred [14].

Clinical Implications from this Case

In current case, we consider that the position of the left cervical skin expander is close to the carotid sinus, and the arrhythmia caused by pulling and compressing the carotid sinus. There were also some similar cases. It was reported that 3 cases of carotid sinus compression with cardiac asystole occurred in healthy patients undergoing routine rhytidectomies [15]. Moreover, it was reported 1 patient developed repetitive junctional rhythm during forehead lift plastic surgery [16]. In light of this, performing skin expander seems to us to be the technique of choice for treatment of the sequelae of burns and loss of facial tissue, it is suggested as the following:

Firstly, when designing the operation plan before the operation, pay attention to the selection of the expander location, and try to avoid the location that may compress the relevant nerves and blood vessels in the later stage. Secondly, when taking out the skin expander during the operation, the surgical operation should be as gentle as possible to reduce unnecessary pulling, pressing, rubbing and other operations; Thirdly, first aid supplies shall be prepared before the operation that may stimulate carotid sinus. Lastly, ask the medical history carefully. For patients with cardiac insufficiency or arrhythmia and other related medical history, carefully select the surgical plan.

Conclusion

There are technical considerations when it comes to the placement of expanders, particularly in areas near the carotid sinus, which is situated at the bifurcation of the internal carotid artery. The use of a neck dilator can potentially lead to carotid sinus syndrome due to compression of the carotid sinus. Therefore, it is important to carefully consider the impact of this factor during the design and selection of the insertion site for skin expanders prior to surgery. The CARE checklist was used when writing this case report in **Supplementary Table 1**.

Availability of Data and Materials

The datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

QL designed the study and wrote the paper, BJ managed the literature searches and analyses, HJ and BN contributed to the analysis of data for the work. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study is approved by the Ethics Committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (No. TJ-IRB2023454). Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.6705.

References

[1] Iskander AJ, Naftalovich R, Yang X. The carotid sinus acts as a mechanotransducer of shear oscillation rather than a baroreceptor. Medical Hypotheses. 2020; 134: 109441.

[2] Conde SV, Sacramento JF, Melo BF, Fonseca-Pinto R, Romero-Ortega MI, Guarino MP. Blood Pressure Regulation by the Carotid Sinus Nerve: Clinical Implications for Carotid Body Neuromodulation. Frontiers in Neuroscience. 2022; 15: 725751.

[3] Krediet CTPP, Parry SW, Jardine DL, Benditt DG, Brignole M, Wieling W. The history of diagnosing carotid sinus hypersensitivity: why are the current criteria too sensitive? Europace: European Pacing, Arrhythmias, and Cardiac Electrophysiology: Journal of the Working Groups on Cardiac Pacing, Arrhythmias, and Cardiac Cellular Electrophysiology of the European Society of Cardiology. 2011; 13: 14–22.

[4] Amin V, Pavri BB. Carotid sinus syndrome. Cardiology in Review. 2015; 23: 130–134.

[5] Kerr SRJ, Pearce MS, Brayne C, Davis RJ, Kenny RA. Carotid sinus hypersensitivity in asymptomatic older persons: implications for diagnosis of syncope and falls. Archives of Internal Medicine. 2006; 166: 515–520.

[6] Goldberger ZD, Petek BJ, Brignole M, Shen WK, Sheldon RS, Solbiati M, *et al*. ACC/AHA/HRS Versus ESC Guidelines for the Diagnosis and Management of Syncope: JACC Guideline Comparison. Journal of the American College of Cardiology. 2019; 74: 2410–2423.

[7] Tajdini M, Tavolinejad H, Aminorroaya A, Aryan Z, Jalali A, Alaeddini F, *et al*. Clinical Associations of Injuries Caused by Vasovagal Syncope: A Cohort Study From a Tertiary Syncope Unit. Journal of the American Heart Association. 2023; 12: e027272.

[8] Pamplona DC, Weber HI, Leta FR. Optimization of the use of skin expanders. Skin Research and Technology: Official Journal of International Society for Bioengineering and the Skin (ISBS) [and] International Society for Digital Imaging of Skin (ISDIS) [and] International Society for Skin Imaging (ISSI). 2014; 20: 463–472.

[9] Sun P, Lu M, Wang C, Pan B. A study on the therapeutic effects of biplane skin dilator implantation in auricular reconstruction. Scientific Reports. 2021; 11: 20532.

[10] Han T, Chen H, Chen J, Cui J, Shen W. Testing the circulation of expanded flaps-prevention of necrosis of expanded flaps (a clinic study). Frontiers in Pediatrics. 2023; 10: 976150.

[11] Guo P, Pan B, Jiang H, Yang Q, Lin L. Burned Ear Reconstruction Using the Combination of an Expanded Postauricular Scar Skin Flap and a Postauricular Fascial Flap. Facial Plastic Surgery: FPS. 2021; 37: 354–359.

[12] Luo SS, Li YQ. Using an Expanded Cervical Flap With an Overlapping Tissue Expansion Technique to Resurface Middle and Lower Facial Defects. The Journal of Craniofacial Surgery. 2023; 34: 1325–1328.

[13] Gao B, Xiao K, Zhu H, Sheng L, Yu Q, Mao X, *et al*. An algorithm for using expanded cervical flaps to resurface facial defects based on five different methods. Burns: Journal of the International Society for Burn Injuries. 2016; 42: 1867–1874.

[14] Zhang L, Yang Q, Jiang H, Liu G, Huang W, Dong W. Reconstruction of Complex Facial Defects Using Cervical Expanded Flap Prefabricated by Temporoparietal Fascia Flap. The Journal of Craniofacial Surgery. 2015; 26: e472–e475.

[15] Rose EH, Laub DR, Avakoff J. Cardiac asystole secondary to carotid sinus compression in the face-lift operation. Plastic and Reconstructive Surgery. 1977; 59: 252–254.

[16] Shih YR, Peng SK, Tsai TC, Luk HN, Chiang CE. Repetitive junctional rhythm during forehead-lift surgery–a case report. Acta Anaesthesiologica Taiwanica: Official Journal of the Taiwan Society of Anesthesiologists. 2005; 43: 109–112.