

## Review Article

# Spinal fusion surgery for high-risk patients: a review of hospitals information

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## Abstract

**Background:** Spinal fusion surgery (SFS) is commonly performed as an elective procedure in the United States that employs minimally invasive techniques; however, it possesses potential risks and side effects and is still considered an experimental treatment. As such, patients can often be hesitant when proposed SFS. In that regard, this study aimed to analyze and critique available SFS instructive materials, to account for the procedure's potential risks for patients.

**Methods:** We have reviewed information concerning surgical procedures and policies (pre-operative to postoperative) on 20 hospitals and medical center websites. All possible keywords regarding SFS were systematically arranged and considered in various ways. The collected data was assessed and compared to identify common themes.

**Results:** Our results indicate that, although some informational sources reaffirm each other's materials, few provided key SFS details, such as potential candidates, outcomes, risks, and aftercare. Moreover, information was neither delivered systematically nor consistently, leading patients to feel anxious, fearful, or confused when making decisions involving SFS.

**Conclusion:** This paper recommends a comprehensive and interactive information system (IS) with a patient-oriented approach, which will facilitate patient decision-making and help people discern between factual data and false information supplied through social media or word of mouth. This information system could then be used for other elective procedures.

**Keywords:** Advisory Services; Elective Surgical Procedures; Health Information Systems; Risk-Benefit Assessment; Spinal Fusion.

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## Introduction

As body modifications through medical procedures become more common in our society (1), we should work to understand what they comprise and how they affect our health (2). One of the most complex body modification procedures consists of implants, which can be classified into three sections: practical/convenient (3),

cosmetics/aesthetic (4), and medical implants (5). We try to evaluate spinal fusion surgery (SFS) as a medical implant category based on public awareness and procedures.

Spinal fusion is a surgery that connects two or more vertebrae and helps to eliminate pain, instability, and other spinal-relevant disease symptoms by preventing motion

between the vertebrae (6). This procedure can also commonly treat spondylolisthesis, scoliosis, infections, tumours, fractures, and disc hernias in the neck (7). Also, SFS is designed to mimic the healing process of broken bones, and the surgeon places bone or bone-like material between two spinal vertebrae. The bones are held together by plates, screws, and rods to promote healing and unite them (8). This operation may be recommended to treat spine deformities (e.g., scoliosis), spinal weakness, and instability or to strengthen the spinal column (e.g., herniated disks). Alternatively, it can stabilize a spine after removing an injured (herniated) disk (9), (6). Figure 1 demonstrates a radiological image of a curved spine with a 53-degree right convex thoracic curve and a 49-degree left convex lumbar curve (1A), in which a segmental posterior spinal instrumentation and fusion were conducted (1B) (10).

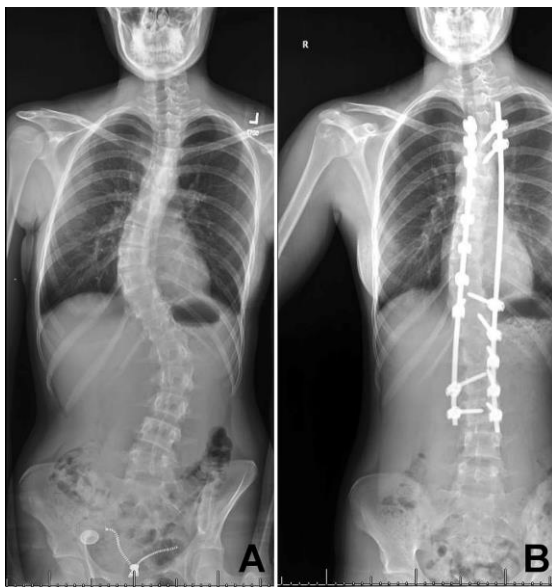


Figure 1. Radiological demonstration of scoliosis (A-Preoperative) corrected with spinal instruments and fusion (B-postoperative), (10, 11).

In terms of the consequences and potential risks, SFS is not a procedure that typically leads to significant morbidity and death, but there are increasing concerns regarding ethical conflicts of interest and ethics in surgery. For instance, no imaging techniques or diagnostic tests can reliably pinpoint the source of pain in patients with non-specific low back pain. Hence, the

likelihood that lumbar fusion effectively treats the patient's pain is unknown (9). Furthermore, although chronic low back pain patients may benefit from spinal fusion, no clinical guidelines for treating them recommend spinal fusions, except for in a few very carefully selected patients (10,15). The studies show that spine surgeons have little consensus regarding perioperative management, instrumentation and implants, surgical technique, and postoperative care (13), despite the increasing prevalence of SFS-elective surgery. For instance, the previous studies proved that there is no conclusive evidence showing that SFS is more beneficial than intensive rehabilitation for patients suffering from chronic low back pain (14). However, SFS is one of the most common elective surgery (15), so that the United States has experienced a rapid increase in lumbar spine fusion rates (336% increase from 1996 to 2001) (9). The rate of growth continued in the following year so that according to the last update, the "volume of elective lumbar fusion increased 62.3% (or 32.1% per 100,000 U.S. adults), from 122,679 cases (60.4 per 100,000) in 2004 to 199,140 (79.8 per 100,000) in 2015" which are most related to spondylolisthesis and scoliosis (16). Therefore, it seems that SFS is still considered a "minimally invasive" procedure in the United States (U.S.), and the label "experimental technique" has been adopted for it (14). Accordingly, patients can still face risks, but since SFS is an elective procedure (15), they usually seek advice from others by word of mouth, hospital information sources, or even social networks. Among all potential informative sources, trustable references such as hospital websites or medical centers play a remarkable role in presenting information regarding the procedure and its consequences (17). However, it seems there is a gap concerning the required quality and quantity of informative sources on SFS and given information and procedure by hospitals. To our best knowledge, few studies have evaluated valuable

information sources like the pre-and postoperative prognosis of SFS to date, which play a significant role, especially for high-risk patients. In this regard, hospitals and health policymakers must consider the public medical informatics resource use—before and after common elective spinal surgery—when deciding how to implement a “return to normal” surgery. Therefore, this study aimed to analyze and assess the public med-information sources found in the U.S. hospital and medical centers, particularly for potential patients living with movement disorders and other related risky conditions. And we specifically try to answer the question: Does the information on SFS provide patients with a complete picture to make an informed and accurate decision? By analysis of the informative sources of hospitals and answering our research question, we provide insight into how hospitals can improve their information services and reduce their workloads. Additionally, this paper can aid in developing virtual interactions between patients, hospitals, and caregivers. This paper consists of three sections: method, results, and discussion.

## Methods

This qualitative study investigates the SFS policies and procedures in 20 hospitals and medical centers that perform the surgical technique in the United States (table 1). We included and selected the medical institutions for our study according to *U.S. News and World Report's* best hospital ranking in 2021-22 (18), as the list only considered hospitals that perform SFS. These medical institutions' websites were reviewed to ensure that they provide basic SFS information, and a final list was compiled. Also, we excluded those medical centers that suggested an in-person consultant for patients. We investigated the websites of the hospitals and medical centers to find out about their procedures and policies regarding SFS. Accordingly, a systematic search was conducted by

entering the following keywords in various configurations: “spinal fusion” or “spinal surgery” AND “types” OR “risks” OR “procedures” OR “side effects.” Then, the collected information was compared to identify common themes, similarities, and differences in policies and procedures.

**Internet-based Qualitative Data:** To provide an overview, we have applied the Internet-based qualitative data from hospitals in three steps: elicitation, reduction (based on IS-facilitated selection, coding, and grouping), and visual presentation (19). Information was extracted from the medical institutions' websites using the search function. On each website, we found information related to spinal fusion by using the following keywords: *spinal fusion surgery (SFS), types of spinal fusions, what to expect from spinal fusion surgery procedures, risks, side effects, and aftercare.* We also followed links within spine fusion webpages to find more detailed information. Finally, all data (articles, motions, and videos) drawn from each hospital was classified and organized into the following categories:

1. What makes someone a potential candidate for spinal fusion surgery?
2. What is the expected outcome?
3. What are the possible complications and risks?
4. What are the side effects?
5. What happens after the surgery and during recovery?

**Ethical approval:** No human participants were involved in this study, so ethical approval was unnecessary.

## Results

**SFS Application Resources General Information:** According to the review, only a small portion of the sources provided detailed information about SFS.

Table 1. A list of medical institutions' webpages conducting SFS (N=20).

No	Name, Webpage of Hospital/Medical centre and URL	Data Accessed	Location
1	Mayo Clinic <a href="https://www.mayoclinic.org/tests-procedures/spinal-fusion/about/pac-20384523">https://www.mayoclinic.org/tests-procedures/spinal-fusion/about/pac-20384523</a>	03/2022	Rochester, Minn. ; Scottsdale and Phoenix, Ariz. and Jacksonville, Fla.
2	Cleveland Clinic. <a href="https://my.clevelandclinic.org/departments/neurological/depts/spine/minimally-invasive-spine-surgery#overview-tab">https://my.clevelandclinic.org/departments/neurological/depts/spine/minimally-invasive-spine-surgery#overview-tab</a>	03/2022	Cleveland, Ohio
3	John Hopkins Hospital <a href="https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/minimally-invasive-spinal-fusion">https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/minimally-invasive-spinal-fusion</a>	03/2022	Baltimore, Maryland
4	Massachusetts General Hospital. <a href="https://www.massgeneral.org/orthopaedics/children/conditions-and-treatments/preparing-for-spine-surgery">https://www.massgeneral.org/orthopaedics/children/conditions-and-treatments/preparing-for-spine-surgery</a>	03/ 2022	Boston, Massachusetts
5	Cedars-Sinai Medical Center. <a href="https://www.cedars-sinai.org/health-library/tests-and-procedures/m/minimally-invasive-spinal-fusion.html">https://www.cedars-sinai.org/health-library/tests-and-procedures/m/minimally-invasive-spinal-fusion.html</a>	03/2022	Los Angeles, California
6	<i>New York-Presbyterian Hospital.</i> <a href="https://www.nyp.org/news/study-compares-benefits-of-surgical-treatments-for-degenerative">https://www.nyp.org/news/study-compares-benefits-of-surgical-treatments-for-degenerative</a>	03/2022	New York City, NY
7	NYU Langone Hospitals. <a href="https://nyulangone.org/search?q=spinal+fusion">https://nyulangone.org/search?q=spinal+fusion</a>	03/2022	New York City, NY
8	San Francisco Medical Center. <i>UCSF Health.</i> <a href="https://www.ucsfhealth.org/treatments/spinal-fusion-surgery-for-scoliosis">https://www.ucsfhealth.org/treatments/spinal-fusion-surgery-for-scoliosis</a>	03/ 2022	San Francisco. California
9	Northwestern Memorial Hospital. <a href="https://www.nm.org/conditions-and-care-areas/treatments/lumbar-fusion">https://www.nm.org/conditions-and-care-areas/treatments/lumbar-fusion</a>	03/2022	Chicago, Illinois
10	University of Michigan Hospital. <a href="https://careguides.med.umich.edu/posterior-spinal-fusion-surgery-preparing-your-peds">https://careguides.med.umich.edu/posterior-spinal-fusion-surgery-preparing-your-peds</a> . PDF file is ready for study.	03/2022	Ann Arbor, Michigan
11	<i>Penn Medicine University City (PMUC).</i> <a href="https://www.pennmedicine.org/updates/blogs/neuroscience-blog/2017/may/spinal-fusion-surgery-the-5-ws-you-should-know-about?_ga=2.268729265.193425008.1640768509-256731554.1640768509">https://www.pennmedicine.org/updates/blogs/neuroscience-blog/2017/may/spinal-fusion-surgery-the-5-ws-you-should-know-about?_ga=2.268729265.193425008.1640768509-256731554.1640768509</a>	03/2022	Philadelphia, Pennsylvania
12	Brigham and Women's Hospital. <a href="https://www.brighamandwomens.org/medical-resources/spinal-fusion">https://www.brighamandwomens.org/medical-resources/spinal-fusion</a>	03/2022	Boston, Massachusetts
13	<i>Houston Methodist.</i> <a href="https://www.houstonmethodist.org/spine/treatments-procedures/">https://www.houstonmethodist.org/spine/treatments-procedures/</a>	03/2022	Houston, Texas
14	Barnes-Jewish Hospital. <a href="https://www.barnesjewish.org/Newsroom/Publications/Innovate-Physician/Summer-2009/Artificial-Disc-Replacement-as-Good-or-Better-Than-Spinal-Fusion-Surgery">https://www.barnesjewish.org/Newsroom/Publications/Innovate-Physician/Summer-2009/Artificial-Disc-Replacement-as-Good-or-Better-Than-Spinal-Fusion-Surgery</a>	03/2022	Saint Louis, Missouri
15	Mount Sinai Hospital. <a href="https://www.mountsinai.org/locations/spine-hospital/treatments/spinal-fusion">https://www.mountsinai.org/locations/spine-hospital/treatments/spinal-fusion</a>	03/2022	New York City, NY
16	Rush University Medical Center. <a href="https://www.rush.edu/services/spine-surgery-services">https://www.rush.edu/services/spine-surgery-services</a>	03/2022	Chicago, Illinois
17	Vanderbilt University Medical Center. <a href="https://www.vanderbilthealth.com/treatment/spinal-fusion-lumbar-spine-treatment-spondylolisthesis">https://www.vanderbilthealth.com/treatment/spinal-fusion-lumbar-spine-treatment-spondylolisthesis</a>	03/ 2022	Nashville, Tennessee
18	Hospital for Special Surgery. <a href="https://www.hss.edu/condition-list_spinal-fusion.asp">https://www.hss.edu/condition-list_spinal-fusion.asp</a>	03/2022	New York City, NY
19	Hoag Orthopaedic Institute. <a href="https://www.hoagorthopedicinstitute.com/what-hurts-/spine/treatments/spinal-fusion/">https://www.hoagorthopedicinstitute.com/what-hurts-/spine/treatments/spinal-fusion/</a>	03/ 2022	Irvine, California
20	Universal Care Surgery Centre. <a href="https://universalcaresc.com/spinal-fusion/">https://universalcaresc.com/spinal-fusion/</a>	03/2022	North Hollywood, California

Approximately less than half of the primary sources presented the basic required information regarding potential candidates, outcomes, risks, and life after surgery. Furthermore, only a few heads reaffirmed each other. These sources provided an overview of SFS and indicated that people with specific disorders and diseases could be potential candidates for the procedure, with the conditions including:

- Degenerative disc disease (occurs when regular changes in the disks of your spine cause pain).
- Spinal stenosis (A narrowing of the spinal canal in the lower part of the back),
- Spondylolisthesis (it's a condition in which the vertebrae move more than they should),
- Spinal deformities (scoliosis),
- Break (fracture) of the spinal column,
- Infection of the spinal column,
- Tumour in the spinal column,
- Spinal weakness or instability (due to tumours or infections),
- A herniated disk, issues stemming from arthritis (e.g., spinal stenosis, a narrowing of the spinal column),
- Vertebrae slippage (A vertebra slips out of place onto the vertebra below. e.g., spondylolisthesis, which squeezes the spinal cord or nerve roots) (8,20-22).

Most medical web sources did not emphasize the targeted group of people, and others only mentioned what type of candidate might use the technique without any encouragement for or against it.

***Informative SFS Videos/Animation for Patients:*** On all sources, there were no videos (animations or movies) that explained the whole process (with the inclusion of pre-and post-op information); however, one of the sources presented graphics on their webpage (23). According to our review, most webpages merely provided information via text, only informing the reader about the preparatory

phase and what might occur during the surgery (8,20,24,25).

***Patient Aftercare Information for SFS:***

There are nine sources of information that explain the aftercare and recovery process of SFS, ranging from presenting minimal to detailed descriptions and protocols. There were two distinct parts for aftercare in the hospital and home on the websites that had comprehensive information.

First, there was information regarding the issues and challenges that could occur after the surgery (short—and long-term) (25). These details that a patient undergoing the operation in a supine position would be placed back in the recovery room or post-anesthesia care unit (PACU) and may feel stiff from having been in a single position for so long. Furthermore, they may not remember the PACU due to feelings of sleepiness and grogginess. It is explained that patients may stay in the recovery room for some hours while recovering from the surgery and anesthesia (21). In this section, three sources also mention the most common side effects, including redness, wound drainage, shaking, chills, fever, and pain (8,24), and (26). Patients usually need to spend one night in intensive care units (ICUs) before going to the adolescent floor (21). However, it depends on the specific circumstances of each patient.

Second, one can find information regarding the recovery program and recommendations for staying home, with additional details on medication and therapy. In general, the advice is to rest. Still, patients are often encouraged to engage in gentle exercise according to training plans from their physical therapy (27,20), aquatic therapy, and pain management programs (28) throughout the course of their recovery (which can take between six and ten months (26,29) depending on the patient) (30). Patients who consent to SFS should be provided with this information beforehand so that to know the extent of the recovery process.

**Potential Risks of SFS:** Hospital websites also describe the risks associated with spinal fusions. As this is a complex surgical procedure involving the implantation of a foreign object into the body, it can result in infection, poor wound healing, bleeding, nerve damage, blood clotting (8,29,34), lack of solid bone fusion (20), pain at the place from which the bone graft is taken (the extent of this will vary according to patient age) (24) and the possible need for a brace (30,32). It is also mentioned that spinal fusion decreases the range of motion at the fusion site, which is not a severe problem in the short term, yet in a long time, it may cause more stress on nearby parts of the spine (24).

**Spinal Fusion Is Not a Cure for All:** All sources—even those with limited information on the procedure—have neither explicitly nor implicitly stated that spinal fusion is not a cure that will work properly for everyone. For instance, people with multiple levels of arthritis or severe disc disease in the spine are not good candidates for SFS (32). Most sources only noted the procedure, with a few adding information on the benefits of undergoing this procedure. These benefits include tiny scars instead of open incisions, reduced postoperative pain, shorter recovery time, lower blood loss and infection risks during surgery (33, 34), and lower pain levels (36) compared to other aggressive surgery (35-37). However, it is essential to note that every patient has a unique condition, and every spinal deformity/issue is different (37,21,33).

## **Discussion**

The 20 hospitals and medical centers delivered varying levels of information (from limited to detailed descriptions) regarding the pre-operative plans, risks, procedures, aftercare, and other effects. This information is summarized in table 2. It should be noted that due to very limited data from some sources (e.g., info regarding the only introduction of the SFS), we

couldn't utilize these primary data to categorize into some subsections (e.g., pre-operative plans, risks, procedures, aftercare, etc.).

**The Importance of Pre-Operation Information:** The sources of information reviewed for this study described the issues that patients should know before undergoing SFS, which, in turn, can give a more apparent expectation of what is entailed. According to one of the studies entitled “preoperative anxiety and associated factors among adult surgical patients in Debre Markos and Felege Hiwot referral hospitals, Northwest Ethiopia,” fear of surgical complications can significantly affect anxiety levels before surgery (38), so having a clear understanding of the surgical procedure—along with other stress relievers (e.g., listening to music)—can positively affect the patient's state of mind (39). Our review of the 20 medical institutions' websites showed no instructive videos or motion graphics. Accordingly, SFS patients might imagine procedures that will be drastically different from reality, which, in turn, could lead to fear and doubtfulness; this can radically influence a patient's decision. In this regard, while realistic-style videos may negatively affect patient attitudes vis-à-vis the procedure (due to the perceived “invasiveness” of SFS), an instructive animation or a short motion graphic of the technique's steps could benefit patients in at least two ways: First, it would allow them to imagine better how SFS works, and it would make sure that they were well informed about the procedure before meeting with a neurosurgeon. Second, patients could use such a graphic to understand the real risks of this surgery based on their specific circumstances (e.g., spiritual and physical), which can affect their readiness levels. Recent studies have confirmed that one of the optimal formats for presenting preoperative surgical information is computer animation and videos (40, 41).

Table 2. The summary of the process, description, and other considerations of SFS.

Stage	Process of SFS	Description	Considerations
1	Pre-operation protocol and education	<ul style="list-style-type: none"> <li>-Discussing procedure with surgeon and nurses</li> <li>-Imaging test of spine (MRI or X-ray)</li> <li>-Health monitoring and performance of a physical examination</li> <li>-Taking a blood sample</li> <li>-Trimming the relevant area for surgery</li> </ul>	
2	Procedure	<ul style="list-style-type: none"> <li><b>-Taking anesthetics (to avoid feeling any pain or discomfort)</b></li> <li><b>-Monitoring the vital signs</b></li> <li>-Giving antibiotics during and after the procedure</li> <li>-Making an incision</li> <li>-Pushing the relevant muscles to make room for the procedure.</li> <li>—Removing the intervertebral disc between the affected vertebrae.</li> <li><b>—Preparing the bone graft</b></li> <li>-Placing a synthetic bone-like material between the vertebrae</li> <li><b>-Fusing the spine</b> (using special screws or other material)</li> <li>-Making other repairs, if necessary</li> <li>-Closing the skin around the incision</li> </ul>	Each case might be dealt with differently based on the type and site of surgery
3	After care and recovery	<ul style="list-style-type: none"> <li>-Going through imaging procedures (X-ray) (possibility)</li> <li>-Leaving the hospitals (depending on patient condition)</li> <li>-Following all healthcare providers’ instructions (e.g., a diet that is high in calcium and vitamin D)</li> <li>-Draining from the incision (possibility)</li> <li>-Contacting physician if the need arises</li> <li>-Following an exercise program under the guidance of a physical therapist.</li> </ul>	Case-by-case basis (might not be necessary)
4	Risks	<ul style="list-style-type: none"> <li>-Infection</li> <li>-Poor wound healing</li> <li>-Bleeding</li> <li>-Nerve damage</li> <li>-Blood clotting</li> <li>-Lack of solid bone fusion</li> <li>-Pain</li> <li>-Possible decrease in range of motion at the site of fusion</li> <li>-Injury to blood vessels or nerves in and around the spine</li> <li>-Pain at the bone graft site</li> </ul>	Differs with each case
5	Benefits	<ul style="list-style-type: none"> <li>-Tiny scars instead of large incisions</li> <li>-Reduced postoperative pain</li> <li>-Shorter recovery time</li> <li>-Less blood loss and infection during surgery</li> <li>-Desirable for reducing the pain</li> </ul>	Differs with each case

Additionally, we found that some sources were not demonstrated the SFS procedure step-by-step, further increasing the likelihood that a patient could experience fear and anxiety.

Elective surgery—like spinal fusions, deep brain stimulation (DBS), etc.—are complex procedures that often involve a comprehensive, multidisciplinary evaluation before surgery (42). Thus,

medical centers and hospitals should provide education (primary and interactive) to patients before SFS procedures and show patients where they can find this information. In many cases, patients do their research about the process and expectations, so there is always the risk of coming across false or inaccurate information that might affect their decision. Hospitals and medical centers are responsible for providing patients with accurate and relevant information about their procedures (43).

***Risks, Benefits, and Long-Term Results:***

According to our review, only a few sources provided the risks (seven sources), and even fewer showed SFS's benefits (two sources). Most websites only refer to surgical procedures. Failure to provide patients with a comprehensive overview of SFS could potentially bias them and keep them away from the process—despite its benefits in some cases. It may even discourage patients from undergoing an initial analysis to determine whether the surgery is appropriate for them in the first place. Furthermore, the risks presented in the sources are more concerned with the biological and anatomical challenges, whereas in many cases, the procedure might negatively impact the activities of daily living (ADL). For example, in one of the latest studies, which investigated the immediate recovery journey of patients with lumbar spinal fusion surgery (LSFS), participants described needing much assistance with ADL in the first week following surgery. The relevant ADLs affected basic tasks, such as washing, dressing, working around the house, and shopping. These activities caused participants to notice their difficulty since their surgery (44).

On the other hand, the benefits are more associated with the function of SFS with the minimally invasive procedure in a short time and not clued with the long positive effect. However, despite a lack of evidence for the benefits and harms of medical

interventions like lumbar spinal fusion surgery (LSFS) (45) and a lack of consensus regarding such surgical interventions (44), patients who are searching for information about SFS will already expect to encounter some of the long-run benefits from SFS in the sources. Otherwise, SFS may not be perceived as possessing functional value, discouraging patients from being optimistic about getting rid of their pain. In that regard, there is an essential need for an information source that presents both the risks and benefits of SFS. Accordingly, the existing literature argues for a stratified model; teaching the expected benefits of LSFS appears essential for surgical decision-making and rehabilitation after surgery to maximize recovery rates (46).

***Recommendations:*** Regarding the data collected, it seems that we need to design an informatics system that accounts for two expectations: patient inquiries and the provision of detailed guidance tuned to each patient's circumstances. The information bank would grow and develop as the patient's experiences aggregated over time. Also, as the elective and minimal risk operations are not limited to SFS (e.g., cleft lip repair, cosmetic surgery, DBS, etc.), designing a comprehensive and interactive info system would help other patients and inform people who might be exposed to non-scientific data from social media or word of mouth (which could have a negative influence on their decisions and behaviours; e.g., by causing them to seek cosmetic surgery when it shouldn't be sought) (47). In many cosmetic surgeries, teenagers and young adults are influenced by media and societal beauty standards without knowing the long-term effects of the procedures that appeal to them (48). Therefore, implementing a *Comprehensive Informatics System* or a *Modern Patient-based Information System* (41) that the relevant doctor's monitor could provide a clear and factual description of the pros and cons of various procedures to patients.



**Future Research:** While this study has attempted to evaluate the level and quality of presenting information about growing electives SFS, further investigation is needed to understand how these factors influence overall tendencies, decisions, and satisfaction in the short and long term. Longitudinal data would provide greater insight into the SFS life course and the relationship between informatics sources and education in predicting the need for SFS. Also, further research can be conducted on the role of 3D animation and video presentation of SFS information in pre- and postoperative patient satisfaction.

Further, the information sources (depth, pre-operation, post-operation stages, etc.) of other types of elective and minimal-risk surgery will be a subject of investigation. An interactive patient-based info system prototype can also be designed and compared to the current presentation of SFS information (or other elective surgery) on websites. The outputs will be the first step toward creating a comprehensive informatics system for elective and minimally invasive surgery. In addition, there is research potential in comparing the virtual blogs of patients and educational information of hospitals and medical centers with videos uploaded to YouTube or TikTok detailing personal SFS journeys. In this regard, a discourse analysis of elective and minimally invasive surgery in media, public pages of hospitals and medical centers, etc., allows healthcare policymakers and hospital administration to gain a deeper understanding of patient behaviours.

Undoubtedly, patients' health decisions are multidimensional and processed in several layers that consciously or subconsciously affect patient attitudes. Therefore, we cannot expect patients to behave only under the information they get from medical sources and therapists. We need to account for other fields (e.g., medical anthropology, health psychology, sociology of health, and technology) to consider the further potential

and hidden perceptive factors that play a role in choosing and making decisions for SFS and other elective and minimal-risk operations.

### **Conclusion**

The Internet-based information provides an expanded data source, but it can be insufficient and negatively impact patient decisions despite its beneficial role in many cases. These issues are highlighted in elective therapies like SFS, DBS, and cosmetic surgery. We showed that SFS decision-making is still very convoluted—so much so that there is no solid consensus, even for orthopedists (13). This crucial decision should be made optimally with information gathered from the collective experience of patients and physicians, as this will ultimately reduce the prevalence/possibility of risks in the short and long term. In the meantime, the role of patients as an essential part of this decision can be very effective if the information is received comprehensively and systematically with the help of video or 3D animation. With the analysis of 20 medical institutions in the U.S., we showed that most of the relevant and required information is scattered.

Furthermore, there is no single procedure that is common in all sources. Hence, improving SFS sources and information for each hospital seems essential. Accordingly, we recommend a patient-oriented, comprehensive, and interactive info system to increase patient awareness and ease the decision toward SFS. The system can be used for SFS and will also be developed to cover elective and low-risk surgery. Finally, making a safer choice for people with SFS high-risk decisions who feel isolated in their situation is crucial. Improving the information sources will not only help patients be clear with the procedure; it will also provide better insight for therapists and health policymakers, allowing them to prevent some unnecessary operations in turn.

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### **Author's contribution**

Mohsen Rasoulivalajoozi (Ph.D. Student and Corresponding Author), acquired the data; Mohsen Rasoulivalajoozi and Ghada Touri (Assistant professor) analyzed and interpreted the data, and Mohsen Rasoulivalajoozi wrote the first draft of the manuscript. A final manuscript draft was approved by all authors, and all authors contributed to editing the manuscript.

### **Ethical considerations**

No human participants were involved in this study, so ethical approval was unnecessary.

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### **Conflicts of interest**

The authors declare that they have no conflict of interest.

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