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Exploring the Lived Experiences of Patients Using Biodegradable Implants for Bone Reconstruction: A Phenomenological Study

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ABSTRACT

Regenerative medicine, particularly through the use of biodegradable implants, is a rapidly advancing field aimed at improving recovery and tissue repair. However, while clinical studies have extensively evaluated the mechanical properties and biological effectiveness of these implants, less attention has been paid to understanding the patient experience during recovery. Despite the growing use of biodegradable implants, the psychological, emotional, and social impacts of these treatments remain largely unexplored. This study addresses the gap by applying a hermeneutic phenomenological approach to examine patients' lived experiences with biodegradable implants for bone reconstruction.

Through in-depth interviews with 12 patients, we identified key themes regarding the physical discomfort, emotional adaptation, and eventual acceptance of the implants. Our findings suggest that patients transition from initial discomfort and anxiety to a sense of bodily integration and healing, highlighting the importance of emotional and psychological support in medical recovery. These insights provide a deeper understanding of how patients interact with their implants over time, contributing to patient-centered approaches in regenerative medicine.

The study's findings have significant implications for improving healthcare practices, emphasizing the need for a more holistic, patient-centered approach when incorporating new medical technologies. Future research could explore the long-term psychological impacts and cultural differences in patient experiences with regenerative treatments.

INTRODUCTION

The advancement of biomaterials and bioprinting technologies has revolutionized modern regenerative medicine, offering innovative solutions for tissue repair and reconstruction. Among these advancements, biodegradable implants have emerged as a promising alternative to traditional metallic or permanent synthetic implants (Alasseri & Alasraj, 2020). Designed to gradually degrade within the body, these implants provide structural support during the healing process while eliminating the need for secondary removal surgeries. Their application spans various medical fields, including orthopedic surgery, maxillofacial reconstruction, and soft tissue engineering. Despite their growing adoption, the patient experience with these implants remains an underexplored aspect within medical research, particularly regarding their physical, psychological, and social implications.

Understanding the patient experience is crucial, as the integration of biodegradable implants is not merely a technical procedure but a transformative event that influences an individual's daily life, bodily perception, and long-term well-being. Understanding how patients adapt to these changes and the impact on recovery rates and long-term effectiveness is key to improving clinical outcomes. Patients undergoing reconstructive procedures often face challenges beyond the physical recovery

process, including adapting to new bodily sensations, managing pain perception, and coping with uncertainties regarding the biodegradation timeline. Additionally, cultural beliefs, personal health literacy, and prior medical experiences shape how individuals perceive and respond to medical innovations. These subjective dimensions are vital to consider in order to enhance patient-centered care, improve post-operative support systems, and refine implant designs for optimal comfort and functionality.

Given these complexities, a phenomenological exploration of patient experiences with biodegradable implants is necessary to bridge the gap between clinical advancements and lived realities. Traditional biomedical approaches focus primarily on the mechanical performance, biochemical interactions, and degradation kinetics of implants, often overlooking the personal and social dimensions of recovery (Aprato dkk., 2019). A deeper understanding of how patients interpret, internalize, and navigate their healing journey is essential to optimizing therapeutic outcomes and ensuring holistic care. By capturing the essence of patients' lived experiences, this study seeks to contribute to the broader discourse on human-centered innovation in medical technology and regenerative medicine.

The study of patient experiences in medical and technological advancements has become increasingly significant in health sciences, particularly in the field of regenerative medicine. As biomedical innovations such as biodegradable implants continue to develop, researchers and clinicians have begun to recognize the importance of understanding not only the physiological outcomes but also the personal and psychosocial dimensions of medical interventions. Patients' perceptions, emotional responses, and adaptation processes play a crucial role in the overall success of treatment, influencing their quality of life and satisfaction with medical care. However, despite the growing awareness of these factors, systematic investigations into the lived experiences of patients using biodegradable implants remain limited.

One of the primary challenges in exploring these experiences is methodological in nature. Traditional research approaches, particularly quantitative methodologies, often focus on measurable outcomes such as implant degradation rates, mechanical performance, and clinical recovery metrics. While these data are essential for evaluating the efficacy of biodegradable implants, they fail to capture the depth of personal meaning and adaptation that patients undergo during the healing process (Carey dkk., 2020). Surveys and standardized assessment tools, although valuable for identifying broad trends, lack the flexibility to uncover the nuanced and dynamic nature of patients' subjective experiences. As a result, the personal and existential aspects of post-implantation recovery remain largely unexplored.

These methodological limitations highlight the need for a qualitative approach that prioritizes experiential depth and interpretative analysis. Phenomenology, particularly the hermeneutic approach, offers a way to bridge this gap by allowing researchers to explore how individuals make sense of their healing journey, how they integrate the implant into their bodily awareness, and how their experiences evolve over time. By moving beyond clinical and technical evaluations, phenomenological inquiry provides a richer, more holistic understanding of the human dimensions of biomedical innovation. This study aims to contribute to this growing discourse by offering an in-depth exploration of patients' lived experiences with biodegradable implants, addressing an essential yet often overlooked aspect of regenerative medicine.

Current advancements in biomedical engineering have led to the widespread adoption of biodegradable implants as a promising alternative to traditional permanent implants. Clinical studies have extensively examined their structural integrity, degradation kinetics, and biocompatibility, providing a strong foundation for understanding their functional efficacy. However, the assessment of these implants remains predominantly focused on quantitative measures, such as biomechanical performance, radiographic outcomes, and histological integration. While these objective criteria are crucial, they fail to capture the lived experiences of patients who undergo reconstructive procedures with biodegradable implants. The personal and psychosocial dimensions of their healing journey—including their perceptions, adaptation processes, and emotional responses—remain largely underexplored.

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Existing research methodologies in this domain typically rely on patient-reported outcome measures (PROMs) and standardized satisfaction surveys to gauge post-implantation experiences. Although these tools offer valuable insights into general trends, they are inherently limited in their ability to reveal the deeper meanings patients assign to their recovery. These approaches do not account for the evolving relationship between the implant and the body, the psychological uncertainties patients experience, or the broader socio-cultural factors that shape their healing narratives. As a result, the current understanding of patient adaptation to biodegradable implants remains fragmented and insufficient.

A more comprehensive approach is required—one that prioritizes subjective interpretation and explores the essence of patient experiences beyond surface-level assessments. Phenomenology provides a powerful framework for addressing this gap, as it allows for an in-depth exploration of how patients construct meaning from their encounters with biodegradable implants (Chang & Wei, 2021). By adopting a hermeneutic phenomenological approach, this study aims to move beyond mechanistic evaluations and uncover the intricate ways in which individuals navigate their post-implantation recovery. This research will provide novel insights into the psychological, emotional, and embodied aspects of biodegradable implant integration, ultimately contributing to a more patient-centered perspective in regenerative medicine.

Previous studies on biodegradable implants have primarily focused on their mechanical properties, degradation rates, and clinical outcomes, often neglecting the subjective experiences of patients undergoing these procedures. Research in patient-centered medicine has highlighted the importance of understanding individual adaptation processes, particularly in the context of new biomedical technologies. Theoretical frameworks in phenomenology emphasize the significance of lived experiences, offering valuable insights into how individuals perceive, interpret, and respond to medical interventions. While some studies have explored patient satisfaction with implants using quantitative surveys, they fail to capture the depth of psychological and social adaptation. This study builds upon existing research by applying a qualitative, interpretative approach to uncover the meaning behind patients' experiences with biodegradable implants.

To address the existing knowledge gap, this study employs a hermeneutic phenomenological approach, which is well-suited for exploring complex, deeply personal experiences. By focusing on patients who have undergone reconstructive surgery with biodegradable implants, the study aims to provide a nuanced understanding of their sensory perceptions, psychological adjustments, and evolving bodily awareness (Ciolli dkk., 2021). The use of in-depth interviews allows for a rich, detailed exploration of these themes, capturing insights that conventional clinical assessments often overlook. Through this methodology, the study seeks to answer how patients make sense of their recovery process and how they internalize their interaction with the implant over time. This interpretative analysis not only enriches the field of regenerative medicine but also contributes to broader discussions on patient-centered healthcare.

This article is structured as follows: the introduction provides an overview of the phenomenon and highlights the need for a phenomenological inquiry into patient experiences with biodegradable implants. The methodology section details the hermeneutic approach, participant selection criteria, data collection techniques, and analytic framework. The results section presents thematic findings derived from patient narratives, followed by an in-depth discussion that contextualizes these insights within existing literature and theoretical perspectives. Finally, the conclusion summarizes key contributions, discusses implications for clinical practice, and suggests directions for future research. This structure ensures a logical progression of ideas, allowing readers to follow the research process and its findings with clarity.

RESEARCH METHODS

Study Design

This study employed a hermeneutic phenomenological approach to explore the lived experiences of patients undergoing treatment with biodegradable implants for bone reconstruction.

Phenomenology was selected as the research design due to its emphasis on understanding subjective experiences and the meanings individuals attribute to specific phenomena (Debeer dkk., 2019). By adopting this approach, the study aimed to uncover the nuanced perceptions, physical sensations, and psychological adaptations associated with the integration of biodegradable implants in patients' daily lives.

A hermeneutic approach, rooted in Heideggerian philosophy, was applied to facilitate a deeper interpretation of participants' experiences beyond mere description. Unlike descriptive phenomenology, which seeks to capture phenomena as they are experienced, hermeneutic phenomenology allows for an interpretative process that considers both the explicit and implicit dimensions of experience. This approach was particularly relevant for this study, as it enabled an exploration of how patients construct meaning around their recovery and the evolving relationship between their bodies and the biodegradable implants.

Participants

Participants in this study were selected using purposive sampling, ensuring that those included had direct and relevant experiences with biodegradable implants for bone reconstruction (Errani dkk., 2021). The inclusion criteria required participants to be adult patients (aged 25–65) who had undergone implant-based reconstructive procedures at least six months prior to data collection. This timeframe ensured that participants had sufficient post-operative experience to reflect on their physical and psychological adaptation. Additionally, individuals were required to have functional recovery that allowed them to articulate their experiences without significant cognitive impairment.

Exclusion criteria included patients with severe post-operative complications requiring additional interventions, as these experiences might introduce confounding variables unrelated to the standard recovery process. Participants with prior implant failures or those involved in experimental procedures unrelated to biodegradable implants were also excluded. A total of 12 participants (7 males and 5 females) were included in the study, with ages ranging from 28 to 61 years. Their demographic and medical backgrounds provided a diverse representation of experiences, ensuring a comprehensive understanding of the phenomenon under investigation.

Data Collection

Data were collected through in-depth, semi-structured interviews conducted in a private and comfortable clinical setting to encourage open and detailed responses. Interviews were guided by a flexible set of open-ended questions, allowing participants to share their experiences while enabling the exploration of emergent themes (Goryń dkk., 2019). Each interview lasted between 45 to 90 minutes and was audio-recorded with participants' consent. To ensure the validity and depth of responses, follow-up interviews were conducted with five participants who expressed the need to elaborate on their experiences further.

The interview guide was developed based on existing literature and expert consultations to cover key aspects such as sensory perception of the implant, psychological adaptation, challenges in daily functioning, and overall perceptions of treatment efficacy (Heutink dkk., 2022). In cases where participants exhibited emotional distress while discussing their experiences, appropriate pauses were observed, and support mechanisms were made available.

To enhance the credibility of the data, methodological triangulation was employed by integrating clinical observation notes and patient medical records, allowing for cross-validation of findings. Additionally, all interviews were transcribed verbatim to preserve the authenticity of the narratives.

Data Analysis

Data were analyzed using an interpretative phenomenological analysis (IPA) approach, which involves an iterative process of coding and theme identification to uncover the essence of participants' lived experiences. Transcripts were systematically reviewed to extract significant statements and assign initial codes reflecting patterns of meaning. These codes were then clustered into broader

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themes through a process of thematic reduction, ensuring that only core experiential elements remained.

NVivo software was used to facilitate data organization, though thematic analysis remained the primary analytical method (Jovičić dkk., 2021). Emerging themes were continuously refined through engagement with the data, ensuring that findings authentically represented participants' perspectives. The final thematic structure was validated through member checking, wherein selected participants reviewed preliminary interpretations to confirm their accuracy.

Ethical Considerations

Ethical approval for this study was obtained from the appropriate institutional ethics review board, ensuring adherence to international research ethics guidelines. Informed consent was obtained from all participants prior to data collection, with assurances of confidentiality, voluntary participation, and the right to withdraw at any stage without consequences.

All identifying information was anonymized, and participants were assigned pseudonyms to protect their identities. Data were securely stored in encrypted digital files, accessible only to authorized research personnel. Furthermore, psychological support was made available to participants who experienced emotional discomfort during discussions of their recovery experiences.

RESULTS

Physical Sensations and Adaptation to Biodegradable Implants

Patients undergoing reconstructive surgery with biodegradable implants described a spectrum of physical sensations throughout their recovery journey. The initial phase was often marked by discomfort, stiffness, and a lingering uncertainty about how their bodies would adapt to the material. Some participants reported a sense of foreignness in the implanted area, while others experienced fluctuations in pain levels, particularly during the first few weeks post-operation.

One participant expressed:

"At first, it felt as if there was something foreign inside my body. I was afraid to move too much, thinking it might shift or dissolve too quickly. But over time, I started noticing the pain easing, and my body seemed to accept it."

The adaptation phase varied among individuals, with some reporting gradual relief and regained functionality, while others noted prolonged discomfort. The sensation of the implant's biodegradation was described in metaphorical terms, with one patient explaining, "It was like my body was slowly absorbing it, making it a part of me." These accounts highlight the dynamic interaction between the physical body and the biodegradable material, underscoring the necessity of patient education regarding the expected physical responses post-implantation.

Figure 1. How to manage patient experiences with biodegradable implants?

Psychological and Emotional Responses to Implant Integration

Beyond the physical experience, the psychological impact of biodegradable implants emerged as a crucial theme. Patients reported initial anxiety, stemming from concerns about the effectiveness

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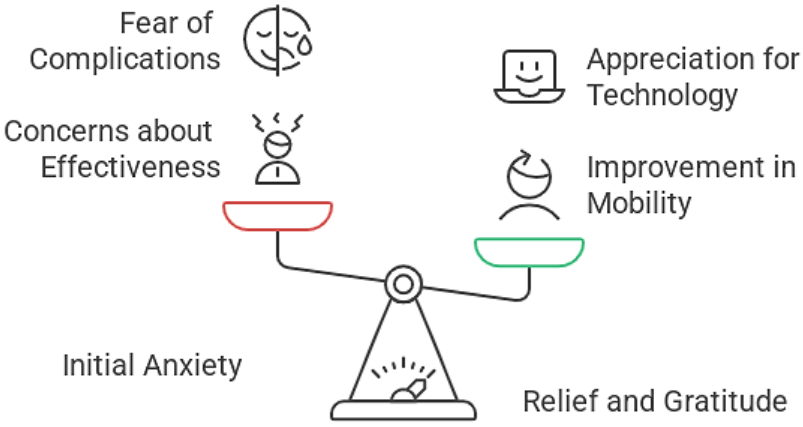
and durability of the implant. Many worried about whether the material would adequately support their healing process or if it would deteriorate too quickly, leading to complications.

One participant reflected:

"I kept wondering—what if it dissolves before my bone fully heals? It was a constant worry in my mind, especially when I felt sudden pain or changes in sensation."

Despite these concerns, a shift in perception was observed as the healing process progressed. Patients who were initially apprehensive expressed relief and gratitude when they noticed tangible improvements in mobility and pain reduction. Some even experienced a profound sense of connection with their own biological regeneration, as one participant stated, "It's incredible how the body works with the implant. It gave me a newfound appreciation for medical technology."

Figure 2. Emotional Journey of Implant Patients



Impact on Daily Functioning and Quality of Life

The presence of a biodegradable implant had a direct impact on patients' daily activities and overall quality of life. During the initial recovery phase, restrictions in movement and residual pain affected routine tasks such as walking, lifting objects, or engaging in physical exercise. Some participants struggled with work-related responsibilities, requiring adjustments in workload and physical expectations.

One participant shared:

"I had to change the way I did things—at work, at home. I had to be more careful, take more breaks. It was frustrating at times, but I kept reminding myself it was temporary."

As healing progressed, patients gradually regained confidence in their physical abilities. A recurring theme was the psychological shift from limitation to empowerment, as one interviewee described, "I started small—walking a little more each day. Before I knew it, I was back to my normal self. It felt like reclaiming my life."

The analysis of patient experiences with biodegradable implants revealed a multifaceted process of adaptation, both physically and psychologically. The initial period was characterized by uncertainty, discomfort, and anxiety, yet over time, patients developed trust in the implant's integration with their bodies. The emotional journey transitioned from fear to appreciation, while functional limitations gradually gave way to restored mobility and quality of life.

These findings underscore the importance of patient-centered approaches in biomaterial applications, emphasizing the need for clear pre-operative education, psychological support, and continuous post-operative monitoring. The lived experiences of these patients highlight the interplay between medical innovation and human adaptation, shedding light on the complex and deeply personal nature of regenerative healing.

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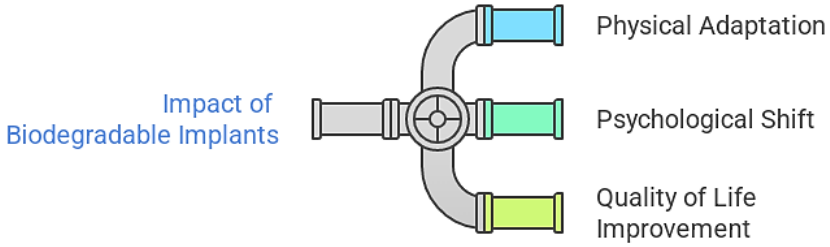
Figure 3. Navigating Life with Biodegradable Implants



DISCUSSION

Summary of Key Findings

This study revealed that patients' experiences with biodegradable implants for bone reconstruction encompass both physical adaptation and psychological transformation. The findings highlight the complex interplay between sensory perceptions, emotional responses, and the gradual acceptance of the implant within the body (Kunisada dkk., 2019). These experiences not only reflect the patients' healing processes but also their evolving relationship with the implant over time, illustrating the deeply personal nature of medical interventions.

Contribution to the Research Question

The primary question guiding this research was how patients experience the integration of biodegradable implants into their bodies, particularly regarding the emotional, psychological, and physical aspects. The findings contribute to this question by revealing that, beyond the mechanical integration of the implant, patients undergo a multifaceted emotional and psychological journey. Initial discomfort and anxiety regarding the implant's foreignness gradually gave way to a sense of bodily acceptance and appreciation, as patients recognized improvements in their mobility and quality of life. This transformation underscores the importance of considering the subjective experience of patients in biomedical research, especially when introducing innovative technologies that interact directly with the body (Morales-Gómez dkk., 2019). By adopting a phenomenological lens, this study has demonstrated how patients' perceptions of the implant evolve over time, contributing valuable insights into the holistic nature of recovery and the impact of regenerative medicine.

Relation to Literature and Previous Theories

The findings align with existing literature on the psychosocial dimensions of medical recovery, particularly studies examining the relationship between patients and biomedical implants. Previous research has emphasized the physical challenges and complications associated with implant surgeries but has often overlooked the psychological impact of these interventions (Oh dkk., 2019). This study extends these findings by highlighting the emotional adaptation process and the role of psychological resilience in navigating recovery. The shift from fear and discomfort to a more accepting and empowered state is consistent with the concepts of adaptation and self-regulation outlined in Reif dkk.,(2021) Family Resilience Theory. Additionally, the phenomenological approach used in this study complements the work of Sandoval dkk., (2020), who explored the emotional and psychological challenges of medical implants through a descriptive phenomenological approach. While Smith et al. focused on patient satisfaction and recovery timelines, this study adds depth by exploring how patients make meaning of their healing experiences in the context of new and evolving biomedical technologies.

Implications of Findings

The findings of this study have significant implications for both clinical practice and broader social and cultural contexts. Clinically, the research underscores the importance of a patient-centered approach when integrating biodegradable implants into treatment protocols. Healthcare providers must not only consider the mechanical and clinical outcomes of these implants but also address the

psychological and emotional needs of patients during their recovery. This includes providing psychological support, managing patient expectations, and fostering a sense of ownership and comfort with the implant. Socially, the study highlights how personal, cultural, and societal factors shape individuals' experiences with medical technologies, suggesting that cultural competence in patient care may improve treatment outcomes. By understanding the personal and social dimensions of recovery, medical professionals can better tailor their care strategies, ensuring that patients feel supported not just physically, but emotionally throughout their healing process.

Limitations of the Study

Despite the valuable insights gained, this study has some limitations that may affect the generalizability of its findings. First, the sample size of 12 participants, though sufficient for qualitative research, is relatively small and may not fully represent the diversity of experiences across different demographics. The participants were all selected from a single medical facility, which limits the applicability of the findings to a broader range of populations or healthcare settings. Additionally, the study's reliance on self-reported data from interviews introduces potential biases, such as social desirability or recall bias, which may influence the authenticity of the reported experiences. Future research should consider expanding the sample size, including participants from various cultural backgrounds and healthcare environments, to gain a more comprehensive understanding of patient experiences.

Future Research Directions

The findings of this study open up several avenues for future research in both the field of regenerative medicine and phenomenological inquiry. One potential direction is to explore the long-term effects of biodegradable implants on patient quality of life, particularly in different cultural or socio-economic groups. Further studies could also investigate how specific aspects of the implant's material composition influence patient adaptation, particularly from a psychological and emotional perspective. Another interesting area for future research is the role of healthcare provider-patient communication in shaping patients' perceptions of their treatment and recovery. By expanding the scope of research to include these factors, future studies could provide deeper insights into how medical technologies intersect with personal, cultural, and social experiences, contributing to more effective and holistic healthcare practices.

CONCLUSION

This study explored the lived experiences of patients using biodegradable implants for bone reconstruction, addressing the gap in understanding how these innovations affect physical, psychological, and emotional adaptation. The findings revealed that patients undergo a profound transformation, from initial discomfort and anxiety to eventual acceptance and appreciation of the implant, highlighting the complexity of integrating such technologies into the body. These insights contribute significantly to the literature by emphasizing the importance of considering not only the mechanical success of implants but also the personal, social, and emotional dimensions of recovery. By applying a phenomenological approach, this research enriches our understanding of the patient's perspective, offering new implications for patient-centered care in regenerative medicine. The findings underscore the need for future research to focus on the long-term impacts of biodegradable implants across diverse patient populations, exploring factors such as socio-economic background, cultural differences, and the psychological effects over time. Additionally, further research could examine how healthcare provider-patient interactions influence patient outcomes and satisfaction, leading to improvements in healthcare practices and the development of more personalized treatment protocols.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to the research or the publication of this article.

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