

Scleral Lens Insertion and Removal Techniques: A Systemic Review

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Abstract:

Background: The primary uses of scleral contact lenses (SCLs) are in the treatment of ocular surface problems, severe dry eye disease, and corneal abnormalities. In order to reduce issues like discomfort, lens contamination, or corneal injury, the success of SCLs usually depends on using the right insertion and removal techniques. In order to offer practitioners and patients evidence-based guidance, this review compares several insertion and removal methods for SCLs.

Objective: To systematically review and analyse the efficacy, safety, and patient compliance associated with different techniques for inserting and removing scleral contact lenses.

DataSources: A comprehensive search was conducted in PubMed, Scopus, Web of Science, and Cochrane Library for studies published . Keywords included "scleral lens," "contact lens," "insertion techniques," "removal techniques," "application methods", "compliance"

StudySelection: Studies were included if they compared different insertion and/or removal methods for SCLs, focused on patient-reported outcomes, safety, or clinical outcomes, and were published in English. Exclusion criteria included case reports, editorials, or studies lacking a clear comparative methodology.

DataExtraction: A team of reviewers extracted data on study design, sample size, insertion/removal methods, patient compliance and outcomes.

Results: The search identified 22 studies that discussed scleral lens application techniques. Out of which 10 match the inclusion criteria. Techniques compared included manual methods, plungers with or without suction, and novel devices designed for lens application and removal. The use of plungers was associated with fewer complications (e.g., air bubble formation, lens misalignment) compared to manual methods. However, patient preference varied, with some reporting greater comfort and ease with manual methods. Emerging automated devices showed promising results for individuals with limited dexterity. Education and proper training significantly improved adherence and reduced adverse events.

Conclusion: The choice of scleral contact lens insertion and removal technique depends on individual patient needs, dexterity, and clinician guidance. Plungers remain a widely recommended option due to their efficacy and safety, but newer technologies may further enhance the patient experience. Proper education and training are critical to

improving outcomes. Further research is needed to standardize best practices and evaluate long-term benefits of emerging tools.

Keywords: abnormalities, complications, practitioners.

1. Introduction

Scleral contact lenses (SCLs) have emerged as a significant advancement in ocular surface management, offering a viable solution for a wide spectrum of visual impairments. These large-diameter lenses vault over the cornea, creating a stable tear reservoir between the lens and the ocular surface. This unique design allows for effective management of irregular corneas, ocular surface diseases, and post-surgical conditions, often resulting in significant visual acuity improvements. While the clinical benefits of SCLs are well-documented, successful wear hinges critically on the patient's ability to effectively insert and remove the lenses. Challenges associated with lens handling can lead to frustration, discomfort, and ultimately, lens abandonment, negating the potential benefits of this technology. (Barnett et al., 2016) (Kanakamedala et al., 2019)

Recent literature highlights the growing importance of patient-centred approaches to SCL fitting. Studies such as "Clinical Experience with PROSE Fitting: Significance of Diagnosis and Age" by Kornberg et al. (2016) have emphasized the need to consider individual patient factors, including age and diagnosis, when assessing the ease of SCL adoption. This shift in focus underscores the critical role of proper patient education and individualized instruction in achieving successful SCL outcomes.

Furthermore, advancements in SCL design and materials have led to the development of more complex lens geometries and specialized features. While these innovations offer enhanced performance, they can also increase the complexity of lens handling. Studies such as "Scleral Lens Issues and Complications Related to a Non-optimal Fitting Relationship Between the Lens and Ocular Surface" by Fadel (2019) highlight the potential for complications arising from improper fitting and the need for meticulous attention to detail during the fitting process.

This systemic review aims to comprehensively examine the current literature on SCL insertion and removal techniques, focusing on identifying and analyzing the challenges faced by patients in inserting and removing SCLs and to evaluate the effectiveness of different instructional approaches and patient education strategies.

2. Theoretical Framework

The successful use of SCLs relies on a multifactorial approach that encompasses the ocular surface health in which maintaining a healthy ocular surface is crucial for successful SCL wear. Factors such as tear film stability, ocular surface inflammation, and lid hygiene significantly influence lens comfort and wearability. Patient factors are also crucial which includes age, visual acuity, manual dexterity, cognitive function, and psychological factors, can influence the ease of lens handling.

2.1. Psychomotor Skills and Cognitive Function

Successful SCL handling requires a degree of fine motor skills and cognitive function. Patients with limited manual dexterity, such as those with arthritis or neurological conditions, may experience significant challenges with lens insertion and removal. Similarly, cognitive impairments can hinder the ability to understand and retain instructions, leading to difficulties in mastering the necessary techniques.

2.2. Patient Motivation and Adherence

Patient motivation and adherence to the prescribed lens wear regimen are critical for long-term success. Factors such as strong patient-clinician relationships, clear communication, and on-going support can significantly impact patient motivation and adherence.

2.3. The Role of Patient Education

Effective patient education is a cornerstone of successful SCL wear. Comprehensive instruction should include clear and concise explanations & step-by-step instructions, both verbal and visual (e.g., diagrams, videos), are essential for effective learning. Hands-on training practice sessions under the supervision of a clinician allow patients to develop the necessary skills and gain confidence. Troubleshooting guidance for patients should be equipped to handle common challenges, such as lens misplacement, fogging, and discomfort. Addressing patient concerns & open communication and addressing patient anxieties regarding lens handling are crucial for building trust and ensuring patient compliance.

3. Research Methodology

This systemic review utilized a comprehensive search of relevant databases, including PubMed, and Cochrane library, using a combination of keywords such as "scleral lens," "contact lens," "insertion techniques," "removal techniques," "application methods", "compliance".

Inclusion criteria included studies investigating SCL fitting and wear in adult populations, with a specific focus on challenges associated with lens handling, patient education strategies, and clinical outcomes. Exclusion criteria included studies focusing solely on animal studies, and case reports with limited data on lens handling.

Data extraction was conducted independently by six reviewers, with discrepancies resolved through discussion and consensus. Quality assessment of included studies was performed using appropriate quality assessment tools.

4. Results

The search identified 22 studies that discussed scleral lens application techniques, with 10 meeting the inclusion criteria. These studies compared different insertion and removal methods, including manual techniques, the use of plungers with or without suction, and novel devices specifically designed for lens handling.

4.1. Challenges in SCL Insertion and Removal

Challenges associated with SCL handling are multifaceted. Patient factors play a significant role, with reduced manual dexterity, particularly in individuals with arthritis or neurological conditions, posing a significant barrier. Visual acuity limitations can hinder lens alignment, location, and placement assessment. Cognitive impairments, such as dementia or attention deficits, can impede understanding and retention of instructions, leading to difficulties in mastering the necessary techniques (Figure 1). Furthermore, psychological factors, including anxiety, fear of eye injury, and low self-efficacy, can create significant barriers to successful lens handling and may lead to avoidance behaviour (Table 1).

Lens-related factors also contribute to the challenges. Complex lens geometries, such as those with multiple curves or specialized haptic designs, can increase the difficulty of insertion and removal. Similarly, stiff lens materials may require more force, potentially increasing the risk of eye irritation or lens damage. Fitting-related factors are equally important. Inadequate initial instruction, failing to provide thorough training on proper techniques and troubleshooting, can lead to ongoing difficulties and frustration. Poor lens fit, whether too loose or too tight, can significantly impact handling. Loose fits can make the lens difficult to center and stabilize, while tight fits can increase insertion resistance and the risk of discomfort or lens displacement. Insufficient follow-up care, lacking ongoing support and adjustments, can exacerbate existing difficulties and lead to lens abandonment.

4.2. Effectiveness of Patient Education Strategies

Effective patient education strategies are crucial for addressing these challenges. Hands-on training sessions under the supervision of a clinician have consistently demonstrated significant effectiveness, providing patients with the opportunity to practice lens handling techniques, receive personalized guidance, and develop the necessary confidence. The use of visual aids, such as diagrams and videos, significantly enhances patient understanding and improves learning outcomes. Tailoring the instructional approach to individual patient needs and learning styles further improves patient engagement and enhances learning outcomes.

4.3. Impact of Patient Factors and Clinical Practice

Patient factors and clinical practice also significantly impact the success of SCL handling. While older patients may face challenges related to manual dexterity and cognitive function, with proper instruction and support, they can achieve successful SCL wear. The expertise and experience of the clinician in SCL fitting and patient education are paramount. Clinicians with specialized training in SCL fitting are better equipped to address individual patient needs, provide effective instruction, and manage potential complications. Access to assistive devices, such as lens holders and suction cups, can significantly improve lens handling for patients with limited dexterity.

A variety of techniques are employed for scleral lens insertion and removal. Manual insertion is the most commonly used method, involving direct placement of the lens on the sclera. Suction-assisted insertion, utilizing large-diameter plungers, provides stability and is particularly beneficial for patients with limited dexterity. Mirror-assisted techniques enhance accuracy by allowing real-time visual feedback, aiding in precise lens alignment. Advanced lens-filled applicators simplify the process and are particularly useful for visually impaired patients by minimizing the need for fine motor skills. For removal, manual techniques are widely used, although suction cups offer a safer

alternative by minimizing stress on the sclera. Double-handed techniques provide greater control for patients with challenges stabilizing their eyelids. Hybrid approaches, combining manual and suction methods, can enhance safety and minimize lens damage.

A successful SCL wear necessitates a multi-faceted approach that addresses the unique needs and challenges of each patient. Effective patient education, including hands-on training, visual aids, and personalized instruction, is paramount. Addressing patient factors, such as age, manual dexterity, and cognitive function, is crucial for optimizing patient outcomes. The expertise and experience of the clinician in SCL fitting and patient education significantly impact patient success. On-going support and follow-up are essential to address emerging issues and ensure long-term success.¹ By incorporating these principles into clinical practice, clinicians can significantly improve patient outcomes and enhance the overall success of SCL wear.

5. Discussion

The findings of this review underscore the critical importance of patient-centred approaches to scleral contact lens (SCL) fitting and management. Addressing the unique needs and challenges of each patient is essential for ensuring successful lens wear and maximizing the benefits of this technology. Effective patient education forms the cornerstone of successful SCL wear. Clinicians must invest the necessary time and resources to provide comprehensive instruction, including hands-on training, visual aids, and personalized guidance. Ongoing support and follow-up are crucial for addressing any emerging issues and ensuring long-term success. This review also highlights the importance of considering patient factors, such as age, manual dexterity, and cognitive function, when assessing patient suitability for SCLs and developing individualized management plans. (Rathi et al, 2012), (Pecego et al 2012)

The choice of insertion and removal techniques is influenced by several factors. Patients with reduced manual dexterity often benefit from assistive tools like suction devices. Larger lenses may require additional stabilization during insertion and removal, making tools like lens holders or plungers essential. Ocular anatomy, such as deep-set eyes, tight eyelids, or irregular scleral surfaces, may necessitate customized techniques. Improper handling techniques can lead to complications such as lens contamination, corneal abrasions, and conjunctival redness. Studies emphasize the importance of maintaining sterile conditions during insertion and removal to prevent microbial keratitis. Jedlicka (2015) reported that patients who adhered to strict hygiene practices experienced fewer infections and lens-related complications.

Assistive devices significantly improve handling success, particularly among patients with disabilities or severe visual impairments. Tools such as suction cups, lens-filled applicators, and stabilization rings reduce handling errors and enhance comfort. However, the cost of these devices may limit accessibility in low-resource settings. Technological advancements, such as automated lens insertion systems and virtual reality-based training modules, have shown promise in improving patient outcomes. Research into innovative materials for scleral lens edges may also reduce the mechanical challenges associated with lens handling (Walker et al., 2021).

6. Conclusions

Successful SCL wear requires a multidisciplinary approach that addresses the unique needs and challenges of each patient. By emphasizing patient-centred care, providing comprehensive instruction, and addressing potential barriers to lens handling, clinicians can significantly improve patient outcomes and optimize the benefits of this valuable technology.

Future Research

Further research is needed to develop and evaluate innovative patient education strategies, such as the use of virtual reality simulations and telemedicine platforms. Studies investigating the long-term impact of different instructional approaches on patient outcomes, including lens wear duration, visual acuity, and quality of life, are warranted. The development of standardized assessment tools to evaluate patient skills and identify individuals at risk for difficulties with lens handling would be beneficial. This review provides a foundation for future research and clinical practice in the field of SCLs. By addressing the challenges associated with lens handling and optimizing patient education strategies, clinicians can improve patient outcomes and enhance the overall success of SCL wear.

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Table 1. Sample size and insertion and removal difficulties by scleral lenses users

	No. of Eyes	Difficulty in insertion and removal
Barnett et al, 2016	34	8 eyes, 42.1%
Kanakamedala e al, 2019	12	8 eyes (67%)
Rathi et al, 2012	20	10 eyes (50%)
Pecego et al 2012	107	22 eyes (20%)



Figure 1. Scleral lens insertion