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ORIGINAL ARTICLE

Postoperative quality of life and patient satisfaction following stapes surgery: a cross-sectional study

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ABSTRACT

Background: Otosclerosis is a progressive disorder characterized by abnormal bone remodeling around the oval window, resulting in stapes fixation and conductive hearing loss. Clinical manifestations vary and may include bilateral hearing loss, tinnitus, and vertigo. This study aimed to evaluate quality of life and patient satisfaction following stapes surgery, and to explore potential associations between operative characteristics and postoperative outcomes.

Methods: A cross-sectional study was conducted at a high-volume tertiary center in Saudi Arabia. Data collected included demographic characteristics, clinical presentation, operative details, and preoperative and postoperative audiological outcomes assessed at 6 months to 1-year follow-up using pure-tone audiometry. Postoperative quality of life and hearing-related handicap were evaluated using the Glasgow Benefit Inventory (GBI) and Hearing Handicap Inventory for Adults (HHIA) questionnaires.

Results: A total of 65 patients were included, of whom 61.5% were female, with a mean age of 40.9 ± 9.4 years. Significant postoperative audiological improvement was observed, with mean air-conduction thresholds improving from 54.6 ± 13.9 dB preoperatively to 39.8 ± 16.5 dB postoperatively ($p < 0.001$), while the mean air–bone gap decreased from 33.0 ± 10.8 to 18.3 ± 12.3 dB ($p < 0.001$). The mean GBI score was 34.4 ± 31.4, indicating improved postoperative quality of life; however, 60.0% of participants still demonstrated significant hearing-related handicap on the HHIA.

Conclusion: Stapes surgery was associated with significant postoperative hearing and quality of life improvement, consistent with favorable audiometric outcomes. No significant associations were found between postoperative outcomes and most operative characteristics.

Keywords: Otosclerosis, stapedotomy, stapedectomy, stapes surgery, hearing loss.

Introduction

Otosclerosis is a progressive condition characterized by abnormal bone remodeling around the oval window, leading to stapes footplate fixation and conductive hearing loss [1]. Clinical manifestations vary and may include bilateral hearing loss, tinnitus, and vertigo [2]. The stapes is the smallest of the middle ear ossicles, attached to the oval window to transmit, amplify, and regulate sound pressure [3]; uncorrected hearing loss may therefore lead to social isolation, cognitive decline, anxiety, depression, and reduced quality of life [4]. Otosclerosis prevalence is estimated at 0.3%-0.38% in European populations, with an incidence of 3.9 per 100,000 person-years in the United States [5,6].

Stapes surgery is considered the most effective treatment option for otosclerosis [7]. Stapedotomy and stapedectomy are surgical procedures used to correct hearing loss caused by otosclerosis [8]. Although generally successful, these procedures carry potential

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complications such as sensorineural hearing loss, postoperative vertigo, and taste disturbance [9].

Health-related quality of life is a multidimensional assessment of how an illness and its management affect patients [10]. It has increasingly become a key criterion for evaluating treatment success by measuring not only disease symptoms but also the patient's daily activities and overall post-operative well-being [11]. Because improvements in audiometric measures do not always translate into perceived functional benefit [12], Patient-reported outcome measures (PROMs) capture the patient's subjective benefit and well-being. These range from general tools, such as the Glasgow Benefit Inventory (GBI), which assesses overall health changes after otosclerosis surgery [13], to disease-specific instruments such as the Hearing Handicap Inventory for Adults (HHIA), which evaluates the social and emotional impact of hearing loss [14]. Assessing the success of stapes surgery requires a comprehensive approach that integrates the patient's subjective experience with objective clinical data [15].

There is a notable gap in the literature, particularly in Saudi Arabia, regarding patients' subjective quality of life after stapes surgery and its correlation with objective audiological outcomes. This study aimed to evaluate quality of life and patient satisfaction after stapes surgery, and to examine associations between operative characteristics and postoperative outcomes to guide patient counseling and postoperative care.

Methods

Study design, setting, and population

This cross-sectional study was conducted at King Abdulaziz University Hospital in Riyadh, Saudi Arabia. The study inclusion criteria included (1) patients who underwent stapes surgery according to their medical charts, (2) Arabic-speaking patients, and (3) adults aged 18-65 years. The exclusion criteria included: (1) patients younger than 18 years or older than 65 years, (2) patients with missing or incomplete data, and (3) those with communication barriers. Eligibility was determined through review of patients' medical records within the hospital's electronic health information system. Participants were recruited using a convenience sampling technique, and a total of 65 patients were identified.

Study instrument

In this study, two instruments were used to collect data. The first instrument, the GBI, is a reliable, validated, and widely used self-reported generic questionnaire designed to assess postoperative changes in quality of life [13]. It consists of 18 items, each answered on a 5-point Likert scale. The total score ranges from −100 to +100, whereas −100 represents the poorest outcome, 0 indicates no change, and +100 reflects the best outcome. The second instrument is HHIA [14]. It consists of 25 items divided into two subscales: The Emotional domain (13 items), which assesses the affective and psychological impact, and the Social domain (12 items), which reflects difficulties in social and situational contexts. Each item has three possible responses: "No," "Sometimes," and "Yes," scored as 0, 2, and 4, respectively. The total score ranges from 0 to 100, with higher scores indicating a greater perceived hearing handicap.

Procedure and data collection

The study started by collecting patients' data from electronic medical records. Collected variables included: (1) patient characteristics, such as gender, age, laterality and type of hearing loss, and associated symptoms including tinnitus, vertigo, and facial weakness; (2) operative data, including the type of surgery, surgical approach, fenestration perforator type and size, and

Table 1. *Demographic characteristics and indications for surgery.*

Characteristic	Description
Gender	
Male	25 (38.5%)
Female	40 (61.5%)
Age at the time of the operation	40.9 ± 9.4
Age (males)	42.7 ± 11.0
Age (females)	39.7 ± 8.2
A family history of Otosclerosis	18 (27.7%)
Hearing Loss	
Right	8 (12.3%)
Left	7 (10.8%)
Bilateral	50 (76.9%)
Bilateral hearing loss is worse in	
Right	14 (29.2%)
Left	34 (70.8%)
Tinnitus	
Absent	32 (50.0%)
Right	6 (9.4%)
Left	8 (12.5%)
Bilateral	18 (28.1%)
Vertigo	
Absent	55 (84.6%)
Present	10 (15.4%)
Facial weakness	
None	62 (95.4%)
Right	0 (0.0%)
Left	3 (4.6%)
Age of onset	
Sudden	3 (4.6%)
Progress	62 (95.4%)
Level of hearing loss (WHO grading)*	
No impairment (better than 20 dB)	6 (9.4%)
Mild (20-34 dB)	24 (37.5%)
Moderate (35-49 dB)	23 (35.9%)
Moderately severe (50-64 dB)	8 (12.5%)
Severe (65-79 dB)	1 (1.6%)
Profound impairment (80-94 dB)	2 (3.1%)

*Based on postoperative air-conduction thresholds in the better ear, according to the WHO classification of hearing impairment.

prosthesis type; and (3) audiological outcomes, assessed preoperatively and at a follow-up period ranging from 6 months to 1 year postoperatively, using pure tone audiometry (PTA) at 500, 1,000, 2,000, and 4,000 Hz.

Ethical approval was obtained from the Institutional Review Board at King Saud University, College of Medicine, Riyadh, Saudi Arabia (approval no. E-25-9704). Participants were interviewed to explain the study's nature and purpose, provided with the primary investigator's contact information, and informed of the confidentiality and data anonymity policy before completing the study questionnaire.

Table 2. *Operative characteristics.*

Characteristic	Missing	Description
Operation	0 (0%)	
Right stapedotomy		34 (52.3%)
Left stapedotomy		31 (47.7%)
Site	0 (0%)	
Right		34 (52.3%)
Left		31 (47.7%)
Incision Trans-canal/end-aural	0 (0%)	
Transcanal		6 (9.2%)
End-aural		59 (90.8%)
Fenestration Perforator	0 (0%)	
Drill		4 (6.2%)
Manual perforator		3 (4.6%)
Perforator		24 (36.9%)
Perforator pick		26 (40.0%)
Seeker/Skater		8 (12.3%)
Fenestration Perforator size (mm)	24 (37%)	1.0 ± 1.5
Prosthesis	0 (0%)	
SMART piston		12 (18.5%)
Robinson piston		5 (7.7%)
Causse loop piston		20 (30.8%)
Teflon piston		7 (10.8%)
Platinum piston		2 (3.1%)
KURZ titanium piston		3 (4.6%)
Bucket handle		2 (3.1%)
Unspecified piston		14 (21.5%)
Prosthesis diameter (mm)	4 (6.2%)	5.0 (4.5-5.0)

Data presented as *n* (%), except for fenestration perforator size (mean ± SD) and prosthesis diameter (median [IQR]).

Statistical analysis

All statistical analyses were performed using RStudio (version 2024.9.1.394, Boston, MA) with R version 4.4.2. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, depending on the distribution. Categorical variables were presented as frequencies and percentages. Comparisons of preoperative and postoperative audiometric outcomes were conducted using paired *t*-tests. Differences in PTA values across operative characteristics and prosthesis types were evaluated using two-sample *t*-tests or one-way analysis of variance (ANOVA), as appropriate. Bivariate correlations between PTA and HHIA and GBI scores were performed using Pearson's correlation analysis. A *p*-value of <0.05 was considered statistically significant.

Result

Demographic characteristics and indications for surgery

Among the 65 patients included in the study, 61.5% were females and 38.5% were males. The overall mean age at the time of surgery was 40.9 ± 9.4 years, with males being slightly older (42.7 ± 11.0 years) than females (39.7 ± 8.2 years). A positive family history of otosclerosis was reported in 27.7% of cases. Bilateral hearing loss was predominant (76.9%), with the left ear more commonly reported as worse in cases of asymmetry (70.8%). Tinnitus was absent in 50.0% of the patients, while 28.1% reported bilateral tinnitus. According to the WHO classification based on postoperative air-conduction (AC) values in the better ear, 9.4% had no hearing impairment, while most patients had mild (37.5%) or moderate (35.9%) hearing loss; severe to profound impairment was present in a small minority (3.1%) (Table 1).

Operative characteristics

Among the 65 surgeries performed, right and left stapedotomies were nearly equally distributed, with 52.3% conducted on the right and 47.7% on the left. The end-aural approach was overwhelmingly preferred (90.8%) compared to the transcanal technique (9.2%).

Table 3. *Temporal changes in AC, BC, and ABG values of the operated side.*

Characteristic[a]	preoperative *N* = 65	Postoperative *N* = 65	*p*-value
AC	54.6 ± 13.9	39.8 ± 16.5	<0.001
BC	22.1 ± 10.0	21.4 ± 11.3	0.642
ABG	33.0 ± 10.8	18.3 ± 12.3	<0.001

[a]Values are presented as mean ± SD in dB. *p*-values were calculated using the paired *t*-test.

BC and AC values are based on average values at 250, 500, 1,000, 2,000, 3,000, 4,000, and 8,000 Hz.

ABG was defined as the difference between mean AC and BC values.

Table 4. *Description of the scores of the GBI domain.*

Characteristic	Median (Q1-Q3)	Mean ± SD	Min-Max	Cronbach alpha	N of items
GBI	36.1 (13.9-58.3)	34.4 ± 31.4	−47.2 to 97.2	0.918	18

Table 5. *Description of the scores of different domains and subdomains of HHIA.*

Characteristic	Median (Q1-Q3)	Mean ± SD	Min-Max	Cronbach alpha	N of items
HHIA	54.0 (34.0-78.0)	53.4 ± 26.1	0.0-100.0	0.951	25
HHIA Emotional	50.0 (30.8-73.1)	52.1 ± 27.7	0.0-100.0	0.919	13
HHIA Social	58.3 (37.5-75.0)	54.9 ± 26.3	0.0-100.0	0.898	12

Regarding the fenestration technique, the perforator pick was the most commonly used method (40.0%). The average perforator size was 1.0 ± 1.5 mm. As for prosthesis types, the most frequently used was the Causse loop piston (30.8%). The median prosthesis size was 5.0 (interquartile range: 4.5-5.0) (Table 2).

Temporal changes in AC, bone-conduction, and air–bone gap values of the operated side

There was a statistically significant improvement in the mean AC thresholds, decreasing from 54.6 ± 13.9 dB preoperatively to 39.8 ± 16.5 dB postoperatively ($p < 0.001$). Similarly, the mean air–bone Gap (ABG) significantly decreased from 33.0 ± 10.8 dB to 18.3 ± 12.3 dB postoperatively ($p < 0.001$). No significant change was observed in bone-conduction (BC) thresholds, which remained relatively stable (22.1 ± 10.0 dB preoperatively *vs.* 21.4 ± 11.3 dB postoperatively, $p = 0.642$, Table 3).

Description of the scores of the GBI domain

The median GBI score was 36.1 (Q1: 13.9, Q3: 58.3), with a mean score of 34.4 ± 31.4, ranging from –47.2 to 97.2. Internal consistency was high (Cronbach's alpha = 0.918) across the 18 items of the scale (Table 4).

Description of the scores of different domains and subdomains of HHIA

The median total HHIA score was 54.0 (Q1: 34.0, Q3: 78.0), with a mean of 53.4 ± 26.1 (range: 0.0-100.0). The emotional subdomain had a median score of 50.0 (Q1: 30.8, Q3: 73.1) and a mean of 52.1 ± 27.7, while the social subdomain had a median of 58.3 (Q1: 37.5, Q3: 75.0) and a mean of 54.9 ± 26.3. Cronbach's alpha values indicated high internal consistency across the total scale (0.951), emotional (0.919), and social (0.898) subdomains (Table 5).

Statistical differences in PTA values across operative characteristics

There was a statistically significant difference in mean postoperative PTA values between right-sided and left-sided surgeries, with better hearing outcomes observed in left-sided operations (33.1 ± 11.0 *vs.* 42.2 ± 21.1 dB; $p = 0.034$). No significant differences in PTA were found across other operative characteristics, including side of stapedectomy, incision type, fenestration method, or prosthesis type ($p > 0.05$ for all comparisons, Table 6).

Table 6. *Statistical differences in PTA values across operative characteristics.*

Characteristic	PTA	*p*-value
Right stapedotomy		0.649
No	38.0 ± 18.5	
Yes	36.4 ± 7.2	
Left stapedotomy		0.231
No	36.5 ± 17.1	
Yes	44.1 ± 18.4	
Site		0.034
Right	42.2 ± 21.1	
Left	33.1 ± 11.0	
Incision Trans-canal/end-aural		0.775
Transcanal	35.8 ± 17.2	
End-aural	38.0 ± 17.6	
Fenestration Perforator		0.361
Drill	34.7 ± 7.5	
Manual perforator	37.1 ± 19.5	
Perforator	36.6 ± 20.2	
Perforator pick	35.8 ± 14.0	
Seeker/Skater	49.8 ± 20.7	
Prosthesis		0.257
SMART piston	37.3 ± 14.3	
Robinson piston	30.3 ± 8.6	
Causse loop piston	37.7 ± 15.6	
Teflon piston	37.1 ± 7.9	
Platinum piston	36.9 ± 16.8	
KURZ titanium piston	27.5 ± 14.1	
Bucket handle	70.0 ± 14.1	
Unspecified piston	39.3 ± 25.2	

PTA: Mean ± SD.

Two-Sample *t*-test/ANOVA test.

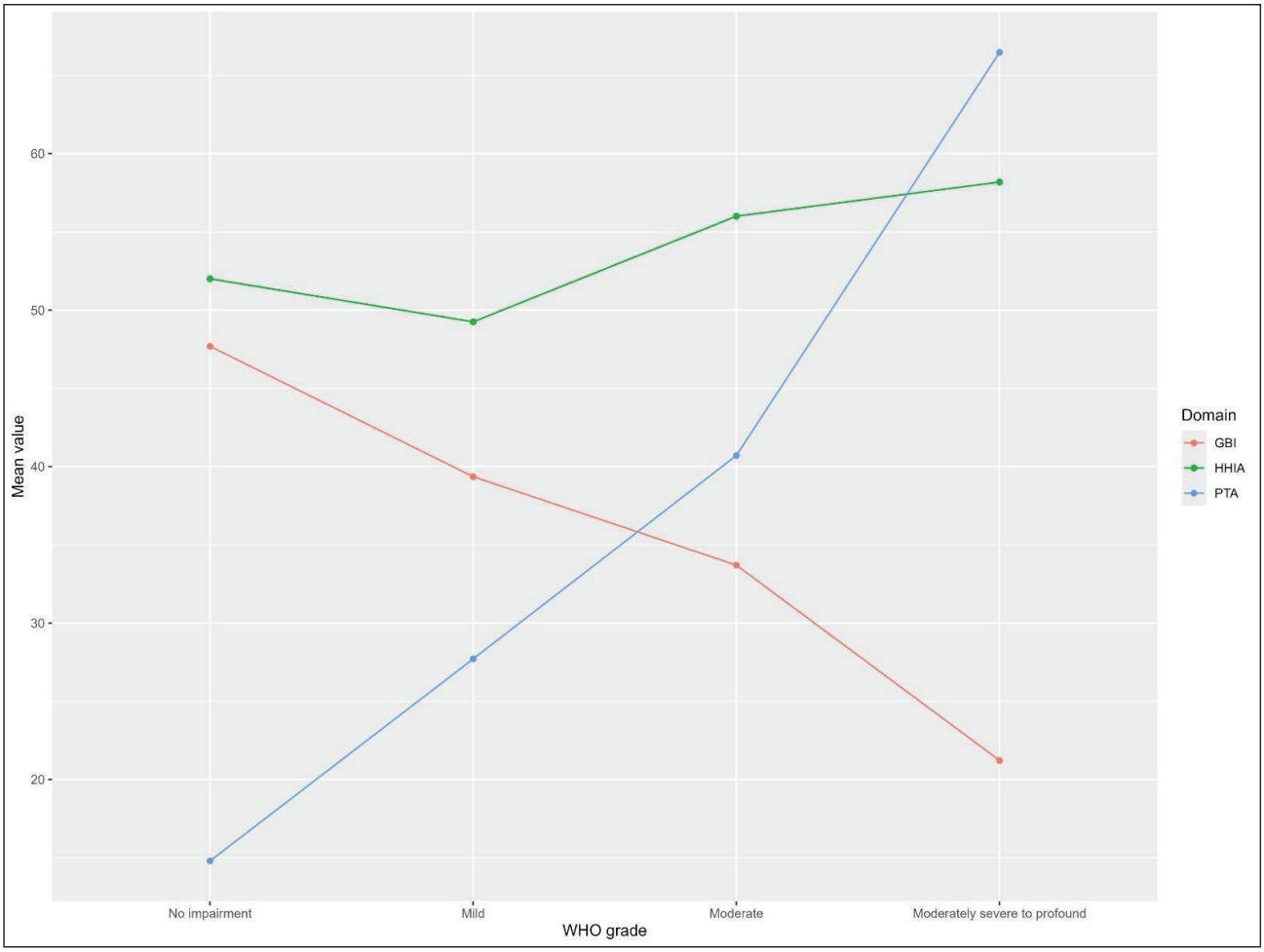


Figure 1. *Mean values of GBI and HHIA scores among different WHO hearing loss categories.*

Statistical differences in GBI and HHIA scores across different WHO hearing loss categories

Postoperative PTA values differed significantly across WHO hearing loss categories, with better scores observed in the no impairment group (14.8 ± 3.0 dB) and progressively worse thresholds among the mild (27.7 ± 4.3 dB), moderate (40.7 ± 5.4 dB), and moderately severe to profound groups (66.5 ± 17.8 dB; $p < 0.001$). However, no statistically significant differences were observed in mean GBI ($p = 0.310$) or HHIA ($p = 0.761$) scores across these categories (Figure 1).

Discussion

Otosclerosis significantly affects quality of life by compromising social interaction, communication, and speech perception. Stapedotomy, the treatment of choice, is consistently associated with a low complication rate. This cross-sectional study evaluated PROMs and PTA results following stapes surgery and explored associations between operative characteristics and postoperative outcomes.

A female predominance was observed in our study, with females comprising 61.5% of the study population; this finding aligns with several international studies [16,17], which have reported that approximately two-thirds of patients with otosclerosis are female. This disparity may stem from hormonal influences on disease progression, though the underlying mechanisms remain unclear and debated [18,19].

The mean age of the study population was 40.9 years, a finding nearly comparable to that reported by Hildebrandt et al. [20], who reported a mean age of 49 years in their study population. This age distribution could be explained by the natural history of the disease, which is typically progressive and becomes clinically symptomatic in middle adulthood.

A family history of otosclerosis has been reported in 27.7% of the study population. Although otosclerosis is considered a multifactorial disease involving both environmental and genetic factors, its exact pattern of inheritance remains unclear. Unlike many other hereditary disorders with known genetic determinants, the genetic basis of otosclerosis remains unclear [21].

Bilateral hearing loss was reported in 76.9% of our patients, consistent with the 63%-88% range of previous studies [22,23]. This reflects the progressive nature of otosclerosis, which usually begins unilaterally and later involves the contralateral ear. A notably lower prevalence (48%) was reported by the Swedish Quality Register for Otosclerosis Surgery [24]. These variations may be attributed to differences in patient presentation or population characteristics. Thus, these findings highlight

the importance of early evaluation and detection of otosclerosis and underscore the need to develop strategies for early screening and timely management.

Postoperative AC thresholds and ABG improved significantly in the operated ears, consistent with previous reports and with established measures of technical success following stapes surgery [7,22,25,26]. Stable postoperative BC indicates preserved cochlear function and absence of inner ear complications

A mean GBI score of 34.4 indicates moderate patient-perceived improvement in quality of life following stapes surgery, consistent with previous literature [27]. In contrast, Dwyer-Hemmings et al. [28] reported a notably lower mean score (20.7), attributed to their cohort design and the inclusion of multiple revision cases.

Overall GBI scores were consistent with postoperative PTA measurements. These favorable outcomes align with previously reported studies [29,30], further validating the clinical relevance of the GBI and its reliability alongside objective hearing assessments such as PTA.

A mean postoperative HHIA score of 53.4 indicates moderate to severe hearing handicap, with persistent emotional and social impact and continued difficulty in communication and daily activities. Because preoperative HHIA was not measured in our study, the magnitude of change in perceived handicap could not be determined; future studies should include both preoperative and postoperative assessments.

Our study has several strengths and limitations. A key strength is that patients were recruited from a specialized tertiary center, ensuring comprehensive and standardized evaluation. To our knowledge, this is also the first local study to assess subjective and objective outcomes concurrently, providing a valuable benchmark for future research. However, the single-center design may limit generalizability, and future multicenter studies are needed to capture more diverse data and enhance external validity. Additionally, the absence of preoperative HHIA data limited our ability to assess postoperative change in hearing-related quality of life; future studies should incorporate standardized pre- and postoperative HHIA assessments for a more comprehensive evaluation. Finally, the cross-sectional design restricts causal inference between operative characteristics and postoperative outcomes, highlighting the need for longitudinal studies.

Conclusion

This study demonstrated significant postoperative hearing improvement following stapes surgery. The GBI scores revealed clear postoperative quality of life improvement that aligned with the audiometric outcomes; however, persistent hearing handicap scores were still observed on the HHIA. Furthermore, no significant association was identified between postoperative outcomes and specific operative characteristics, including prosthesis type, incision type, and perforation method.

List of Abbreviations

ABG	Air–bone gap
AC	Air-conduction
BC	Bone-conduction
GBI	Glasgow Benefit Inventory
HHIA	Hearing Handicap Inventory for Adults
PROMS	Patient reported outcomes measurements
PTA	Pure tone average

Conflicts of interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

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None.

Consent to participate

Informed consent was obtained from all participants included in this study. Participation was voluntary, and all participants provided their consent prior to enrollment and completion of the study questionnaire. The study was conducted in accordance with the ethical standards of the institutional research committee and the principles of the Declaration of Helsinki.

Consent for publication

Not applicable (no individual identifying data are presented).

Ethical approval

The study was approved by the Institutional Review Board of the College of Medicine, King Saud University (Project No. E-25-9704) on 29 April 2025, in accordance with the Declaration of Helsinki.

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Supplementary content (If any) is available online.

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