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RESEARCH ARTICLE

Patient-Reported Outcomes Following Transsphenoidal Surgery for Acromegaly: A Cross-Sectional Study of Quality of Life, Sleep Quality, and Body Image

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ABSTRACT

Objective: Acromegaly is associated with substantial physical and psychosocial morbidity that may persist despite biochemical disease control. This study aimed to evaluate patient-reported quality of life, sleep quality, and body image in patients with acromegaly following transsphenoidal surgery and to examine their relationships with biochemical remission.

Materials and Methods: This single-center cross-sectional study included 36 adults who underwent transsphenoidal surgery for acromegaly. Quality of life was assessed using the Acromegaly Quality of Life Questionnaire (AcroQoL), with preoperative scores retrospectively reconstructed from patient recall and postoperative scores assessed at the time of the study. Sleep quality and body image were evaluated using the Pittsburgh Sleep Quality Index (PSQI) and Body Image Scale (BIS), respectively. Biochemical remission was defined according to postoperative GH and IGF-1 levels. Nonparametric tests, effect sizes, and Spearman correlation analyses were used.

Results: Postoperative normalized AcroQoL scores were higher than retrospectively recalled preoperative scores (80.11±17.34 vs. 60.64±20.85; $p<0.001$; effect size $r=0.77$). Patients who achieved biochemical remission had higher postoperative AcroQoL scores than those without remission (88.80±10.95 vs. 74.03±18.59; $p=0.013$). In contrast, PSQI and BIS scores did not differ significantly according to remission status. Poorer sleep quality was moderately associated with lower postoperative AcroQoL scores (Spearman $\rho=-0.39$; $p=0.018$). Postoperative follow-up duration was not significantly correlated with AcroQoL, PSQI, or BIS scores.

Conclusion: Higher postoperative patient-reported quality-of-life scores were observed, particularly among patients with biochemical remission. However, sleep disturbances and body image concerns frequently persisted, supporting the routine use of patient-reported outcome measures alongside biochemical assessment during postoperative follow-up.

Keywords: Acromegaly, body image, pituitary adenoma, quality of life, sleep, transsphenoidal surgery

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INTRODUCTION

Acromegaly is a rare chronic endocrine disorder caused by prolonged exposure to excessive growth hormone (GH), most commonly resulting from a GH-secreting pituitary adenoma.[1] Persistent GH hypersecretion and elevated insulin-like growth factor-1 (IGF-1) levels induce progressive structural and functional alterations involving multiple organ systems, including the cardiovascular, metabolic, respiratory, and musculoskeletal systems.[2] Owing to its insidious onset and delayed diagnosis, many patients present with irreversible somatic changes, multiple comorbidities, and substantial impairment in health-related quality of life (HRQoL).[3,4]

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The primary objective of acromegaly treatment is to achieve biochemical disease control through transsphenoidal surgery, medical therapy, and, when indicated, radiotherapy.[2,5] Transsphenoidal surgery remains the first-line treatment for most patients, and biochemical remission rates have improved considerably over the past decades. Nevertheless, accumulating evidence indicates that biochemical remission alone does not necessarily translate into complete recovery of patients' perceived health status or overall well-being.[4,6] Accordingly, recent international consensus statements recommend complementing biochemical outcomes with patient-reported outcome measures (PROMs) to provide a more comprehensive assessment of treatment success.[1]

Among PROMs, health-related quality of life is the most extensively investigated outcome in acromegaly and is commonly assessed using the disease-specific Acromegaly Quality of Life Questionnaire (AcroQoL).[7] Although significant improvements in quality of life have been reported following surgical treatment, recovery is often incomplete, particularly in psychosocial domains.[6,8] Sleep disturbances, especially obstructive sleep apnea and impaired sleep quality, frequently persist despite biochemical disease control and continue to adversely affect daily functioning and HRQoL.[9–11] Likewise, persistent craniofacial and acral changes may negatively influence body image and psychosocial adjustment even after successful treatment.[12]

Despite increasing recognition of PROMs in acromegaly, studies simultaneously evaluating quality of life, sleep quality, and body image remain scarce. Furthermore, the relationship between these patient-reported outcomes and biochemical remission has not been sufficiently investigated. Therefore, the present study aimed to evaluate quality of life, sleep quality, and body image in patients who had undergone transsphenoidal surgery for acromegaly and to investigate their association with biochemical remission.

MATERIALS and METHODS

Study Design and Participants

This single-center, cross-sectional survey was conducted at the Department of Neurosurgery, Acıbadem Maslak Hospital following approval from the İstinye University Human Research Ethics Committee (date: 04.04.2024; approval no: 24-65). Adult patients who had previously undergone transsphenoidal surgery for acromegaly and were under routine postoperative follow-up were invited to participate during Acromegaly Awareness Day, held on November 1, 2023.[13] All participants provided written informed consent before enrollment.

A total of 36 consecutive patients were included in the study. The diagnosis of acromegaly was established according to internationally accepted clinical, biochemical, and radiological criteria.[1] Biochemical remission was defined as age- and sex-adjusted normalization of serum IGF-1 concentrations with adequate suppression of GH after oral glucose tolerance testing, in accordance with current consensus recommendations.[14]

Data Collection

All data were collected during a single face-to-face interview conducted by the investigators using a standardized questionnaire. Demographic characteristics, clinical information, surgical history, biochemical remission status, and postoperative follow-up duration were recorded.

Quality-of-life assessments referring to the preoperative period were reconstructed retrospectively based on patients' recall, whereas sleep quality and body image were evaluated only for the current postoperative period. Because the study employed a cross-sectional design, no prospective preoperative assessments were available.

Health-Related Quality of Life

HRQoL was evaluated using the AcroQoL, a disease-specific instrument consisting of 22 items that assess physical functioning and psychological well-being, including appearance and personal relationships.[7]

Raw AcroQoL scores range from 22 to 110. To facilitate interpretation and comparison with previous studies, total scores were normalized to a 0–100 scale according to the developers' recommendations, with higher scores indicating better quality of life. Participants completed the questionnaire twice: once reflecting their current postoperative status and once retrospectively recalling their perceived quality of life before surgery.

Sleep Quality

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), which evaluates subjective sleep quality over the previous month across seven domains.[15] Total scores range from 0 to 21, with scores >5 indicating poor sleep quality. The validated Turkish version of the PSQI was used.[16]

Body Image

Body image was evaluated using the Body Image Scale (BIS)[17] developed by Secord and Jourard and validated in Turkish by Hovardaoğlu.[18] The scale consists of 40 items scored on a five-point Likert scale, yielding total scores ranging from 40 to 200, with higher scores indicating greater body satisfaction.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was evaluated using graphical methods (histograms and Q–Q plots) together with the Shapiro–Wilk test.

Because questionnaire scores are commonly reported as mean±standard deviation (SD) in the acromegaly literature, these variables were summarized accordingly despite the use of nonparametric statistical methods to facilitate comparison with previous studies. Categorical variables are presented as frequencies and percentages.

Preoperative and postoperative AcroQoL scores were compared using the Wilcoxon signed-rank test. Comparisons between patients with and without biochemical remission were performed using the Mann–Whitney U test. Associations between postoperative AcroQoL and PSQI scores were assessed using Spearman's rank correlation coefficient. In response to the potential heterogeneity associated with postoperative follow-up duration, additional Spearman's rank correlation analyses were performed to assess the relationships between follow-up duration and postoperative AcroQoL, PSQI, and BIS scores.

For nonparametric analyses, effect size (r) was calculated using the formula $r=Z/\sqrt{N}$ and interpreted according to Cohen's criteria (0.10=small, 0.30=medium, ≥0.50=large effect). All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

RESULTS

Study Population

A total of 36 patients who had undergone transsphenoidal surgery for acromegaly were included in the study. The mean age was 46.9±12.5 years, and 23 (63.8%) were female. The mean postoperative follow-up period was 7.3 years (range, 1–19 years). Biochemical remission was achieved in 16 patients (44.4%). Demographic, socioeconomic, and clinical characteristics are presented in Table 1.

The most common presenting symptoms were enlargement of the hands (61.1%), enlargement of the feet (50.0%), facial coarsening (25.0%), snoring or respiratory difficulty (25.0%), and headache (22.2%). Bitemporal hemianopia was present in four patients (11.1%). Mean serum GH levels decreased from 19.70±28.30 ng/mL before surgery to 2.39±3.66 ng/mL postoperatively, whereas mean IGF-1 levels decreased from 614.2±111.5 ng/mL to 188.9±100.9 ng/mL.

Table 1. Demographic, socioeconomic, and clinical characteristics of the study population

Variable	Value
Age, years	46.9±12.5
Female sex, n (%)	23 (63.8)
Marital status, n (%)	
Married	30 (83.3)
Single	5 (13.9)
Widowed	1 (2.8)
Children, n (%)	
Yes	25 (69.4)
No	11 (30.6)
Education, n (%)	
Primary school or below	9 (25.0)
High school	7 (19.4)
University or higher	20 (55.6)
Employment, n (%)	
Employed	19 (52.8)
Unemployed/Retired	17 (47.2)
Years of employment	3.1±1.5
Follow-up duration, years	7.3 (1–19)
Biochemical remission, n (%)	16 (44.4)

Values are presented as mean±standard deviation (SD), median (range), or number (%), as appropriate. SD: Standard deviation

Among the tumors, 30.6% were microadenomas, 61.1% were macroadenomas, and 8.3% were giant adenomas. Knosp grade 3–4 invasion was observed in 38.9% of patients. Endoscopic transsphenoidal surgery was performed in 77.8% of patients, while 22.2% underwent microscopic transsphenoidal surgery. Sparsely granulated somatotroph adenoma was the most common histopathological subtype (45.8%). Reoperation was required in 16.7% of patients.

Quality of Life

Normalized AcroQoL scores were significantly higher in the postoperative assessment than in the retrospectively reconstructed preoperative assessment (80.11±17.34 vs. 60.64±20.85; Wilcoxon signed-rank test, p<0.001). The magnitude of this difference was large (effect size r=0.77), indicating a substantial difference between retrospectively recalled preoperative and current postoperative patient-reported quality-of-life scores (Table 2, Fig. 1). The median paired improvement in the normalized AcroQoL score was 18.2 points (Hodges–Lehmann estimate; 95% CI: 12.5–24.8).

Table 2. Comparison of normalized AcroQoL scores

Outcome	Mean±SD	p	Effect size (r)
Preoperative AcroQoL	60.64±20.85	<0.001*	0.77
Postoperative AcroQoL	80.11±17.34		
No biochemical remission	74.03±18.59	0.013†	0.43
Biochemical remission	88.80±10.95		

*: Wilcoxon signed-rank test; †: Mann–Whitney U test. Effect size interpreted according to Cohen's criteria. AcroQoL: Acromegaly quality of life questionnaire; SD: Standard deviation

Postoperative AcroQoL scores were significantly higher among patients who achieved biochemical remission than among those without remission (88.80±10.95 vs. 74.03±18.59; Mann–Whitney U test, p=0.013). The corresponding effect size was r=0.43, indicating a moderate-to-large between-group difference.

To further characterize patient-reported quality of life, AcroQoL domain scores were analyzed separately. Significant postoperative improvements were observed in the physical, appearance, and personal relationship domains. The greatest improvement was observed in the physical domain, whereas improvements in appearance-related and interpersonal domains were more modest.

Table 3. Comparison of postoperative sleep quality and body image according to biochemical remission

Variable	No remission	Biochemical remission	p
PSQI	5.80±3.61	5.06±2.82	0.496
BIS	130.30±24.37	133.31±33.74	0.767

Values are presented as mean±standard deviation. PSQI: Pittsburgh sleep quality index; BIS: Body image scale

Sleep Quality

The mean postoperative PSQI score was 5.47±3.26. Although patients with biochemical remission demonstrated lower PSQI scores than patients without remission (5.06±2.82 vs. 5.80±3.61), this difference was not statistically significant (p=0.496). The effect size was small (r=0.12) (Table 3).

Body Image

The mean BIS score was 131.64±28.51. No statistically significant difference was observed between patients with and without biochemical remission (133.31±33.74 vs. 130.30±24.37; p=0.767). The corresponding effect size was r=0.05, indicating a negligible difference (Table 3).

Nineteen patients (52.8%) had body image scores above 135, suggesting generally favorable body image perception. The most frequently reported areas of dissatisfaction

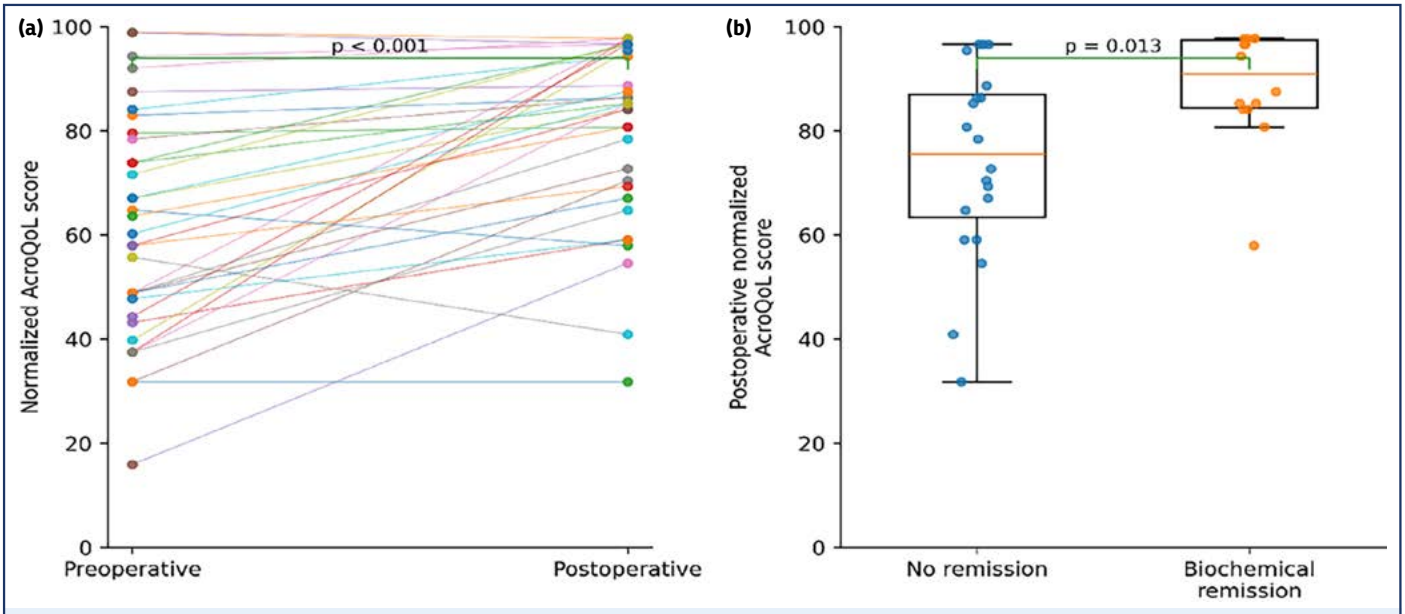

Figure 1. Patient-reported quality-of-life outcomes following transsphenoidal surgery for acromegaly. **(a)** Paired preoperative and postoperative normalized AcroQoL scores. Each line represents an individual patient. Postoperative scores were significantly higher than retrospectively reconstructed preoperative scores (Wilcoxon signed-rank test, p<0.001). **(b)** Distribution of postoperative normalized AcroQoL scores according to biochemical remission status. Patients with biochemical remission had significantly higher scores than those without remission (Mann–Whitney U test, p=0.013)

were sleep pattern, nose, sexual functioning, body posture, and voice.

Correlation Analysis

Spearman correlation analysis demonstrated a moderate negative correlation between postoperative AcroQoL and PSQI scores (ρ=−0.39, p=0.018), indicating that poorer sleep quality was associated with lower quality of life.

Postoperative follow-up duration was not significantly correlated with postoperative AcroQoL (Spearman's ρ=0.12, p=0.483), PSQI (ρ=−0.10, p=0.569), or BIS scores (ρ=0.03, p=0.859).

DISCUSSION

Acromegaly is increasingly recognized as a chronic disease in which treatment success extends beyond biochemical remission.[4,19] Although normalization of GH and IGF-1 concentrations remains the principal therapeutic goal, contemporary consensus statements emphasize that patient-reported outcome measures should complement biochemical assessment.[1,2] This broader perspective is particularly relevant because persistent comorbidities and irreversible somatic changes may continue to affect patients even after successful treatment.[20–22] Accordingly, the present study simultaneously evaluated health-related quality of life, sleep quality, and body image in patients who had undergone transsphenoidal surgery for acromegaly.

The principal finding was the marked difference between retrospectively reconstructed preoperative and current postoperative AcroQoL scores. The approximately 20-point difference in normalized scores was accompanied by a large effect size, indicating a substantial difference in patient-perceived quality of life. Previous studies have similarly reported improved quality of life after transsphenoidal surgery.[8] A systematic review and meta-analysis also demonstrated overall improvements in symptoms and health-related quality of life following treatment of acromegaly.[23] However, quality-of-life recovery is not necessarily complete or uniform. AcroQoL captures physical functioning, appearance, and personal relationships,[7] and previous studies have demonstrated that quality of life may remain impaired despite treatment.[24]

Importantly, the preoperative AcroQoL scores in our study were reconstructed retrospectively from patient recall rather than obtained prospectively. Given the wide range of postoperative follow-up durations, current clinical status and adaptation over time may have influenced patients' recollection of their preoperative condition. Therefore, the observed preoperative–postoperative difference should be interpreted as patient-perceived change rather than as a prospective longitudinal estimate of the effect of surgery. This distinction limits causal interpretation of the observed difference and underscores the need for prospective studies using standardized preoperative and postoperative assessments.

Patients who achieved biochemical remission had significantly higher postoperative AcroQoL scores than those without remission, with a moderate-to-large effect size. This finding is consistent with previous evidence associating long-term biochemical control with better quality of life[6] and disease activity with cognitive and psychological outcomes.[19] Nevertheless, hormonal normalization may not eliminate chronic cardiovascular and metabolic disease, arthropathy, persistent pain, established craniofacial and acral changes, or psychological morbidity.[4,12] Thus, postoperative quality of life likely reflects the combined influence of biochemical activity, chronic comorbidities, psychological status, and social functioning rather than biochemical remission alone.

Sleep quality remained impaired in a substantial proportion of the cohort. The mean postoperative PSQI score was above the commonly accepted threshold for poor sleep quality, and PSQI scores did not differ significantly according to biochemical remission. Sleep-disordered breathing is highly prevalent in acromegaly and may be only partially reversible after biochemical control because of persistent upper-airway changes, craniofacial remodeling, obesity, and associated cardiometabolic disease.[9,25] The moderate negative correlation between PSQI and postoperative AcroQoL further indicated that poorer sleep quality was associated with lower quality of life. Similar associations have been reported in patients with pituitary adenomas.[10] These findings support the systematic assessment of sleep symptoms during follow-up; however, because PSQI was assessed only postoperatively, no conclusion can be drawn regarding the effect of surgery on sleep quality.

Body image was similarly not explained by biochemical remission alone. BIS scores did not differ significantly between remission groups, and although more than half of the patients had scores compatible with generally favorable body image, dissatisfaction persisted in areas including nasal appearance, body posture, sexual functioning, and voice. Previous work suggests that body image perception in acromegaly may be more closely associated with depressive symptoms than with objectively measured acromegalic features.[26] In addition, established skeletal and craniofacial changes may

be only partially reversible. These observations suggest that body image reflects an interaction among persistent physical changes, psychological adaptation, self-esteem, bodily function, and social experience, supporting multidisciplinary assessment when clinically indicated.

The present findings have practical implications for long-term follow-up. Biochemical remission remains an important therapeutic target and was associated with better postoperative quality of life in our cohort. Nevertheless, biochemical control should not be assumed to represent complete patient-perceived recovery. Validated PROMs can identify persistent sleep disturbance, body image concerns, psychological distress, and functional limitations that may not be apparent from endocrine or radiological assessment alone. Incorporating instruments such as AcroQoL and targeted assessments of sleep and body image may therefore provide a more comprehensive evaluation of treatment outcomes.

Several limitations should be considered. The single-center, cross-sectional design and relatively small sample size limit generalizability and preclude causal inference. Most importantly, preoperative AcroQoL scores were retrospectively reconstructed from patient recall, introducing substantial potential for recall bias. The wide range of postoperative follow-up durations may also introduce heterogeneity related to treatment era, additional therapies, comorbidities, and psychosocial adaptation. In additional analyses, however, follow-up duration was not significantly correlated with postoperative AcroQoL, PSQI, or BIS scores. Reliable patient-level data regarding symptom duration before diagnosis, duration of active disease before surgery, and cumulative exposure to GH/IGF-1 excess were not consistently available. This is relevant because prolonged hormonal exposure may contribute to irreversible somatic changes, chronic comorbidities, and persistent impairment in quality of life and body image. Furthermore, PSQI and BIS were assessed only postoperatively, preventing longitudinal evaluation of sleep quality and body image. The absence of healthy or medically treated comparison groups and potential residual confounding by depression, anxiety, obesity, obstructive sleep apnea, pain, and other comorbidities should also be acknowledged.

Despite these limitations, this study simultaneously evaluated three complementary patient-reported outcome domains using validated instruments and focused specifically on surgically treated patients. The inclusion of effect sizes and the additional assessment of follow-up duration strengthen the interpretation of the findings. Prospective multicenter studies incorporating standardized preoperative PROMs, repeated postoperative measurements, objective sleep assessment, and psychological profiling are needed to better define the longitudinal course and determinants of patient-reported outcomes in acromegaly.

CONCLUSION

Transsphenoidal surgery was associated with improved patient-reported quality of life in patients with acromegaly, particularly among those who achieved biochemical remission. Nevertheless, persistent sleep disturbances and body image concerns suggest that successful hormonal control does not necessarily translate into complete recovery of patients' perceived health status. Therefore, postoperative assessment should extend beyond biochemical remission and routinely incorporate validated patient-reported outcome measures to provide a more comprehensive evaluation of treatment success. Future prospective longitudinal studies are needed to confirm these findings and further define the long-term trajectory of patient-reported outcomes after treatment.

Disclosures

Ethics Committee Approval: The study was approved by the İstinye University Human Research Ethics Committee (No: 24-65, Date: 04/04/2024).

Informed Consent: Written informed consent was obtained from all participants before enrollment in the study.

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