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Acoustic outcomes and voice-related quality of life in male-to-female transsexuals undergoing Wendler glottoplasty: a single-centre experience

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Abstract

Introduction: Many transsexual women seek to feminise their voice through pitch elevation surgeries so that it becomes congruent with their gender identity. This study aims to determine the safety and effectiveness of Wendler glottoplasty (WG) in vocal feminisation through the assessment of acoustic and aerodynamic parameters of the voice, as well as voice-related quality of life (QoL) in male-to-female transsexuals.

Material and methods: We retrospectively reviewed the medical records of transsexual women who underwent WG for voice feminisation at our institution between 2016 and 2023. All acoustic and aerodynamic analyses, a voice self-assessment, and a videolaryngostroboscopic evaluation were performed in the immediate preoperative period and at the follow-up visit 6 weeks after the procedure.

Results: A total of 11 patients with a mean age of 32.73 years were included. After WG, there was a significant fundamental frequency and speaking fundamental frequency increase of 109.64 Hz and 83.48 Hz, respectively ($p < 0.001$), representing an average rise by 9.71 semitones and 8.36 semitones (STs), respectively. No significant differences were found between the mean pre- and postoperative values of fundamental frequencies, frequency range, upper limit of the frequency range of spoken voice, and maximum phonation time. Contrarily, the mean lower limit of frequency range rose by 75.56 Hz ($p < 0.001$), representing an average increase of 10.56 STs. None of the assessed spirometric parameters changed significantly after WG ($p > 0.05$). The mean overall Voice Handicap Index (VHI) and Voice-Related Quality of Life (V-RQOL) scores significantly improved after the surgery, decreasing by 24.54 points ($p = 0.008$) and 11.5 points ($p = 0.001$), respectively. A significant improvement was observed in the functional and emotional domains of VHI. Additionally, significantly fewer patients considered the overall quality of their voice to be "poor" after WG.

Conclusions: WG constitutes an effective method of surgical voice feminisation in male-to-female transsexuals with concurrent improvement in their voice-related QoL. Furthermore, it remains a safe procedure without persistent complications and negative influence on the acoustic-aerodynamic measures of the voice. **(Endokrynol Pol 2024; 75 (2): 222–229)**

Key words: *transgender; phonosurgery; voice feminisation; pitch elevation; acoustic measures; fundamental frequency*

Introduction

Since a person's voice is uniquely tied to their identity, its incongruence with the female gender in male-to-female (MtF) transsexual patients might have a significant impact on their emotional, social, and vocational functioning and, ultimately, their quality of life (QoL) [1]. Although in transsexual men, testosterone masculinising hormone therapy combined with speech training might result in deepening the voice [2], in transgender women hormonal replacement therapy with oestrogens applied after puberty does not noticeably alter the pitch [3, 4]. Therefore, many MtF transsexuals opt for additional methods to feminise their voice, which include voice therapy (VT) and surgical intervention.

VT might aid in acquiring female vocal behaviour, such as intonation, resonance, articulation, prosody, and nonverbal communication patterns [5]. Nevertheless, some MtF transsexuals might require voice feminisation surgery to achieve the desired pitch, satisfactory even in uncontrolled situations, such as laughter, crying, sneezing, and yawning [6, 7]. Several surgical strategies altering vocal folds (VFs) tension, mass, or length of their vibrating portion (such as cricothyroid approximation, laser vaporisation, endoscopic Wendler glottoplasty [WG], and feminisation laryngoplasty) have been found effective in increasing the perceived vocal femininity [8, 9]. The endoscopic glottoplasty technique described by Wendler is currently considered the standard practice [6]. The procedure consists of

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endoscopic deepithelialisation of the anterior one-third of the VFs with sharp microinstruments or CO_2 laser. The corresponding portions of both VFs are then sutured together, creating an anterior synechia, thereby retropositioning the anterior commissure and reducing the vibratory length of the VFs.

Despite the meaningful increase of fundamental frequency (F0) after WG, which correlates with the perception of vocal femininity, other acoustic parameters, such as maximum phonation time (MPT) and frequency range, have been reported to worsen, which might influence the overall voice quality after the procedure [10, 11]. Therefore, this study aims to determine the safety and effectiveness of WG in vocal feminisation through the assessment of objective acoustic and aerodynamic parameters of the voice, as well as subjective patient-reported outcome measures in MtF transsexual individuals.

Material and methods

Following Institutional Review Board approval, data were collected retrospectively for MtF transsexuals who underwent WG for voice feminisation in the Department of Otorhinolaryngology and Oncological Laryngology, Medical University of Silesia, Zabrze, Poland, between 2016 and 2023. All subjects met the following inclusion criteria: (1) at least 18 years of age; (2) established diagnosis of gender dysphoria and female gender identity; (3) previously received or currently ongoing oestrogen replacement therapy; (4) being under the supervision of an endocrinologist and a psychiatrist; and (5) initiated lawsuit for gender transition. The exclusion criteria were prior pitch-elevation surgery and clinical comorbidities prohibiting surgical intervention. Pre- and postoperative VT is not required in our department; however, some patients received preoperative VT outside our institution before being referred for WG.

Voice assessment

Objective acoustic and aerodynamic evaluation of the voice was based on the following parameters: (1) F0 (in Hz); (2) formant frequencies (FFs, in Hz) — first (F1), second (F2), third (F3), and fourth (F4) formant frequency; (3) speaking fundamental frequency (sF0, in Hz); (4) lower and upper limit of the frequency range of spoken voice (in Hz); and (5) MPT (in s). Additionally, the differences in F0, sF0, and frequency range of spoken voice between the pre- and postoperative periods were calculated in semitones (STs).

All audio samples were digitally recorded with a Zoom H2N Microphone. Acoustic analysis of voice recordings was performed using the PRAAT program (Paul Boersma and David Weenink, University of Amsterdam, Netherlands). To evaluate F0, patients were asked to prolong the vowel /a/ at a comfortable pitch and loudness for approximately 10 s. For MPT assessment, the greatest MPT value from 3 consecutive measurements was considered representative of the patient.

Furthermore, to assess the impact of voice on the QoL, the following 2 questionnaires, self-completed by the patients, were implemented: Voice Handicap Index (VHI) and Voice-Related Quality of Life (V-RQOL) questionnaire. VHI takes into account the physical, functional, and emotional impact of the voice disorder, with higher scores reflecting greater vocal difficulties. A cut-off score of 20 was determined to identify voice-related disability [12].

The V-RQOL questionnaire measures the subjective burden elicited by voice disorders across emotional, physical, and functional domains. The overall V-RQOL score can range from 10 (excellent) to 50 (poor), reflecting the intensity of vocal interference with daily activities. Additionally, the patients are asked to determine whether they consider the overall quality of their voice to be "poor", "fair", "good", or "very good".

All objective and subjective voice measurements were obtained in the immediate preoperative period and at the follow-up visit 6 weeks after the procedure.

Videolaryngostroboscopy

Preoperatively, the videolaryngostroboscopy was carried out to screen for eventual laryngeal pathologies (Fig. 1A). Additionally, the stroboscopic assessment of the mucosal wave in terms of symmetry, phase, and closure was performed on each patient. During the videolaryngostroboscopy at the 6-week follow-up visit, the larynx was inspected for oedema, scarring, granulation tissue, persistence of the suture material, and quality of VF vibration (Fig. 1B). After confirmation of healing and formation of an anterior web, patients were advised to return to their regular voice use.

Spirometry

Spirometry was performed as a complementary examination before WG and 6 weeks after the procedure. The following parameters were

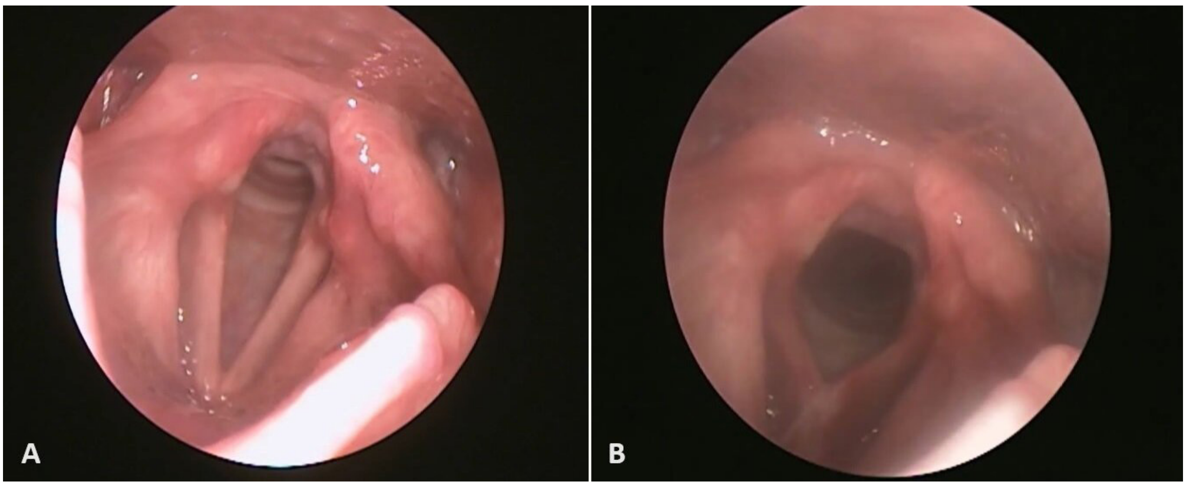

Figure 1. A. *The preoperative view of the normal glottis during the videolaryngostroboscopic examination;* **B.** *The follow-up image of the anterior glottal web and the reduced vibratory portion of the vocal folds*

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evaluated: (1) forced expiratory volume in the first second (FEV1); (2) ratio of the forced expiratory volume in the first second to the forced vital capacity (FEV1/FVC); (3) forced expiratory flow at 50% of forced vital capacity (FEF50); and (4) peak expiratory flow (PEF).

Surgical procedure

All procedures were performed by the senior author (M.M.) using Wendler's technique. The surgery was performed under general anaesthesia. The endolarynx was exposed through a rigid suspension Kleinsasser laryngoscope. The VFs were examined under appropriate magnification with an OPMI PROergo microscope (Carl Zeiss Meditec AG, Jena, Germany). The anterior one-third of the VFs was de-epithelised using the SmaXel CO_2 laser (IDS Ltd, Paju-si, Republic of Korea) with a 10–13 W intensity beam. Additionally, the anterior portions of both VFs were scarified using microinstruments. The corresponding tissue of the VFs was firmly sutured with two 4.0 PDS absorbable sutures to obtain the desired synechia size. No fibrin sealant was used to strengthen the suture. Postoperatively, all individuals were advised smoking cessation and complete vocal rest for 2 weeks to limit the tension forces and prevent suture dehiscence.

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Statistical analysis

Tests for 2 dependent samples were performed to compare pre- and postoperative data. When the assumptions for parametric tests were met, a t-test was used; otherwise, the Wilcoxon test was applied. Normality was tested using the Shapiro-Wilk test. Proportion tests for structure indicators were applied to define the change in the rate of patients in each category of postoperative voice quality in relation to the preoperative period. Values of $p < 0.05$ were considered statistically significant. All analyses were performed using Statistica 13.3 software (StatSoft Polska, Krakow, Poland).

Results

A total of 11 patients with a mean age of 32.73 years [standard deviation (SD) = 11.32] were included.

Acoustic analysis of the voice

After WG, there was a significant F0 increase of 109.64 Hz (from 144.18 Hz to 253.82 Hz) ($p < 0.001$), which represented an average F0 increase amounting to 9.71 STs. Furthermore, mean sF0 rose by 83.48 Hz (from 136.07 Hz to 219.55 Hz), which was statistically significant ($p < 0.001$) and corresponded with an average sF0 increase of 8.36 STs.

No significant differences were found between the mean pre- and postoperative FFs values. Additionally, the observed decrease in the mean frequency range of spoken voice from 17.35 STs to 12.42 STs was not significant ($p = 0.205$). The mean upper limit of the frequency range did not change after WG ($p = 0.122$). Contrarily, the mean lower limit of frequency range rose by 75.56 Hz (from 87.31 Hz to 162.87 Hz) ($p = 0.001$), which represented an average increase of 10.56 STs.

The detailed data regarding the pre- and postoperative acoustic assessment of the voice are presented in Table 1.

Aerodynamic evaluation

Mean MPT did not differ significantly between the pre- and postoperative periods ($p = 0.942$). Furthermore, none of the assessed spirometric parameters changed significantly after WG ($p > 0.05$). Since 2 patients did not undergo spirometry, the analysis of spirometric parameters was based on the data obtained from 9 patients. The detailed characteristics regarding the pre- and postoperative spirometric parameters are presented in Table 2.

Voice-related QoL assessment

Regarding the voice-related QoL, the mean overall VHI score significantly improved after WG, decreasing by 24.54 points ($p = 0.008$). A significant improvement was observed in the functional and emotional domains of VHI, in which a mean decrease of 6.91 points

Table 1. *Acoustic and aerodynamic parameters of the voice*

Parameter	Preoperative		Postoperative		p
	Mean	SD	Mean	SD	
F0 [Hz]	144.18	33.70	253.82	62.62	< 0.001***
sF0 [Hz]	136.07	27.05	219.55	38.38	< 0.001***
F1 [Hz]	681.95	137.55	618.97	186.01	0.411
F2 [Hz]	1309.22	146.78	1418.47	360.71	0.333
F3 [Hz]	2696.40	386.07	2717.17	387.74	0.849
F4 [Hz]	3733.02	261.51	3669.46	217.57	0.579
Upper limit of frequency range of spoken voice [Hz]	254.95	123.42	327.69	69.12	0.122
Lower limit of frequency range of spoken voice [Hz]	87.31	20.59	162.87	46.70	0.001**
Frequency range of spoken voice [ST]	17.35	7.87	12.42	5.25	0.205
MPT [s]	17.86	5.66	18.34	9.01	0.942

SD — standard deviation; F0 — fundamental frequency; sF0 — speaking fundamental frequency; F1 — first formant frequency; F2 — second formant frequency; F3 — third formant frequency; F4 — fourth formant frequency; MPT — maximum phonation time; s — seconds; Hz — Hertz; ST — semitones; **$p < 0.01$; ***$p < 0.001$

Table 2. *Spirometric assessment*

Parameter	Preoperative			Postoperative			p
	Mean	SD	Percentage of predicted normal value	Mean	SD	Percentage of predicted normal value	
FEV1 [L]	4.11	0.33	111.67%	4.09	0.30	111.22%	0.794
FEV1/FVC (%)	87.33	8.40	107.11%	89.22	7.81	109.00%	0.486
FEF50 [L/s]	5.35	1.33	110.89%	5.63	1.50	115.56%	0.293
PEF [L/min]	541.67	94.47	109.89%	488.67	97.27	102.22%	9.498

SD — standard deviation; FEV1 — forced expiratory volume in the first second; FEV1/FVC — ratio of the forced expiratory volume in the first second to the forced vital capacity; FEF50 — forced expiratory flow at 50% of forced vital capacity; PEF — peak expiratory flow; # — because 2 patients did not undergo spirometry, the analysis of spirometric parameters is based on the data obtained from 9 patients

Table 3. *Voice-related quality of life scores*

Parameter	Preoperative		Postoperative		p
	Mean	SD	Mean	SD	
VHI — total	61.18	21.09	36.64	18.22	0.008**
VHI — functional	18.27	8.55	11.36	5.68	0.036*
VHI — emotional	26.18	7.69	10.27	7.81	< 0.001***
VHI — physical	16.73	7.32	15.00	6.10	0.509
V-RQOL score	31.90	7.94	20.40	6.70	0.001**

SD — standard deviation; VHI — Voice Handicap Index; V-RQOL — voice-related quality of life; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 4. *Self-assessed overall voice quality*

Voice quality	Preoperative		Postoperative		p
	n#	%	n#	%	
Poor	5	50.00	0	0.00	0.009*
Fair	4	40.00	4	40.00	–
Good	1	10.00	3	30.00	0.264
Very good	0	0.00	2	20.00	0.136

n — number of patients; *$p < 0.05$; #V-RQOL questionnaire was not collected from the first operated patient in our series. Additionally, one patient did not complete the V-RQOL questionnaire in the postoperative period.

and 15.91 points, respectively, was observed ($p = 0.036$ and $p < 0.001$, respectively). However, the mean score in the physical domain of VHI did not change significantly ($p = 0.509$). Moreover, the mean score in the V-RQOL questionnaire significantly improved after WG, decreasing by 11.5 points ($p = 0.001$). Additionally, significantly fewer patients considered the overall quality of their voice to be "poor" after WG. The detailed data regarding the voice-related QoL evaluation and self-assessed voice quality are presented in Table 3 and 4, respectively.

Complications

The videolaryngostroboscopy performed during the follow-up visit rendered abnormal findings in 3 out of 11 patients. One patient developed a granuloma on the suture site, which resolved after administration of glucocorticosteroids. In the second patient, the lack of phonatory closure of VFs near the suture site was observed, resulting in the necessity of reoperation and unilateral augmentation of the VF through the injection of polydimethylsiloxane (Vox Implant®). In the third patient, the suture dissolution was prolonged, which did not require further intervention since the sutures dissolved entirely during the next few weeks (Fig. 2).

Discussion

Acoustic evaluation of the voice

Since the voice constitutes a major characteristic of human identity, its incongruence with perceived gender might preclude public acceptance of transsexual women after gender reassignment surgeries, as well

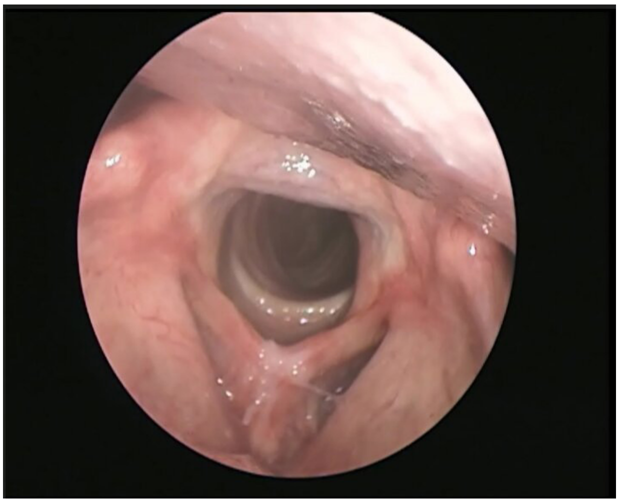

Figure 2. *A follow-up videolaryngostroboscopic examination of a patient with prolonged suture dissolution revealed the formation of the anterior glottal web with unabsorbed suture material*

as handicap their daily occupational and social activities [13]. The principal acoustic parameter influencing gender perception is F0, responsible for 50–60% of vocal femininity when assessed by transgender individuals, as well as by external listeners [14]. The F0 characteristic for male voices ranges between 80 Hz and 145 Hz, whereas the F0 of a typical female voice amounts to 165–225 Hz [15, 16]. The mean postoperative F0 value in our series, equalling 253.82 Hz, noticeably exceeds the overlap F0 range from 145 Hz to 165 Hz, above which the given voice can be unequivocally assigned to the female gender [5, 16]. Interestingly, the mean F0 increase following WG, amounting to 109.64 Hz, is much higher than the values reported in the meta-analyses conducted by Nolan et al. [6] and Aires et al. [11] (with the mean postoperative F0 increase of 72.21 Hz and 78.49 Hz, respectively), which might be partially attributed to the limited sample size in our study. Furthermore, the postoperative sF0 value, a parameter more representative of the individual's actual pitch in daily conversations, amounted to 219.55 Hz in our series, thus yielding lower values than F0, consistent with the existing literature on the topic [17]. Furthermore, we observed that the lower limit of the pitch frequency range rose significantly from 87.31 Hz to 162.87 Hz, which suggests that following WG, the patients lost access to the lower frequencies characteristic of male voices. The inability to produce a low-pitched voice even in uncontrolled situations, such as laughter, sneezing, yawning, and crying [7], might be associated with diminished fear and dysphoria surrounding the voice in transsexual women after WG, which might contribute to the ultimate therapeutic success.

Notably, the significant changes in F0 and sF0 following WG were also observed when a logarithmic ST scale was applied instead of a linear Hz scale. When expressed in STs, an F0 and sF0 increase by 9.71 STs and 8.36 STs, respectively, was found in our study, which is consistent with previous reports regarding the acoustic outcomes of WG [18–20]. Gross et al. [18] reported a 9.2 ST increase of the mean spontaneous F0 following WG, whereas Casado et al. suggested an average postoperative F0 rise of approximately 9 STs [19]. Since the human auditory system perceives pitch in a logarithmic rather than linear manner, a more appropriate measure of the perceptual consequences of differences in F0 seems to be a logarithmic scale based on STs. Therefore, the above-mentioned differences in the F0 increase expressed in Hz between our study, the Nolan et al. paper [6], and the Aires et al. review [11] might stem from diverse preoperative F0 values in each study group. For instance, although the F0 increase from 87 Hz to 147 Hz and from 147 Hz to 210 Hz amounts to approximately 60 Hz, in the first case, the voice will be raised by 9 STs, while in the second case — by only 6 STs. Due to the scarcity of reports on WG in MtF transsexuals expressing acoustic changes in STs, the broader implementation of the ST scale might facilitate the comparison between the results of different studies regarding the impact of WG on acoustic voice parameters.

In patients with F0 and sF0 near the gender-neutral range (145–165 Hz), the perceived vocal femininity is influenced by the FFs, which reflect the enhancement of specific frequency bands as a part of the resonance phenomenon occurring in the supralaryngeal vocal tract (SVT). FFs values are associated with the vocal tract length, rounding of the lips, tongue height and position, lowering of the mandible, and hyoid bone positioning [21]. The lack of statistically significant changes in FFs after surgical voice feminisation in our series, in line with the existing literature [22, 23], is attributed to WG's inability to modify the architecture of the SVT, from which the FFs are generated.

Aerodynamic assessment of laryngeal function

Spirometry has a secondary value in the assessment of the vocal organ; it primarily evaluates the pulmonary function and is of fundamental importance in the diagnosis of respiratory diseases, including determining the role of the larynx in breathing difficulties (e.g., associated with lesions narrowing the width of the glottis) [24]. The measurement of vital lung capacity also plays a secondary role during the assessment of phonation – the air exhaled during phonation corresponds to 70–80% (up to 100% in singers) of vital capacity (VC) [24]. One of the so-called aerodynamic indicators of laryngeal function constitutes the phonation quotient (PQ), defined as the ratio of the largest measured VC to the longest MPT, which provides an indirect estimate of glottal airflow. The average PQ values range from 125.8 mL/s to 137 mL/s in females and oscillate between 135 mL/s and 145 mL/s in males [25, 26]. In turn, the average MPT values vary from 17.7 s to 34.6 s in men and from 11.5 s to 25.7 s in women [25, 27], whereas in singers, the MPT might reach 40–60 s [24]. Contrarily, the MPT values below 10 s indicate a significant pathology in the phono-respiratory system [24]. In our study, the results of the spirometric assessment did not differ significantly between the pre- and post-operative periods. Similarly, the MPT did not change significantly following WG, with both pre- and post-operative mean MPT values falling within the physiological range, which suggests the lack of negative WG impact on the aerodynamic function of the vocal organ in our series. Although similar findings were reported in several studies [22, 28–30] concerning WG in transsexual women, Casado et al. reported a significant MPT reduction from 21.4 s to 20.8 s following the surgery [19]. However, despite a tendency towards MPT worsening in 11 out of 18 patients in their series, no patient developed post-operative dyspnoea, which suggests a sufficient glottic space for optimum respiration after WG [19]. Nevertheless, in a meta-analysis performed by Aires et al. [11], a significant MPT reduction by 1.11 s was reported, which might be attributed to the less effective voice production due to the anterior synechia formation during WG, inadvertently changing the anatomy of the vocal organ. Therefore, the restriction of MPT, alongside with the decrease in pitch frequency range, despite not being observed in the present study, are among the risks associated with WG [11, 18]. Through the reduction of pitch variation, these changes might result in a voice considered less natural by external listeners [7], of which the candidates for surgery, especially professional voice users, should be informed.

Notably, obtaining a reliable MPT value depends on properly instructing the patient to take a deep breath and maintain phonation at a comfortable volume for the longest possible time. Additionally, the MPT value is associated with the VC, highly dependable on age, gender, and lower respiratory tract diseases. Determining PQ might therefore be useful in eliminating the measurement inaccuracies related to establishing the MPT. The lack of VC calculation in our study precluded the ascertainment of PQ values — the forced vital capacity (FVC) routinely obtained during spirometry in our clinic might differ from VC, especially in patients with lower respiratory tract diseases [31, 32]. Future large-cohort studies evaluating the PQ in the context of WG in transsexual women are highly warranted to precisely determine the impact of phonosurgery on the aerodynamic indicators of laryngeal function.

To the best of our knowledge, this is the first study incorporating spirometry into the management of transgender women undergoing WG. Notably, the observed lack of significant changes in the assessed spirometric parameters following WG in our series does not necessarily reflect the lack of direct WG impact on airflow restriction since spirometry is not dedicated to evaluating the upper respiratory tract. Future implementation of novel modalities such as computational fluid dynamics (CFD), enabling the assessment of airflow patterns and shear stress changes at a given level of the respiratory tract, might aid in quantifying aerodynamic changes specifically in the larynx following surgical intervention [33]. Nevertheless, due to the limited availability of CFD, this technique is currently applied predominantly in scientific research; however, it would be of great interest to further evaluate its usefulness in predicting the impact of WG on airflow restriction and to assess its reliability in routine clinical practice regarding the transsexual patients.

Voice-related QoL assessment

When analysing the usefulness of medical procedures, in recent years increasing emphasis has been placed on considering the QoL of patients undergoing various therapeutic interventions. To assess the effectiveness of surgical voice feminisation, apart from the measurable acoustic changes, the patient's satisfaction with the procedure should be considered since it largely contributes to therapeutic success. In our series, the mean postoperative VHI-30 score, despite showing a significant improvement compared to the preoperative period, exceeded 30 points, which is associated with moderate voice-related difficulties. Since several authors have reported the additional benefits regarding voice-related QoL seen after VT and WG compared to WG alone [19, 34], an even greater decrease in VHI score in our series could have presumably been obtained after incorporating VT into the routine management of transsexual individuals in our department. However, the actual contribution of VT to obtaining the feminine pitch remains uncertain, necessitating further research. Nevertheless, a significant score decrease in emotional and functional domains of VHI was observed in our study, reflecting the positive impact of WG on patients' feelings surrounding their voice, as well as on their social and professional activity, respectively.

Furthermore, the mean V-RQOL score diminished significantly from 31.90 points, associated with a high intensity of vocal interference with daily activities, to

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20.40 points, suggesting a considerable improvement in voice-related QoL. Nonetheless, due to the specific difficulties with voice emission among transsexual women, it would be valuable to implement the tools dedicated to this subgroup of patients when assessing the quality of voice and its impact on the QoL. Currently, the most widespread, validated patient-reported outcome measure constitutes the Trans Women Voice Questionnaire (TWVQ), enabling the self-assessment of vocal femininity, the intensity of vocal difficulties, and the extent to which the voice affects the psychosocial aspects of everyday functioning [35]. Due to the retrospective character of our study, we could not obtain TWVQ data in our cohort. We believe that incorporating the TWVQ, as well as external listeners' ratings of vocal femininity before and after WG, could have deepened our understanding of the procedure's success.

Limitations

The limitations of the present study include a small sample size, partially due to the fact that voice feminisation procedures are not performed routinely in our country. To the best of our knowledge, this is the first case series in Poland regarding WG for vocal feminisation in MtF transsexuals.

The lack of standardised perioperative VT protocol and the diversity among the patients regarding VT attendance precluded the analysis of the impact of VT on WG outcomes. Additionally, the quantitative results should be interpreted with caution due to the lack of long-term follow-up data, limiting the determination of the persistence of acoustic outcomes. In our experience, the VFs can eventually pull slightly apart at the posterior end of the webbing, which might contribute to the ultimate F0 decline. Similarly to WG, the decline of the initially increased pitch might be observed following the stand-alone VT [36, 37]; therefore, aiming at comparing the results of the WG with or without VT over the long term in future studies might give a better insight into the role of VT in consolidating the pitch acquired after surgical intervention.

Conclusions

WG constitutes an effective method of surgical voice feminisation in MtF transsexuals with concurrent improvement in their voice-related QoL. Furthermore, it remains a safe procedure without persistent complications and negative influence on the acoustic-aerodynamic measures of the voice.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Ethics approval

The Institutional Review Board of the Ethics Committee of Medical University of Silesia in Katowice, Poland, approved the study protocol (No. BNW/NWN/0052/KB/267/23).

Consent to participate

Informed consent was obtained from all participants involved in the study.

Availability of data and material

The data generated during this study are available within the article. Datasets analysed during the current study preparation are available from the corresponding author upon reasonable request.

Authors' contributions

Conceptualisation — M.M.; methodology — M.M. and A.K.; formal analysis — A.K.; data curation — M.R., M.Z., and A.K.; writing — original draft preparation: M.R.; writing — review and editing: M.M. and M.Z.; visualization — M.R. and M.Z.; supervision — M.M. and M.Z. All authors have approved the final version of the manuscript.

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