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# Quantifying the impact of androgen therapy on the female larynx<sup>☆</sup>

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## Abstract

**Objective:** To describe the timing of changes in fundamental frequency of the female voice following androgen therapy during female to male gender reassignment.

**Methods:** A 33-year-old female semi-professional singer undergoing gender reassignment and intramuscular androgen injections was examined at monthly intervals to monitor the impact of therapy on the voice. Laryngostroboscopy and acoustic analysis were performed simultaneously to monitor for potential laryngeal pathology.

**Results:** Pretreatment mean fundamental frequency (MF<sub>0</sub>) was 228.45 Hz and ranged from 140.26 Hz to 430.64 Hz. Between month 3 and month 4 of treatment, MF<sub>0</sub> declined to 116.52 Hz and ranged from 90.75 Hz to 201.07 Hz. Shimmer increased from 3.4% to 7.8%. Noise to harmonics ratio (NHR) also increased from 0.12 to 0.17. The patient has continued to sing semi-professionally despite these changes in laryngeal function.

**Conclusion:** Androgen therapy exerted a profound change on mean fundamental frequency between the third and fourth months of treatment. In addition, pitch range was reduced in a commensurate fashion. Patients undergoing androgen therapy may undergo a significant change in speaking voice between the third and fourth months of therapy. Moreover, though these changes may exert a profound impact on the singing voice, patients undergoing gender reassignment may still be able to achieve personal and professional success in their singing careers.

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**Keywords:** Larynx; Female; Transgender; Testosterone; Voice

## 1. Introduction

The importance of hormonal influences on the normal maturation and development of the human larynx has long been recognized. Testosterone exerts profound effects on the development of the human larynx, particularly in females exposed to exogenous testosterone. Grossly, these effects are seen as a lowering of the pitch of the voice, and prominence of the thyroid cartilage. There is relatively little quantitative data, however, on the exact timing and magnitude of voice changes in adult females exposed to exogenous testosterone.

## 2. Report of case

This work was reviewed and approved by the Institutional Review Board of the Stanford University Medical Center. A 33-year-old female attorney and semi-professional jazz singer undergoing gender reassignment was followed clinically over a 16-month period during her transition from female to male gender. The patient was treated with testosterone ethanate 200 mg intramuscularly bimonthly. Voice analysis and laryngostroboscopy were made prior to the onset of hormone therapy and monthly thereafter for the first 6 months, then every 3–6 months over the next 16 months. Laryngostroboscopy was performed using a rigid endoscope and digital stroboscopy system (Model 9295, Kay/Pentax, Lincoln Park, NJ). Voice samples were obtained with a unidirectional dynamic microphone (Shure, SM48, Niles, IL). A sustained/a/at habitual loudness and pitch was recorded for 5 s. Acoustic parameters including

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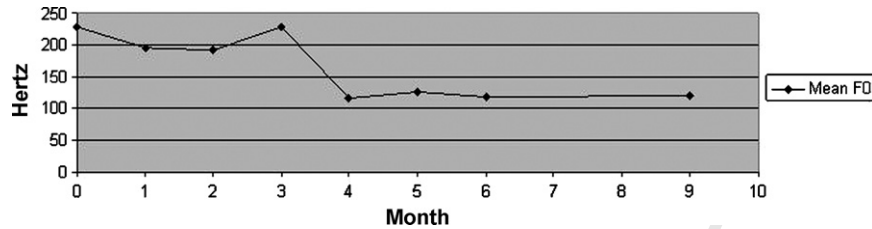


Fig. 1.

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mean fundamental frequency ( $MF_0$ ), shimmer, noise to harmonics ratio (NHR), and voice turbulence index (VTI) were measured using the Digital Strobe Voice Analysis Program (Model 9223, Version 2.6.2, Kay/Pentax, Lincoln Park, NJ).

$MF_0$  decreased from 228.47 Hz to 112.74 Hz (S.D.  $\pm$  27.46). The patient experienced a marked decline in  $MF_0$  between the third and fourth months of treatment (Fig. 1). Overall there was a marked shift and contraction of pitch range. Maximum  $F_0$  declined from 338.49 Hz to 201.07 Hz. Minimal  $F_0$  showed a smaller decline from 140.26 Hz to 90.75 Hz (Fig. 2). Shimmer increased from 3.39% to 7.79% (S.D.  $\pm$  0.79%) (Fig. 3). NHR increased from 0.12 to 0.17 (S.D.  $\pm$  0.01) (Fig. 4). VTI increased

from 0.029 to 0.073 (S.D.  $\pm$  0.01). Endoscopically, no gross morphological changes were noted.

From a clinical standpoint, the patient tolerated the transition well. The patient continued to work full-time. After an initial respite from singing, the patient began work with a voice instructor approximately 6 months into treatment. A mezzo soprano prior to transition, the patient now performs as a baritone, and, stylistically, continues to sing in the jazz and pop genres. The patient has released several albums as well as a music video, all of which have met with critical and commercial success.

### 3. Discussion

While voice change following androgen therapy has long been recognized, the exact timing, quality, and nature of change in patients who undergo therapy are not well characterized. This process is better characterized in males than in females. For example, in males undergoing androgen therapy for idiopathic hypogonadotropic hypogonadism (IHH), a change in mean fundamental frequency occurs somewhere between the 10th day and third month of treatment, with a decline in  $MF_0$  from an average of 229 Hz to 173 Hz [1]. Patients with IHH have a pretreatment  $MF_0$  near that of normal females and a post treatment  $MF_0$  which is near but somewhat higher than that of normal males. Prior reports in male singers undergoing testosterone replacement have noted the following: increase in vocal range after 2 weeks; loss of high notes with deepening of speaking voice in 4 weeks; difficulty with pitch control and subsequent stabilization at 6 months; and persistent vocal control problems with unstable vibrato [2].

Androgen exposure in female patients, such as is seen in congenital adrenal hyperplasia or from treatment with exogenous testosterone results in androglottia (masculine voice characteristics with typical male prominentia larynges) [3]. Histologically, testosterone administration produces thyroarytenoid muscle fiber hypertrophy and hyperplasia, epithelial parakeratosis and squamous metaplasia, and hyperplasia of seromucinous glands after 4 weeks and which is permanent after 8 weeks [4]. Perceptually, females undergoing gender reassignment have noted voice changes from anywhere from a few weeks to more than a year after starting testosterone therapy as well as

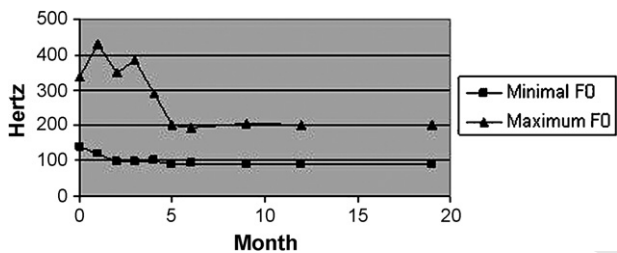


Fig. 2.

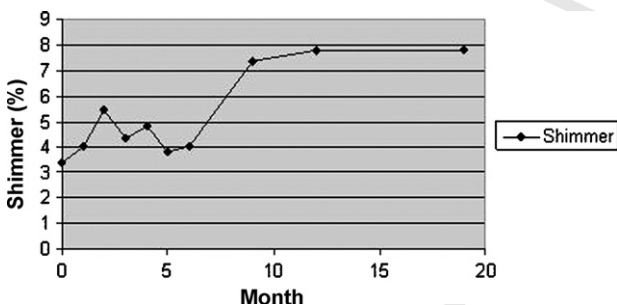


Fig. 3.

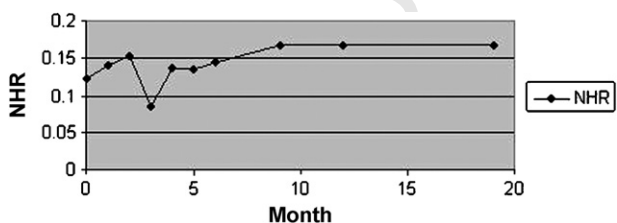


Fig. 4.

114 decreased pitch range and singing ability, although these  
115 changes are not well quantified [5].

116 In this patient, testosterone exerted a profound  
117 reduction in mean fundamental frequency within 3-4  
118 months of exposure. This was accompanied by a marked  
119 lowering and contraction of pitch range which, after  
120 almost 2 years, has remained stable. Despite these  
121 changes, the patient proved capable of continuing to  
122 work full-time as an attorney. In addition, after adapting to  
123 these changes, the patient was able to resume singing at a  
124 level which afforded personal and professional gratifica-  
125 tion. Because the data presented in this report represent  
126 the experience of a single patient, it is impossible to draw  
127 sweeping conclusions for all patients considering female  
128 to male gender reassignment. Closer scrutiny of the  
129 impact of androgen therapy on the female voice should be  
130 undertaken to more accurately quantify the changes to  
131 fundamental frequency and pitch range, as well as the

131 timing of these changes. It will also be important to  
132 determine whether or not the timing and degree of voice  
133 change is consistent from patient to patient.  
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## References

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- [1] Akcam T, Bolu E, Merati AL, Durmus C, Gerek M, Ozkaptan Y. Voice changes after androgen therapy for hypogonadotropic hypogonadism. *Laryngoscope* 2004;114:1587-91.
  - [2] King A, Ashby J, Nelson C. Effects of testosterone replacement on a male professional singer. *J Voice* 2001;15:553-7.
  - [3] Furst-Recktenwald S, Dorr HG, Rosanowski F. Androglossia in a young female adolescent with congenital adrenal hyperplasia and 21-hydroxylase deficiency. *J Ped Endo Met* 2000;13:959-62.
  - [4] Talaat M, Talaat AM, Kelada I, Angelo A, Elwany S, Thabert H. Histological and histochemical study of effects of anabolic steroids on the female larynx. *Ann Otol Rhinol Laryngol* 1987;96:468-71.
  - [5] Van Borsel J, De Cuypere, Rubens R, Destaeke B. Voice problems in female-to-male transsexuals. *Int J Lang Comm Dis* 2000;35:427-42.

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