Types of Testosterone Therapy and their Effects on the Voices of Transgender Singers

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INTRODUCTION

In order better to navigate the vocal challenges faced by transgender singers, voice teachers and singers must understand the vocal effects of hormone therapy. Testosterone therapy is the only type of hormone therapy that permanently changes the voice and most often results in a dramatic lowering of a person's spoken fundamental frequency.[1] Due to such a radical shift, the process of vocal change can be turbulent. This turbulence is further exacerbated depending on the type of testosterone therapy undergone, whether it be the pill, the patch, or the injection, to name a few.

Testosterone therapy is also the only type of hormone therapy with an accompanying myth that transgender singers will lose their singing voice should they undergo it. Despite being the only type of hormone therapy that permanently changes and lowers the voice, many professional and nonprofessional singers to date have successfully navigated this vocal transition and maintained a singing career.[2] Drawing from a multitude of sources, including clinical studies with both transgender singers and hypogonadal (testosterone deficient) cisgender men, one to one interviews, and analysis of recordings of professional transgender singers, this article maps the vocal changes that will occur during the first two years of testosterone therapy and how the process of vocal change varies based on the form that the therapy takes. The information contained in this article is designed to help transgender singers and their singing teachers understand what to expect vocally during the initial vocal changes that occur on testosterone therapy in order to build awareness around and facilitate the accommodation of this period of rapid vocal change.

BACKGROUND

Hormone therapy (HT) is the administration of hormones in an attempt to relieve gender dysphoria by obtaining the phenotype and vocal quality of one's gender identity.[3] Gender dysphoria is the distress accompanying the juxtaposition between assigned gender at birth and gender identity.[4] The two most common types of HT are testosterone therapy and estrogen therapy.[5] This article will focus on testosterone therapy because it is the form of HT resulting in the most vocal change.[6]

In the transgender community, testosterone therapy is undergone by transgender people assigned female at birth (AFAB) who may identify within a number of categories, including nonbinary, gender queer, or transmasculine. Testosterone therapy in transgender recipients is generally utilized in order to "induce and maintain virilization and testosterone levels within the normal male range," which is 300–1000mg/day.[7] For transgender recipients who do not identify as transmasculine or within the gender binary, such as gender queer and nonbinary persons, a lower sustained dosage of testosterone may be desired. Currently, testosterone therapy can be undergone only after a one reaches 16 years of age.[8] Those who choose to undergo testosterone therapy may choose to do so temporarily or for an indefinite period of time—potentially for the rest of their lives.

THE VOCAL TRANSITION ON TESTOSTERONE

Laryngeal and Other Anatomic Changes

The hormonal shift that occurs for transgender recipients on testosterone therapy is often compared to the hormonal shift during puberty experienced by people assigned male at birth. This comparison is relevant because of the newly high levels of testosterone introduced to the body and the few similar physical changes that occur. In regard to the larynx, the only similar change that occurs is the thickening of the vocal folds both vertically and horizontally.[9] The thickening of the vocal folds during "male" puberty, however, usually occurs during the latter half of puberty, whereas transgender people on testosterone experience vocal fold thickening within the first four months.[10] Additionally, the vocal folds do not become as thick as average "male" vocal folds post puberty.[11]

While the vocal folds of transgender testosterone therapy recipients *thicken*, there is no evidence as yet that the vocal folds *lengthen.* This is due to the lack of growth of the laryngeal cartilage, which, in turn, is likely because of cartilage ossification, or the process by which cartilage becomes more rigid and eventually turns to bone beginning at age twenty.[12] Incidentally, testosterone also is known to lead to early ossification, and the majority of transgender testosterone therapy recipients have already undergone puberty. The absence of cartilage growth during testosterone therapy also may be due to the use of testosterone without growth hormone, as it is the combination of these two hormones that results in cartilage development during "male" puberty.[13] Although individual anecdotes, particularly of transgender testosterone therapy recipients under age 30, assert that the facial bone structure also shifts during testosterone therapy, there is no clinical evidence to date that testosterone therapy results in growth of the pharynx, chest cavity, or lungs.[14] Thus, testosterone therapy in regard to the vocal mechanism is proven only to change the thickness of the vocal folds.

Vocal Change

In order to maintain and facilitate the transition of the singing voice during testosterone therapy, it is important to understand how these anatomic changes affect the singing voice. Singers and their voice teachers need to understand what kind of vocal change and vocal side effects to expect, when to expect them, and why they occur, particularly during those first two turbulent years on testosterone. The primary effect on the singing voice on testosterone therapy, and in fact the reason that many recipients undergo this therapy, is the lowering of the voice. Often, the tessitura of a gender variant tenor, baritone, or bass will be three semitones lower than the cisgender voice type equivalent, although the voice may never be as powerful.[15]

Despite vocal fold thickening, some individuals do not experience any lowering of the voice.[16] At the same time that testosterone therapy irreversibly thickens the vocal folds, it can also make them uneven and alter the connective tissue of the vocal ligaments so that blending registers is more difficult.[17] Phonation breaks may also be due to the lack of significant cartilage growth, in which case the vocal folds have limited ability to stretch or lengthen.[18]

Resonance Change

Though clinical evidence claims that cartilaginous growth and vocal fold lengthening do not occur for transgender recipients of testosterone therapy—leading potentially to entrapment—some anecdotal evidence suggests the opposite. Several interviewees reported having a more pronounced Adam's apple through testosterone therapy, which would occur through cartilaginous

growth.[19] Nevertheless, the typical lack of cartilaginous growth coupled with vocal fold thickening in transgender recipients of testosterone results in a unique vocal timbre, which might be characterized as a lean sound. While speech masculinization techniques can help "round" resonance for those who would like to have a vocal timbre closer to cisgender "male" voices, some timbral differences will always be present.[20] Additionally, the singing voice after testosterone therapy will never completely resemble the typical range and tessitura of a cisgender tenor, baritone, or bass.[21]

Entrapment

The lack of ability to stretch the vocal folds, or the vocal fold thickening coupled with the absence of cartilaginous growth and vocal fold lengthening, may result in what has been referred to as "entrapment." Entrapment is the encasing of thickened vocal folds within an already established laryngeal structure resulting in a highly pressurized, weak, and permanently hoarse sound that lacks the "right" harmonics.[22] Entrapment has been found to occur more commonly in testosterone therapy recipients above the age of forty, which is not the only case of testosterone therapy resulting in divergent effects depending on age.[23] In two transgender individuals above the age of fifty, testosterone therapy caused permanent hoarseness, lack of vocal control and quality, and limited vocal power.[24] In these instances, the singing voice was no longer adequate and the larynx did not descend properly.[25]

Entrapment may also be equivalent to hyperfunctional voice use, or extralaryngeal tension and overadduction of the vocal folds.[26] It is common for AFAB people undergoing testosterone therapy to "develop hyperfunctional voice production" in order to "force out" lower notes of the emerging lower range due to timbral differences between the cisgender "male" voice and the AFAB voice on testosterone.[27] Anecdotal evidence also suggests that persistent hoarseness and weakness in the voice can occur through testosterone therapy irrespective of age.[28] Similar to "male" puberty, this persistent hoarseness and weakness regardless of age is likely due to testosterone's ability to enflame the vocal folds.[29] Additionally, testosterone can lead to early ossification, which results in less vocal flexibility and exacerbation of typical vocal transitional issues.[30]

Periods of Heavy Mutation

Vocal side effects of testosterone therapy vary from person to person, but there are a few landmarks along the way. Most recipients report noticeable lowering of the voice and therefore the thickening of the vocal folds at three months on testosterone. Other vocal side effects reported within the first three month include mild hoarseness, loss of vocal control, and more pronounced registral changes. These side effects are a result of inflammation, which is often localized within the larynx.[31] Three months appears to be a clear turning point in the process of vocal change on testosterone therapy. For this reason, it may be categorized as a period of heavy mutation.

The second potential period of heavy mutation may occur at five months on testosterone. At this point, the separation between different registers becomes more established and difficult to manage, and several recipients reported that they were able to sing an octave below their lowest sung note prior to testosterone. The third period of heavy mutation is around month eight. At that time, voice cracks and breaks both while singing and speaking occur with more frequency, and the *passaggio* between what was previously the "female" head voice (now falsetto) and chest voice is now more apparent. In fact, there may be little accessibility (if any) in the acoustic region between the chest voice and the falsetto for a period of time.

These periods of heavy mutation may not be a healthy period during which to challenge or stretch the voice. Instead, these are periods during which vocal exercises should remain scalar and within a small range, and open vowels and loud singing should be avoided.[32] Any repertoire sung at this point in the vocal transition should be made to fit the voice, not vice versa. It is still crucial, however, to continue to sing throughout the process of vocal change in order to maintain vocal health and to process the ways in which the singing voice is shifting.[33]

Periods of Relative Stability

In addition to periods of heavy mutation, there also appear to be periods of relative stability in the vocal change process on testosterone therapy during the first two years. The first period of relative vocal stability is at six months. At six months, reports have included some stability in the spoken fundamental frequency and some control of the singing voice. Six months is also a point at which there are fewer reports of cracking and break-

Table 1. Vocal Change Trajectory of Transgender AFAB People on Testosterone Therapy.[34]

Time (since beginning Testosterone therapy)	Vocal Change Trajectory
Week 1	• tightness in the voice • necessity to "reach" for the higher notes
Week 2	• may be possible to sing lower than ever before
Month 1	• voice feels scratchy and hoarse • constant need to clear throat • voice beginning to drop • highest notes in the singing voice are lost • fundamental frequency of speaking voice begins to drop • difficulty controlling pitch • register changes and phonation breaks
Month 2	• some reported no change in fundamental frequency of voice yet • lowered voice • potentially largest voice drop period • development of a falsetto but unstable • difficulty producing a clear singing tone • lowest sung pitch drops a third • mix between chest and head voices is no longer present • highest sung pitch raises a whole tone • lower *passaggio* (B_3-E_4) is noisy, breathy, and strained in chest voice
Month 3	• beginning of voice deepening process for some • potentially largest voice drop period • speaking voice dropped a third • potential use of chest voice up to A_4→ transition to tenor voice type • everything above E_5 was unavailable or too "noisy" • "female" head voice is still present • unstable middle range • cracking becomes frequent • may experience laryngitis • "sounded like I had a cold" • start losing some of higher register notes
Month 4	• little overall change • potentially largest voice drop period • head voice turning more into pure falsetto • falsetto is weak and hollow • may experience laryngitis • may start losing some higher register notes

(continued)

ing occurring during singing and speaking. The second period of relative stability is at one year, when the spoken fundamental frequency is beginning to stabilize, vocal stamina improves, and vocal control begins to return. These periods of relative stability are periods during which a singer could feasibly attempt exercises with a wider vocal range and more intervallic movement.

Vocal Change Trajectory Chart

For more detail on reported vocal changes and side effects during the first two years of testosterone therapy, the chart in Table 1 maps the experiences of over 50 recipients. Of the information gathered from transgender testosterone recipients below, age ranged from early 20s to late 50s, and each person was on a different or

Table 1 (continued).

Time (since beginning Testosterone therapy)	Vocal Change Trajectory
Month 5	• ability to sing in falsetto but still unstable, especially around the *passaggio* (B_3/C_4) • unease in transitioning between chest voice and falsetto • speaking voice fundamental frequency dropped an octave • upper falsetto is still weak and turns over into an even lighter production at G_4 • chest voice is strong up to F_4 • may start losing some of higher register notes • difficulty registering and producing pitches in newly lowered chest voice
Month 6	• falsetto still weak and "of two qualities" • fundamental frequency of the speaking voice and control of the voice stabilize • lower singing range may begin developing and cracking may become less frequent • adam's apple becomes more prominent • begin gaining low notes and losing high notes • breaking and cracking become more frequent and loss of notes in the *passaggio*
Month 7	• mixed register decreases • larynx becomes wider • breaking and cracking become more frequent and loss of notes in the *passaggio*
Month 8	• total voice break • breaking and cracking become more frequent and loss of notes in the *passaggio*
Month 9	• bass/baritone range potential but weak • no mixed range • break into falsetto around C_4 but falsetto is strong/flexible • breaking and cracking become more frequent and loss of notes in the *passaggio*
Month 10	• vocal stamina improvement after consistent practice • varied dynamics possible again • breaking and cracking become more frequent and loss of notes in the *passaggio*
Month 12	• beginning of range stability as tenor, baritone, or bass • light head voice still relatively present • continued hoarseness, lack of control and color, and limited power • overall decrease in range from lowest to highest sung note
2 Years	• maximum deepening of voice • continued hoarseness, lack of control and color, and limited power • range settled • vocal fatigue no longer present

indeterminate regimen of testosterone therapy administration. The singers whose experiences are reported here varied in experience level from hobby to professional. Vocal change may continue to occur after two years on testosterone therapy either due to the therapy itself or the process of ossification, which occurs naturally with age.

As one might have noticed from the chart, the vocal change and side effects during the first two years of testosterone therapy do not necessarily demonstrate any consistencies, due to the varied means of administration of the recipients whose reports have created this chart, as well as the variability of the body's reaction to hormones. Nevertheless, the recipients reporting in this chart generally experienced nonlinear vocal side effects during the first two years on testosterone, which is also made clear by the fluctuating periods of heavy mutation and relative stability discussed earlier.

Since the body is a mercurial instrument, anything is possible on any given day. Therefore, what is most important in working with the transitioning voice of a

Table 2. Testosterone Therapy Options.[35]

Type	Frequency/Dosage	Pros	Cons
Testosterone Injection (Parenteral Testosterone: testosterone cypionate or enanthate)	• intermuscular injection once every 1–4 weeks • 100–250 mg	• widely available/most common	• may lead to highs/lows in energy and mood between doses (exacerbated with biweekly, triweekly, and monthly injections) • vocal changes not always consistent from time of administration to end of shot cycle
Testosterone Patch (Transdermal Testosterone: Androderm)	• patch worn and replaced every day on upper arm, back, thigh, or stomach • 2.5–10 mg/day	• hormone administered at consistent rate eliminating highs/lows in energy and mood	• slower rate of bodily change means less rapid easing of gender dysphoria
Testosterone Gel (Transdermal Testosterone: Androgel or compounded testosterone gel/cream)	• gel/cream applied to skin at same time each day • 25–100 mg/day	• hormone administered at consistent rate, mimics "normal physiological male" circadian rhythm of testosterone • testosterone concentrations can be unpredictable	• highest, sustained overall dosage resulting in potentially most rapid vocal change, which may exacerbate vocal inflammation • may expose scene partners to the hormone through contact with the gel
Testosterone Pill (testosterone undecanoate)	• pill taken 1–3 times daily • 40–240 mg/day	• hormone administered at consistent rate eliminating highs/lows in energy and mood	• can cause laryngopharyngeal/acid reflux • most of hormone is lost during digestive process resulting in slow vocal change and less rapid easing of gender dysphoria
Testosterone Pellet (Testopel)	• 2–6 pellets implanted subcutaneously (under the skin) every 3–6 months • each pellet contains 75 mg	• hormone administered at consistent rate eliminating highs/lows in energy and mood	• slower rate of bodily change means less rapid easing of gender dysphoria

transgender person is being extremely compassionate to individual needs. This chart shows the possibilities for vocal side effects during the first two years on testosterone so that a teacher of a transgender singer and a transgender singer can account for those possibilities, and to abate the feeling of loneliness by singers undergoing this vocal change.

TESTOSTERONE THERAPY OPTIONS

To date, there are five existing means of testosterone therapy administration. Additional means vary by country. Table 2 provides the basics of testosterone therapy administration options and an assessment of the advantages and disadvantages of each option as it applies to voice production. As will be evident from the chart and subsequent analysis, each type of testosterone therapy is unique in its relation to vocal change and vocal side effects. It is important for singers and their voice teachers to be aware of the particularities of each type of testosterone therapy as it applies to the voice in order to more easily account for and manage the resulting change.

Additional General Vocal Side Effects

The negative side effects of testosterone therapy—mood swings, energy highs and lows, unpredictable testosterone concentration levels—are directly proportional to dosage and length of time between administrations.[36] The total period of time that a person is on testosterone therapy does not necessarily affect the magnitude of or frequency of negative side effects.[37] In other words, the

side effects of testosterone therapy will not necessarily subside with time. Therefore, if a person is on testosterone therapy for their entire life, they may experience side effects from the therapy for their entire life. However, as evident in the previous chart, anecdotal evidence suggests that the voice and the body may experience a "settling" after two years on testosterone therapy, and periods of relative stability leading up to two years, as discussed earlier. Since negative side effects are influenced by dosage, it is important to note that, while there are international variations, most people undergoing testosterone therapy are either recommended to begin with or choose to begin with the highest recommended dosage.[38]

Testosterone Injection

The highest recommended dosage of testosterone administered at one time is through injection. Testosterone injection is the most popular of testosterone therapies because it is the cheapest and most convenient in that it does not require daily administration on the part of the recipient. It is also popular because, due to a larger initial dosage, it often results in a lowered speaking voice and the development of the "male" or androgynous phenotype quicker than lower initial dosage alternatives, which is desirable in order to ease gender dysphoria as soon as possible. However, this form of testosterone therapy may result in one of the most turbulent singing voice transitions.

Due to the high testosterone dosage and its being administered all at once at less frequent intervals, the voice fluctuates often between injections, and it is accompanied by potentially extreme fluctuations in mood and energy.[39] A high dose of testosterone administered all at once may initially result in vocal fold thickening occurring at a faster rate, therefore potentially causing more dramatic vocal inflammation that results in more dramatic hoarseness and loss of vocal control. A longer digestion period between administrations of testosterone will mean vocal change may not be consistently sustained from initial injection through the time of next injection, again exacerbating the negative side effects reported in Table 1. Given these potential side effects, testosterone therapy by injection is potentially one of the most difficult to manage vocally because it offers less hormonal stability resulting in less vocal stability. The additional effect of fluctuations in mood and energy may result in lack of breath control necessary for singing, as well as the motivation and concentration needed for sustained practice.

Testosterone Patch

The testosterone patch allows for testosterone to be administered and absorbed by the body at a more consistent rate than injection because the patch has a lower dosage and is replaced with a patch of the same dosage every day. Due to the body's consistent rate of absorption through this means, the potential for fluctuation in energy and mood is much smaller. This form of testosterone administration is the most gradual of the five options listed in Table 2, which means vocal change may also be more gradual and therefore potentially easier to manage. However, the rate of vocal and phenotypical change may not be rapid enough to ease severe gender dysphoria. Thus, while the testosterone patch may seem like an option in which vocal change could be more easily managed, this may be at the expense of overall emotional health.

Testosterone Gel

With the transdermal gel, testosterone is absorbed by the body at a consistent rate, but with a much higher dosage than the patch, and with an unpredictable concentration of the hormone.[40] In fact, due to its frequency, testosterone gel results in a much higher sustained dosage than injection: a recipient of the gel absorbs ~100mg of testosterone *per day*, while a recipient of injection absorbs ~100mg of testosterone *per week*. Thus, the gel carries the same negative vocal side effects as injection and potentially even more rapid vocal change than injection. However, the gel mimics the "normal physiological male" circadian rhythm of testosterone release and absorption, therefore allowing for a vocal change rate potentially similar to that experienced during "male" puberty on which topic of vocal transition much has already been published.[41] An additional negative side effect of the gel, which is relevant to singing actors, is the potential to expose others to the hormone through bodily contact prior to the body's full absorption of the gel daily.[42] This may result in less freedom of movement and expression when singing with a scene partner.

Testosterone Pill

The testosterone pill, similar to the patch and the gel, allows for bodily absorption of testosterone at a consistent rate. While dosage per pill is higher than the gel and injection, and multiple pills may be ingested per day, most of the testosterone is digested before it can be absorbed into the body.[43] The pill is known to cause laryngopharyngeal reflux or acid reflux, which notoriously results in laryngeal inflammation. Inflammation in turn results in hoarseness, among other negative vocal side effects.[44] Therefore, the negative vocal side effects of testosterone therapy listed in Table 1 may be exacerbated by the additional side effect of acid reflux with testosterone ingested in pill form.

Testosterone Pellet

The testosterone pellet is the oldest administration of testosterone therapy, but also one of the least common.[45] Though in frequency of dosage it is similar to injection, the body absorbs testosterone in pellet form beneath the skin at a more consistent rate than it absorbs testosterone via injection. Therefore, along with the patch, it is one of the most gradual means of testosterone administration. For this reason, the rate of vocal and overall physical change similarly may not be rapid enough to ease severe gender dysphoria, and so it may not be an accessible option for emotional health.

Mixed Regimen

Not listed on the chart is the option to receive testosterone therapy through a mixed regimen or to intake testosterone by multiple simultaneous means. For example, transgender singer and researcher Alexandros Constansis underwent testosterone therapy through bimonthly 100mg injections and daily 40mg pills.[46] This may be an appealing option in order to find a happy balance between dosage and consistency of absorption that results in the vocal change necessary to relieve gender dysphoria, while also allowing a gradualness to ease the vocal change side effects listed in Table 1. Due to the yet uncommonness of this means of testosterone therapy, more evidence is needed to draw further conclusions about how it applies to the voice.

CONCLUSION

In analyzing testosterone therapy as it applies to the voice and variations through means of administration, it is certain that testosterone therapy for the transgender singer will result in a dramatic, permanent vocal shift. However, the ability to sing will never be lost through testosterone therapy, as evident by the list of professional singers in the notes who have successfully navigated the vocal changes brought on by testosterone therapy. In navigating this vocal change, understanding the potential side effects of each means of testosterone therapy and how those side effects manifest vocally is paramount to a smooth vocal transition. It is also crucial that voice teachers internalize the above information in order to understand and aid in the vocal changes that a transgender student will experience on testosterone therapy, especially if the voice teacher is cisgender and/or will never experience this vocal transition first hand. This information also has been presented with the hope that singers undergoing testosterone therapy may feel less isolated in coping with their vocal change.

Much still needs to be determined and discovered in regard to testosterone therapy and its effects on the voice. One important research team continuing to undertake this research is Ari Agha and Laura Hynes whose ongoing investigation is periodically reported on keyoft.com. In undergoing this research, I am indebted to the generosity of Phoenix Transgender Community Choir in Broomfield, Colorado founded by Sam Bullington. It is thanks to the openness of the Phoenix members that I was able to learn and collect information for this research, so that this information might be widely accessible and available to others experiencing or assisting in managing this vocal change.

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45. Carruthers, Cathcart, and Feneley, 217.
46. Meriggiola, 599; Constansis, "The Changing FTM Voice."

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