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PROMENE NIVOA POLNIH HORMONA SA STARENJEM I NJIHOV UTICAJ NA GLAS

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SAŽETAK

Cilj ovog preglednog rada je da pruži uvid u savremena istraživanja etiologije, patofiziologije i simptomatologije promena u nivou hormona povezanih sa starenjem i njihovoj uzročno-posledičnoj vezi sa kvalitetom glasa, sa posebnim osvrtom na analizu različitih vrsta mutacija (*mutatio precox* i *mutatio perversa*), menstrualnih i klimakteričnih disfonija. Glas se smatra važnom sekundarnom seksualnom osobinom koja daje samostalan pečat karakteru i ličnosti pojedinca. Poremećaji endokrinog sistema u mnogim slučajevima utiču na kvalitet glasa i mogu da dovedu do brojnih patologija glasa. U poređenju sa muškim glasom, ženski glas ne prolazi kroz drastične promene u toku puberteta. Kod muškaraca, povećani nivoi testosterona i dihidrotestosterona tokom puberteta odgovorni su za povećanje hrskavice larinksa što prouzrokuje smanjenje bazalnog tona za trećinu oktave. Ukoliko dete prevremeno uđe u pubertet ova neravnoteža hormona dovešće do pojave patologije glasa - *mutation precox*. *Mutatio perversa* se javlja iznenada kod osoba ženskog pola i karakteriše je dubok muški glas i drugi znaci virilizacije. Pojava submukoznog krvarenja u periodu pre menstruacije i povećano lučenje estrogena koje dovodi do pojave edema prouzrokovaće *disfoniju premenstrualis*. Kvalitet glasa u ovom periodu karakteriše vokalni zamor, smanjen opseg glasa sa gubitkom visokih tonova, gubitak vokalne snage i pojava hrapavosti glasa. Menopauzni vokalni sindrom karakteriše se smanjenom fleksibilnošću i smanjenim opsegom vibracione amplitude. Može se zaključiti da su glasnice ciljani organ, osetljiv na fluktuaciju u nivou polnih hormona usled fiziološkog procesa starenja i nastalih endokrinih poremećaja tokom života.

Ključne reči: polni hormoni, poremećaji glasa, glas i starenje

Uvod

Glas se smatra važnom sekundarnom polnom osobinom koja daje samostalan pečat karakteru i ličnosti pojedinca. U dubokom uticaju polnih hormona na karakteristike glasa posreduju hormonski receptori prisutni u glasovnom aparatu (1). Laringealne strukture su izložene spoljašnjem okruženju, što stalno dovodi do glasovnih promena (2).

Nivo hormona u ljudskom telu se menja sa godinama. Promene u nivou hormona koje se javljaju tokom starenja tela razlikuju se kod muškaraca i žena. Iako u telu postoji mnogo hormona, postoje dokazi koji ukazuju na to da promene u nivou polnih hormona, hormona štitne žlezde i hipofize imaju direktan uticaj na glas (3).

Ljudski glas je usko povezan sa endokrinim sistemom pojedinca. Gonadni i tiroidni hormoni igraju glavnu ulogu u promenama glasa, a sve druge hormonske osovine igraju manju ulogu u proizvodnji glasa. Hormonski uticaj na glas traje tokom čitavog života pojedinca i različit je kod muškaraca i žena. Ove promene su posebno važne kod vokalnih profesionalaca kao što su nastavnici i pevači. U tom smislu, kliničari treba da imaju visok indeks sumnje da identifikuju endokrinu abnormalnost sa neobjašnjivom promenom glasa (4).

Kada endokrine žlezde odstupe od normalnog funkcionisanja, mnoge funkcije u telu osećaju posledice. Poremećaji endokrinog sistema u mnogim slučajevima utiču na kvalitet glasa i mogu dovesti do brojnih patologija. Najčešći poremećaji glasa uzrokovani poremećajima u lučenju polnih hormona su: različite vrste mutacija (*mutatio precox* i

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REVIEW ARTICLE

CHANGES IN THE LEVEL OF SEX HORMONES WITH AGING AND THEIR INFLUENCE ON THE VOICE

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SUMMARY

The aim of this study is to review modern literature to provide an insight into contemporary research into the etiology, pathophysiology and symptomatology of changes in hormone levels associated with aging and their pattern-consequential relationship with voice quality, with special reference to the analysis of different types of mutations (*mutatio precox* and *mutatio perversa*), menstrual and climacteric dysphonia. The criteria for inclusion of works obtained from the search were: works published during the last 15 years, published in English. Compared to the male voice, the female voice does not go through drastic changes during puberty. In males, the increased levels of testosterone and dihydrotestosterone during puberty are responsible for the enlargement of the laryngeal cartilage, which causes the basal tone to decrease by a third of an octave. If the child enters puberty prematurely, this hormone imbalance will lead to the appearance of voice pathology - mutation precox. *Mutatio perversa* occurs suddenly in females and is characterized by a deep male voice and other signs of virilization. The appearance of submucosal bleeding in the period before menstruation and the increased secretion of estrogen that leads to the appearance of edema will cause premenstrual dysphonia. Voice quality in this period is characterized by vocal fatigue, reduced voice range with loss of high tones, loss of vocal power and hoarseness of voice. Menopausal vocal syndrome is characterized by reduced flexibility and a reduced range of vibrational amplitude. It can be concluded that the vocal cords are a target organ, sensitive to fluctuations in the level of sex hormones due to the physiological aging process and the resulting endocrine disorders during life.

Key words: sex hormones, voice disorders, voice and aging

Introduction

The voice is considered an important secondary sexual trait that gives an independent seal to the character and personality of the individual. The profound influence of sex hormones on voice characteristics is mediated by hormone receptors present in the vocal apparatus (1). Laryngeal structures are exposed to the external environment, which constantly leads to voice changes (2).

The level of hormones in the human body changes with age. Changes in the level of hormones that occur during the aging of the body differ between men and women. Although there are many hormones in the body, there is evidence to suggest that changes in the levels of sex hormones, thyroid and pituitary hormones have direct effects on the voice (3).

The human voice is closely related to the endocrine system of the individual. Gonadal and thyroid hormones play a major role in voice changes, and all other hormonal axes play a minor role in voice production. The hormonal influence on the voice lasts throughout an individual's lifetime and is different for men and women. These changes are especially important in vocal professionals such as teachers and singers. In this regard, clinicians should have a high index of suspicion to identify an endocrine abnormality with an unexplained voice change (4).

mutatio perversa), menstrualna disfonija i klimakterijska disfonija (5).

Cilj ove studije je pregled savremene literature kako bi se pružio uvid u najnovija istraživanja etiologije, patofiziologije i simptomatologije promena nivoa hormona povezanih sa starenjem i njihovog uzročno-posledičnog odnosa sa kvalitetom glasa, sa posebnim osvrtom na analizu različitih vrsta mutacija (*mutatio precox* i *mutatio perversa*), menstrualnu i klimakterijsku disfoniju.

Metode

U ovom preglednom radu pretražene su elektronske baze podataka *Google Scholar* napredne pretrage i Konzorcijuma biblioteka Srbije za objedinjenu nabavku - KoBSON. U pretrazi su korišćene sledeće ključne reči i fraze: endokrini poremećaji, polni hormoni, polni hormoni i poremećaji glasa, *mutatio falsa*, *mutation precox*, *mutation perversa*, menstrualni disfonični poremećaj, klimakterijska disfonija, starenje i poremećaji glasa. Kriterijumi za uključivanje radova dobijenih pretraživanjem su bili: radovi objavljeni tokom poslednjih 15 godina, objavljeni na srpskom ili engleskom jeziku. Uključeni su u studiju svi radovi koji predstavljaju savremena istraživanja etiologije, patofiziologije i simptomatologije promena nivoa hormona povezanih sa starenjem i njihovog uzročno-posledičnog odnosa sa kvalitetom glasa, sa posebnim osvrtom na analizu različitih tipova mutacija (*mutatio precox* i *mutatio perversa*), menstrualni disfonični poremećaj i klimakterijska disfonija.

Mutacija glasa tokom puberteta - rane mutacije glasa (lat. *mutatio precox*)

Pre puberteta, devojčice i dečaci imaju približno isti raspon glasa. Tokom puberteta, larinks se diferencira i glas prolazi kroz promene koje se obično dešavaju u ovoj fazi. Glasovne promene kod devojčica se javljaju u dve vremenske faze. Između 7. i 8. godine kada glas opada za nekoliko oktava i između 16. i 17. godine kada glas postaje definitivan (6).

Prevremeni pubertet se definiše kao pojava prvih znakova puberteta kod devojčica pre sedme godine, a kod dečaka pre devete godine. Promene koje prate početak puberteta javljaju se znatno ranije, a uzrokovane su povećanim lučenjem hormona estrogena kod devojčica i progesterona kod dečaka, što je posledica povećane aktivnosti gonada stimulisanih gonadotropinima hipofize (7).

Kod muškaraca, povećani nivoi testosterona i dihidrotestosterona tokom puberteta su odgovorni za povećanje hrskavice larinksa. Polni hormoni omogućavaju smanjenje bazalnog tona za trećinu oktave. Ovo povećanje je praćeno povećanom mišićnom masom laringealnih ligamenata, što dovodi do pada visine glasa za oko jednu oktavu. Kako se larinks menja kod muškaraca u seksualnom razvoju, povremeno se lomi i glas (8,9). Tokom puberteta, promene u glasu žene su manje očigledne. Ženski glas ne prolazi kroz tako drastične promene u odnosu na muški (9).

Ova vrsta mutacije se javlja kao deo sindroma preranog puberteta, koji se može javiti kod oba pola. Glas dece sa preranim pubertetom dobija karakteristike glasa odrasle osobe, što izaziva iznenađenje kod slušalaca. Razni su uzroci ovih pojava i endokrinolozi se prvenstveno bave njima. Fonopedska rehabilitacija se sprovodi po potrebi i u dogovoru sa drugim specijalistima (5).

Perverzna mutacija glasa (lat. *mutatio perversa*)

Ovaj oblik mutacije nastaje kada se kod žene iznenada pojavi dubok muški glas i drugi znaci virilizacije. Ovaj simptom se često smatra prvim ranim znakom ozbiljne endokrine bolesti. Ukoliko je moguće lečiti osnovnu bolest i lečenje započeti na vreme, moguća je uspešna rehabilitacija glasa, ali ako je osnovna bolest dugotrajna i promene na larinksu stabilne, nemoguće je izvršiti rehabilitaciju glasa (5).

Menstrualni disfonični poremećaj

U životnom ciklusu svake žene postoje tri faze, a to su: predmenstrualna, menstrualna i postmenstrualna faza. U svakoj od ovih faza, fiziološki je normalno da dođe do promene u glasu svake žene, ali u nekim slučajevima može doći do patoloških promena glasa kao posledica hormonske neravnoteže (10).

Predmenstrualni period karakterišu brojni simptomi povezani sa promenama u kvalitetu glasa, od kojih je najčešći smanjenje tona. Usled povećanog nivoa estrogena u predmenstrualnom periodu javlja se predmenstrualni sindrom (PMS), koji se karakteriše epizodama razdražljivosti, osetljivosti dojki, pojačanog refluksa, anksioznosti i pojave edema. U sklopu ovih simptoma, kod

When endocrine glands deviate from normal functioning, many functions in the body feel the consequences. Disorders of the endocrine system in many cases affect the quality of the voice and can lead to numerous pathologies. The most common voice disorders caused by disorders in the secretion of sex hormones are: different types of mutations (*mutatio precox* and *mutatio perversa*), menstrual dysphonia and climacteric dysphonia (5). The aim of this study is to review modern literature to provide an insight into contemporary research into the etiology, pathophysiology and symptomatology of changes in hormone levels associated with aging and their pattern-consequential relationship with voice quality, with special reference to the analysis of different types of mutations (*mutatio precox* and *mutatio perversa*), menstrual and climacteric dysphonia.

Methods

In this review study, the electronic databases of Google Scholar Advanced Search and the Consortium of Serbian Libraries for Unified Procurement - KoBSON were searched. The following keywords and phrases were used in the search: endocrine disorders, sex hormones, sex hormones and voice disorders, *mutatio falsa*, *mutation precox*, *mutation perversa*, menstrual dysphonia, climacteric dysphonia, aging and voice disorders. The criteria for inclusion of works obtained from the search were: works published during the last 15 years, published in Serbian or English. Papers have been collected that present contemporary research into the etiology, pathophysiology and symptomatology of changes in hormone levels associated with aging and their pattern-consequential relationship with voice quality, with special reference to the analysis of different types of mutations (*mutatio precox* and *mutatio perversa*), menstrual and climacteric dysphonia.

Voice mutation during puberty - Early voice mutations (lat. *mutatio precox*)

Before puberty, girls and boys have about the same range of voice. During puberty, the larynx differentiates and the voice undergoes changes that normally occur at this stage. Voice changes in girls occur in two time phases. Between the ages of 7 and 8 when the voice drops a few octaves and between the ages of 16 and 17 when the voice becomes definitive (6).

Premature puberty is defined as the appearance of the first signs of puberty in girls before the age of seven, and in boys before the age of nine. The changes that accompany the onset of puberty appear much earlier, and are caused by the increased secretion of estrogen hormones in girls and progesterone hormones in boys, which is a consequence of the increased activity of the gonads stimulated by pituitary gonadotropins (7).

In males, increased levels of testosterone and dihydrotestosterone during puberty are responsible for the enlargement of the laryngeal cartilage. Sex hormones make it possible to reduce the basal tone by a third of an octave. This increase is accompanied by an increased muscle mass of the laryngeal ligaments, which leads to a drop in voice pitch by about one octave. As the larynx changes in sexually developing males, the voice occasionally breaks (8,9). During puberty, the changes in a woman's voice are less obvious. The female voice does not go through such drastic changes compared to the male voice (9).

This type of mutation occurs as part of the syndrome of precocious puberty, which can occur in both sexes. The voice of children with precocious puberty acquires the characteristics of an adult's voice, which causes surprise in listeners. There are various causes of these phenomena and endocrinologists primarily deal with them. Phonopedic rehabilitation is carried out as needed and in agreement with other specialists (5).

Perverse voice mutation (lat. *mutation perversa*)

This form of mutation occurs when a deep male voice and other signs of virilization suddenly appear in a female. This symptom is often considered the first early sign of a serious endocrine disease. If it is possible to treat the underlying disease and the treatment starts on time, successful voice rehabilitation is possible, but if the underlying disease is long-lasting and the changes in the larynx are stable, it is impossible to perform voice rehabilitation (5).

Menstrual dysphonic disorder

There are three phases in the life cycle of every woman, namely: the premenstrual phase, the menstrual phase and the postmenstrual phase. In each of these phases, it is physiologically normal

predmenstrualnog sindroma mogu se javiti brojne promene u kvalitetu glasa, koje označavamo pojmom predmenstrualni glasovni sindrom ili premenstrualna disfonija (11). Postoji nekoliko uzroka koji mogu dovesti do ovog stanja, a neki od njih su pojava submukoznog krvarenja u periodu pre menstruacije i pojačano lučenje estrogena što dovodi do pojave edema. Ove pojave izazivaju kretanje tečnosti iz unutrašnjosti ćelija i kapilara ka spolja. Vremenski period pre pojave prve menstruacije takođe je praćen značajnim promenama u glasu. Jedna od najuočljivijih promena je nemogućnost proizvodnje visokih tonova (6). Sam tok predmenstrualne faze praćen je raznim promenama kao što su suve glasne žice, povećan nivo kiselosti povezan sa refluksom jednjaka, smanjen tonus mišića larinksa, edem glasnih žica i proširenje vena. Neke od karakteristika glasa su: zamor glasa, smanjen opseg glasa sa gubitkom visokih tonova, gubitak vokalne snage, promukao glas. Osim toga, mogu se javiti: nervoza, bol u stomaku, nadimanje, kratkotrajna depresija, promena apetita i slično (12).

Ženski glas prolazi kroz ciklične promene tokom menstrualnog ciklusa. Početak menstrualnog ciklusa, folikularne faze, obeležava povećana količina estrogena i znatno niži nivo progesterona. Kombinacija ovih hormona je odgovorna za formiranje edema na glasnicama i povećan protok krvi u ovim strukturama (13). Polisaharidi u glasnicama se lakše razgrađuju i vezuju vodu, produbljujući tečnost koja se akumulira u glasnim naborima. Krvni sudovi u nosnom kanalu se takođe šire, što dovodi do promena u propustljivosti vazduha tokom fonacije (11). U drugoj polovini menstrualnog ciklusa, lutealnoj fazi, nivo progesterona dostiže najviši nivo u odnosu na nivo estrogena. Progesteron podstiče gubitak epitela larinksa i deluje protiv proliferacije. Ovo čini sekreciju žlezda viskoznijim, što dovodi do smanjenja vibracione efikasnosti i mogućnosti povećanja oštećenja ćelija glasnih žica. Ove promene su odgovorne za promene glasa tokom menstrualnog ciklusa (13). Ako žena ima bolne menstruacije i grčeve tokom menstrualnog ciklusa u predelu stomaka, može doći do promena u kvalitetu fonacije, zbog čega glas postaje tiši i slabiji, a govor je prekinut (11).

Kod žena se glas menja i tokom trudnoće pod uticajem hormona (14,15). Period trudnoće se redovno deli na trimestre. Glas žene u prvom i drugom mesecu trudnoće je u skladu sa referentnim vrednostima glasa. Međutim, ulaskom u treći mesec dolazi do promene glasa. Promene nastaju jer usled rasta ploda dolazi do pojačanog pritiska na disajne organe, čime se gubi oslonac organa za disanje neophodan za fonaciju, a glas gubi snagu i kvalitet. Dalje, u četvrtom i petom mesecu, usled rasta materice, dolazi do gastroezofagealnog refluksa. Gastroezofagealni refluks utiče na promene glasa, koje najčešće karakteriše promuklost (15).

Istraživanja o samoproceni kvaliteta glasa kod žena tokom menstrualnog ciklusa pokazuju da same ispitanice uočavaju promene u kvalitetu glasa u pojedinim fazama ciklusa. Žene ističu da im je glas adekvatnog kvaliteta, u sredini menstrualnog ciklusa, kada je lučenje estrogena i progesterona približno jednako (12).

Klimakterična disfonija

Oko četrdesete godine smanjuje se nivo hormona koji proizvode jajnici. Kada broj hormona padne ispod nivoa koji dovodi do menstruacije, dolazi do pojačanog lučenja luteinizirajućeg i folikulostimulirajućeg hormona i do izostanka menstruacije (16,17).

Menopauza predstavlja poslednje fizičko krvarenje iz materice, koje se javlja oko 51. godine, a najčešće između 48. i 58. godine. Tada dolazi do smanjenog lučenja estrogena i progesterona i poremećena je njihova ravnoteža (17). Za razliku od dramatičnog pada estrogena tokom menopauze kod žena, koncentracija testosterona kod muškaraca postepeno opada sa godinama. Procenjuje se da oko 30% muškaraca starijih od 60 godina ima nizak nivo testosterona, što je često praćeno simptomima kao što su prekomerno taloženje masti, niska koštana i mišićna masa i oštećena seksualna, kognitivna i fizička funkcija (1,18). Kako ljudsko telo stari, bilo da je reč o patološkim procesima ili starenju kao normalnom fiziološkom procesu, dolazi do promena u glasu. Kada govorimo o ženskom polu, normalna karakteristika starosti je početak menopauze. Hormonske promene su vidljive i tokom menopauze i posle nje. Usled procesa starenja, mišići larinksa se smanjuju, hrskavice okoštavaju i glasne žice su zadebljane (16).

Neki od prvih simptoma početka menopauze su umor, iscrpljenost, depresija, poremećaj sna i iznenadni talasi vrućine, koji su obično uzrokovani proširenim krvnim sudovima. Talasi vrućine su uzrokovani promenama u hipotalamusu. Nekoliko godina nakon završetka menopauze dolazi do promena na koži i kosi, slabljenja kognitivnih

for changes to occur in the voice of every woman, but in some cases, voice pathologies may appear as a result of hormonal imbalance (10).

The premenstrual period is characterized by numerous symptoms associated with changes in the quality of the voice, the most common of which is a decrease in pitch. Due to the increased level of estrogen in the premenstrual period, Premenstrual Syndrome (PMS) occurs, which is characterized by episodes of irritability, breast tenderness, increased reflux, anxiety and the appearance of edema. As part of these symptoms, in the premenstrual syndrome, numerous changes in voice quality can appear, which we denote by the term premenstrual voice syndrome or *dysfonia premenstrualis* (11). There are several causes that can lead to this condition, and some of them are the appearance of submucosal bleeding in the period before menstruation and the increased secretion of estrogen that leads to the appearance of edema. These phenomena cause the movement of fluid from the inside of cells and capillaries to the outside. The time period before the appearance of the first menstruation is also accompanied by significant changes in the voice. One of the most noticeable changes is the inability to produce high tones (6). The course of the premenstrual phase itself is accompanied by various changes such as too dry vocal cords, increased level of acidity associated with esophageal reflux, decreased tone of laryngeal muscles, edema of the vocal cords, venous dilatation. Some of the voice characteristics are: vocal fatigue, reduced voice range with loss of high tones, loss of vocal power, hoarse voice. In addition, the following can occur: nervousness, stomach pain, flatulence, short-term depression, changes in appetite and the like (12).

A woman's voice goes through cyclical changes during the menstrual cycle. The beginning of the menstrual cycle, the follicular phase, is marked by an increased amount of estrogen and a significantly lower level of progesterone. The combination of these hormones is responsible for the formation of edema on the vocal folds and increased blood flow in these structures (13). Polysaccharides in the vocal folds break down more easily and bind water, deepening the liquid that accumulates in the vocal folds. Blood vessels in the nasal canal also dilate, resulting in changes in air permeability during phonation (11). In the second half of the menstrual cycle, the luteal phase, the level of progesterone reaches its highest level in relation to the level of estrogen. Progesterone promotes loss of laryngeal epithelium and acts against proliferation. This makes the secretions of the glands more viscous, leading to a decrease in vibrational efficiency and the possibility of increased damage to the vocal cord cells. These changes are responsible for voice changes during the menstrual cycle (13). If a woman has painful periods and cramps during the menstrual cycle in the abdominal area, there may be changes in the quality of phonation, making the voice quieter and weaker, and speech interrupted (11).

In women, the voice also changes during pregnancy under the influence of hormones (14,15). The pregnancy period is regularly divided into trimesters. The voice of a woman in the first and second month of pregnancy is in accordance with the reference values of the voice. However, entering the third month, there is a change in voice. The changes occur because due to the growth of the fruit, there is increased pressure on the respiratory organs, which loses the support of the respiratory organs necessary for phonation, and the voice loses its strength and quality. Furthermore, in the fourth and fifth months, due to the growth of the uterus, gastroesophageal reflux occurs. Gastroesophageal reflux affects voice changes, which are most often characterized by hoarseness (15).

Research on self-assessment of voice quality in women during the menstrual cycle shows that the respondents themselves notice changes in voice quality in certain phases of the cycle. Women emphasize that their voice is of adequate quality, in the middle of the menstrual cycle, when the secretion of estrogen and progesterone is approximately equal (12).

Climacteric dysphonia

Around the age of forty, the level of hormones produced by the ovaries decreases. When the number of hormones falls below the level that leads to menstruation, there is increased secretion of luteinizing and follicle-stimulating hormone and absence of menstruation (16,17).

Menopause represents the last physical bleeding from the uterus, which occurs around the age of 51, and most often between the ages of 48 and 58. At that time, there is a reduced secretion of estrogen and progesterone and their balance is

funkcija, posebno pažnje i pamćenja. Menopauza može biti jedan od uzroka vaskularnih oboljenja i osteoporoze (19). U ovom procesu najveće promene se primećuju u larinksu. Javlja se edem, atrofija mišića larinksa, redukcija i degeneracija vlakana koja inerviraju larinks, osifikacija i kalcifikacija hrskavice, degeneracija krikoaritenoidnog zgloba i stanjivanje lamine propria (20).

Skup svih vokalnih simptoma koji uključuju menopauzu naziva se menopauzalni vokalni sindrom. Sastoji se od: smanjenog vokalnog intenziteta, zamora glasa, smanjenog dometa glasa, gubitka visokih tonova, opšteg gubitka kvaliteta glasa, vokalne disfunkcije, suvoće glasnih žica, učestalog kašljanja za pročišćavanje grla, smanjene frekvencije glasa, grubog i promuklog glasa. Prilikom laringoskopskog pregleda uočava se poremećaj funkcije i strukture glasnih žica. Oštećenu funkciju karakteriše smanjena fleksibilnost i smanjen opseg amplitude vibracija. Krikoaritenoidni zglob obavlja svoju funkciju normalno, ali mnogo sporije, zbog gubitka fleksibilnosti ligamenata i prisustva artroze u nekim slučajevima. Poremećaj u strukturi glasnih žica karakteriše njihova asimetrija i jednostrana i bilateralna atrofija mišića (10).

Poslednjih godina sve je češća primena hormonske supstitucione terapije (HST) za žene u menstrualnom i postmenstrualnom periodu. Na ovaj način se povećava mogućnost ograničavanja nekih neželjenih promena koje se javljaju u menopauzi, uključujući i one vezane za glas. Problemi sa ovom terapijom nastaju kada se prepisuju estrogen i progesteron. Poznato je da stimulacija estrogenom dovodi do zadebljanja epitela koji pokriva glasnicu, a stimulacija progesteronom izaziva promene u centralnom sloju lamine proprije u vokalnim naborima. Izgleda da su promene glasa povezane sa ravnotežom ovih hormona i postoje jasni dokazi da su neke žene koje koriste HST svesne izmenjenih karakteristika glasa. Takođe, ne treba zaboraviti da je menopauza, nezavisno od svojih fizičkih efekata, velika promena u životu žene koja se često dovodi u vezu sa promenama u porodičnom okruženju (samostalnost dece i njihovo napuštanje porodičnog doma, gubitak najmilijih, odlazak u penziju) rezultiraju osećanjima koja takođe mogu uticati na promene u kvalitetu glasa (18).

Starenjem hormoni mogu izazvati češću pojavu gastroezofagealnog refluksa usporavanjem pokretljivosti želuca. Zajedno sa hormonskim promenama nakon menopauze, efekti starenja postaju očigledni nakon menopauze. Mišići larinksa se skupljaju, hrskavice očvršćavaju i na kraju okoštavaju, glasne nabore postaju deblje, a količina kolagenih vlakana se smanjuje, što dovodi do ukrućenja glasnog aparata (21). Može se javiti i gluvoća kod starijih, koja takođe može u velikoj meri poremetiti funkciju govora (22).

Zaključak

Ljudski glas je tokom života podložan hormonskim promenama, od puberteta do starosti. Gonadni hormoni imaju ogroman uticaj na strukturu i funkciju vokalnog aparata. Promena glasa se primećuje čak i u fiziološkim stanjima kao što su pubertet i menstruacija. Poslednjih godina vokalni patolozi sve češće upućuju pacijente kod endokrinologa. Ova sve češća pojava može se povezati sa činjenicom da prvi simptomi endokrinih poremećaja polnih hormona utiču na kvalitet glasa. S tim u vezi, neophodan je multidisciplinarni pristup evaluaciji i terapiji endokrinih poremećaja i rehabilitaciji glasa.

Konflikt interesa

Autori su izjavili da nema konflikta interesa.

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disturbed (17). Unlike the dramatic drop in estrogen during menopause in women, testosterone concentrations in men gradually decline with age. It is estimated that approximately 30% of men aged 60 years or older have low testosterone, which is often accompanied by symptoms such as excess fat deposition, low bone and muscle mass, and impaired sexual, cognitive, and physical function (1,18). As the human body ages, whether it is pathological processes or aging as a normal physiological process, there are changes in the voice. When we talk about the female sex, a normal feature of old age is the onset of menopause. Hormonal changes are visible both during menopause and after it. Due to the aging process, the laryngeal muscles decrease, the cartilages ossify and the vocal cords are thickened (16).

Some of the first symptoms of the onset of menopause are fatigue, exhaustion, depression, sleep disturbances and sudden hot flashes, which are usually caused by dilated blood vessels. Hot flashes are caused by changes in the hypothalamus. A few years after the end of menopause, there are changes in the skin and hair, weakening of cognitive functions, especially attention and memory. Menopause can be one of the causes of vascular diseases and osteoporosis (19). In this process, the biggest changes are observed in the larynx. There is edema, atrophy of laryngeal muscles, reduction and degeneration of fibers that innervate the larynx, ossification and calcification of cartilages, degeneration of the cricoarytenoid joint and thinning of the lamina propria (20).

The set of all vocal symptoms that include menopause is called Menopausal Vocal Syndrome. It consists of: reduced vocal intensity, vocal fatigue, reduced voice range, loss of high tones, general loss of voice quality, vocal dysfunction, dryness of the vocal cords, frequent coughing to clear the throat, reduced voice frequency, rough and hoarse voice. During the laryngoscopic examination, a disturbance in the function and structure of the vocal cords is observed. Impaired function is characterized by reduced flexibility and a reduced range of vibration amplitude. The cricoarytenoid joint performs its function normally, but much more slowly due to the loss of flexibility of the ligaments and the presence of arthrosis in some cases. The disorder in the structure of the vocal cords is characterized by their asymmetry and unilateral and bilateral muscle atrophy (10).

In recent years, the use of hormone replacement therapy HRT - (Hormone replacement therapy) for women in the menstrual and postmenstrual period has become increasingly common. In this way, the possibility of limiting some of the unwanted changes that appear in menopause, including those related to the voice, increases. Problems with this therapy appear when estrogen and progesterone are prescribed. It is known that estrogen stimulation results in thickening of the covering epithelium of the vocal fold, and progesterone stimulation causes changes in the central layer of the laminae propria in the vocal folds. Voice changes appear to be related to the balance of these hormones and there is clear evidence that some women using HRT are aware of altered voice characteristics. We should also not forget that menopause is independent of its physical effects, a major change in a woman's life that is often associated with changes in the family environment (independence of children and their leaving the family home, loss of loved ones, retirement) that result in feelings that can also affect changes in voice quality (18).

With aging, hormones can cause more frequent occurrence of gastroesophageal reflux by slowing down the motility of the stomach. Along with hormonal changes after menopause, the effects of aging become apparent after menopause. The muscles of the larynx shrink, the cartilages harden and eventually ossify, the vocal folds become thicker, and the amount of collagen fibers decreases, which leads to a stiffening of the vocal apparatus (21). Elderly deafness can occur, which can also greatly disturb the function of speech (22).

Conclusion

The human voice is subject to hormonal changes throughout life, from puberty to old age. Gonadal hormones have a huge impact on the structure and function of the vocal apparatus. Voice change is observed even in physiological states such as puberty and menstruation. In recent years, vocal pathologists have increasingly referred patients to endocrinologists. This increasingly frequent phenomenon can be connected with the fact that the first symptoms of endocrine disorders of sex hormones have an impact on the quality of the voice. In this regard, a multidisciplinary approach to the evaluation and therapy of endocrine disorders and voice rehabilitation is necessary.

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Competing interests

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