EFFECT OF AGING ON THE ELASTIC FIBERS OF THE TUNICA ALBUGINEA OF THE PENIS

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ABSTRACT

Objective: A decrease in erectile function usually accompanies the aging process. Tunica albuginea (TA) with its well-known role in the mechanism of erection may also be affected with this process. The structural disorders of the tunica albuginea lead to impairment in penile erection. Our aim was to investigate the guantity and guality of the elastic fibers of the TA and its relevance with aging.

Methods: The elastic fiber concentrations of TA using a computarized image processing and analysis system, were calculated and evaluated in 26 potent men with 15-79 years of age.

Results: A statistically significant reduction of the area of the elastic fibers was found in patients with 50 years of age or older when compared to those younger than 50 (p=0.0002). Also unlike the younger men the structure of the elastic fibers were impaired in older men.

Conclusion: Reduction and irregularity in the elastic fibers of the TA of the corpora cavernosa in older men may be an additional factor complicating the adverse effects on erectile mechanism in aging men.

Key Words: Tunica albuginea, erection, aging

INTRODUCTION

Despite the dramatic developments on impotence research over the past decade providing a new insight into the underlying causes of erectile dysfuntion, the exact effect of aging on erectile function remains debatable. Impotence, the inability to achieve and maintain an erection sufficient for sexual intercourse is a common problem among aging males. Kinsey who was one of the pioneers correlating impotence and aging, found that at 40 years of age, only 2% of men were impotent. Whereas this rate jumped to 6.7% at age 55, 18.4 % at age 60, and up to 75% by age 80(1). Proceeding studies provided similar convincing evidences that aging has an important role in the prevelance of impotence among older men (2-5). Although the incidence of impotence increases after 70, the interest in sexual activity remains strong.(6)

Penile erection is a complex phenomenon involving not only the coordination of hemodynamic events but also the interaction of the brain, nerves, neurotransmitters, muscles, and the tunica albuginea of the corpus cavernousum.(7) Vascular, neurological, endocrinological, psychological factors individually or coexistingly are mainly responsible in the etiology of impotence. In a study among the geriatric population, it had been reported that the most frequent cause of impotence was the coexistence of neurological and vascular disorders due primarily to age associated chronic diseases.(8)

The Tunica Albuginea (TA) of the corpora cavernosa which is composed mainly of thick collagen bundless and elastic fibers, as the key structures of the compliant tissue, plays an important role in the mechanism of erection and is essential for appropriate extensibility, rigidity, and tissue strength of the penis. The collagen fibers that compose the

two layers of the TA are arranged in an undulating wave pattern. The elastic fibers on the other hand are oriented longitudinally and connect the bundles of collagen fibers enabling them to cooperate together(9). The elastic fibers are particularly abundant and they are intertwinned with collagen between TA and Buck's fascia along the penile shaft of TA. Disturbances of collagen and elastic fibers of TA can cause erectile dysfunction particularly effecting the veno-occlusive mechanism by alteration of the compliance of the corpora cavernosa. Recent studies demonstrated that quantitative structural alterations of corpora cavernosa are also responsible for erectile dysfunction (9,10). Also as described by Devine, aging men have a decrease in the elasticity of their tunica albuginea.(11)

The aim of this study was to quantify and evaluate the effect of aging on the contents of the elastic fibers within the TA of potent men.

MATERIALS AND METHODS

Twenty-six potent patients, undergoing penile surgery for either congenital penile curvature or radical cystoprostatectomy or radical retropubic prostatectomy operations were included in our study. Their ages ranged from 15 to 79 (mean 46.42). Tunica albuginea specimens were taken from the patients at the time of the surgery.

Tunica albuginea tissues were fixed in neutral buffered formalin and processed for paraffin embedding. Five um sections were adhered to charged slides, deparaffinized and hydrated to distilled water. Briefly, sections were stained for 5 minutes with potassium permanganate solution, rinsed with water, and placed in oxalic acid solution until sections were clear. After washing with water, sections were stained overnight in a working solution of resorcin-fuchsin. After a thorough washing, sections were counterstained in Van Gieson solution for 1 minute, dehydrated and coverslipped. Elastic fibers appeared blue black to blue, nuclei blue to black, collagen pink to red, and other tissue elements yellow.

The area of the elastic fibers of each specimen were quantitatively analyzed under 40 magnification in 10 random fields using a computarized image processing and analysis system (Quantimet 500+, Leica) linked to the microscope (Leica).

The area of the elastic fibers within each specimen were correlated with the age of the patients. The patients were divided into two groups. The first group was 14 patients under 50 years of age and the second group involved 12 patients who were 50 or older.

The histological structures of the elastic fibers were also observed microscopically under 40 magnification.

The results were analyzed with Stat View 4.02 using Mann-Whitney test.

RESULTS

The area of the elastic fibers in 10 fields of each specimen and the ages of the patients are listed in Table I. There was a statistically significant reduction of the area of the elastic fibers in patients who were 50 years of age or older when compared to the first group who were younger than 50 ($p=0.0002$) (Fig.1). The area of the elastic fibers in the first group ranged from 6242.86 to 13443.25 μm^2 (mean 9795.49 μm^2) where in the second group the range was 2771-8642.21 μm^2 (mean 5771.73 μm^2) (Fig.2).

We also recognized histologically that unlikely the younger men, the elastic fibers had varying lengths within the TA of some older men. The elastic fibers were shorter or broken in some areas and their normally seen longitudinal arrangements to the collagen fibers were impaired when compared to the younger men (Fig.3).

DISCUSSION

Sexual function remains a vital aspect of life for most healthy men even in advanced ages. Impotence is a common age-dependent problem but should not be considered as a normal event of aging. Even though there is an age-related decline, the pathophysiology of impotence with aging is usually multifactorial. Hormonal decline and psychological disturbances causing lack of sexualy interest, performance anxiety, and loss of self-esteem, underlying physical diseases like cardiovascular, respiratory, musculoskeletal deteriorations interacting with the aging process, and adverse effects of medications impairing erectile function are all paraaging phenomena. Decrease in potency related with neurovascular changes and some disorders of the corpora cavernosa or TA complicate the above difficulties. It has been demonstrated that the penile vascular walls and the trabeculae undergo fibrosis from 50 years onwards which may later on turn into sclerosis of these structures(12). Ruzbarsky and Michal had also discovered a progressive fibrosis of the intima in the arterial wall of the penis that occurred with aging (13). Investigations demonstrated significant hormonal

Table I. The ages and the area of the elastic fibers in the tunica albuginea of the corpora cavernosa in 26 potent men.

CASE	AGE	ELASTIC FIBER (μm^2)	POTENCY
1	79	2771.07	POTENT
2	57	6316.60	POTENT
3	66	8524.40	POTENT
4	63	4872.66	POTENT
5	60	4919.16	POTENT
6	63	4246.56	POTENT
7	60	8642.21	POTENT
8	15	9030.48	POTENT
9	32	7324.90	POTENT
10	23	12330.41	POTENT
11	38	8075.36	POTENT
12	20	11008.69	POTENT
13	40	6242.86	POTENT
14	29	9635.25	POTENT
15	24	12001.10	POTENT
16	49	13443.25	POTENT
17	23	9816.18	POTENT
18	26	10217.62	POTENT
19	34	10106.71	POTENT
20	28	11423.68	POTENT
21	47	6480.38	POTENT
22	69	6250.16	POTENT
23	60	4736.56	POTENT
24	66	6707.28	POTENT
25	73	5214.23	POTENT
26	63	6059.96	POTENT

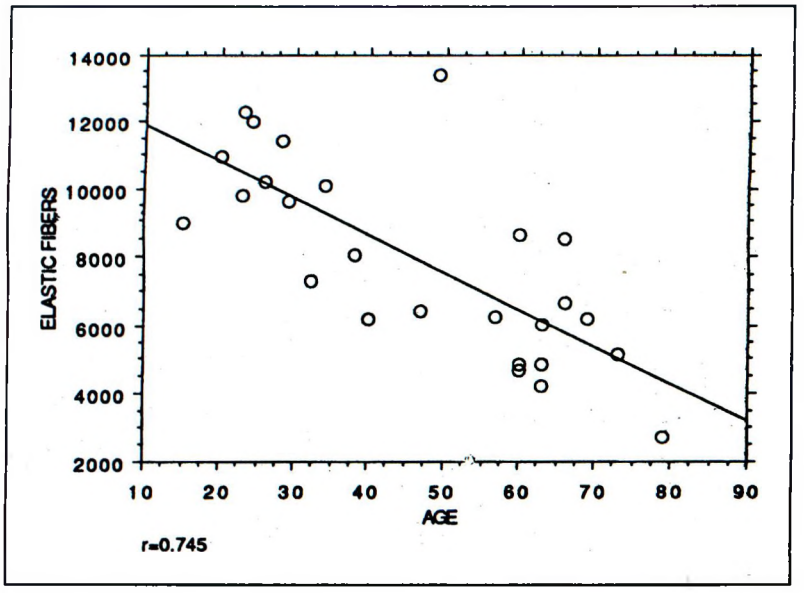


Fig. 1: Correlation of the area of the elastic fibers (μm^2) with age in regression plot (r = 0.745, p=0.0002).

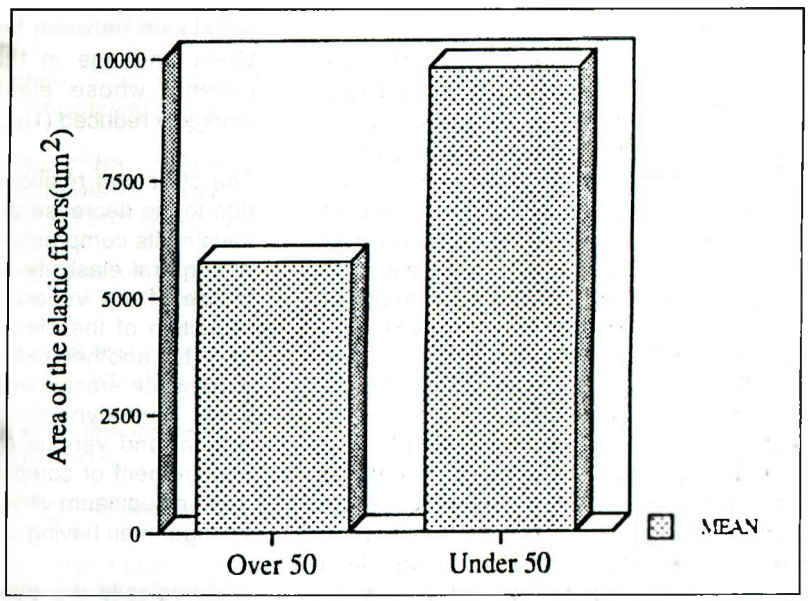
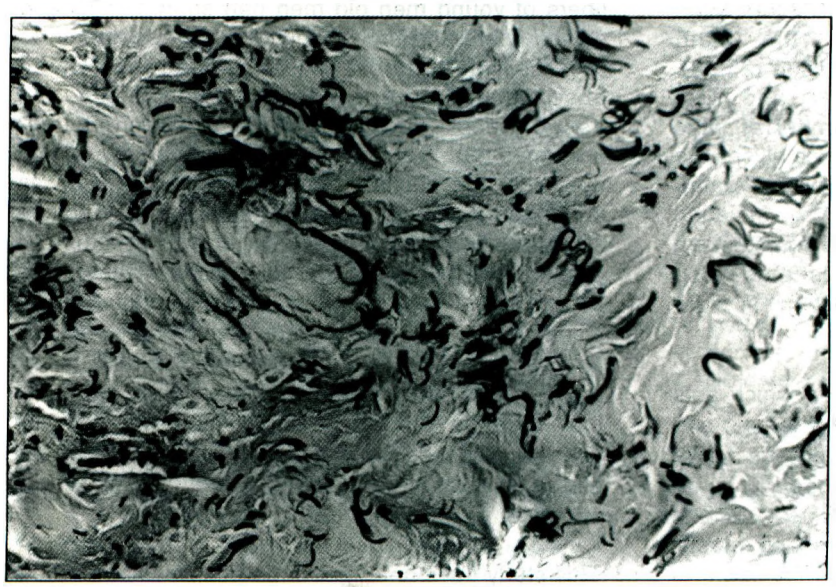
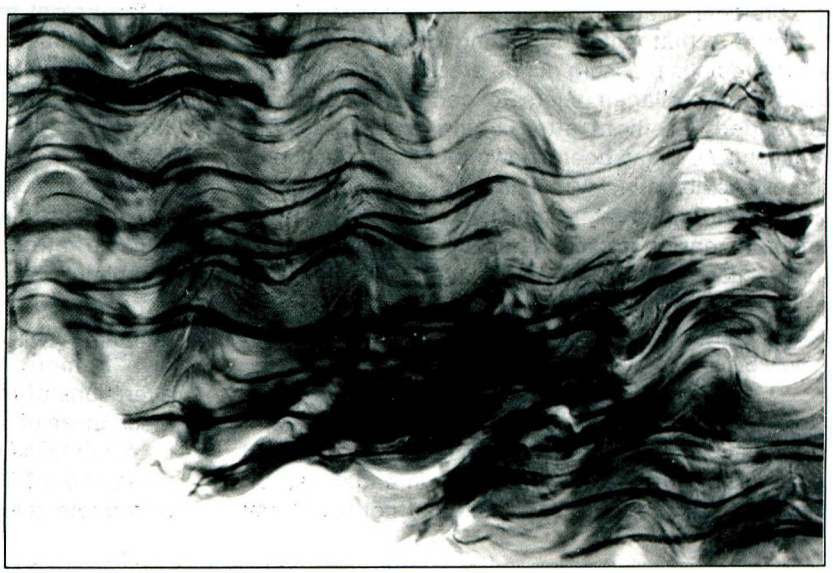


Fig. 2: Comparison of the mean concentrations of the elastic fibers in men under and over 50 years of age.



(A)



(B)

Fig. 3: The photomicrographs of the tunica albuginea of the corpora cavernosa. Note the irregularities with short, and broken elastic fibers in an older patient in A, when compared to the normal structure in a younger one in B.

alterations in impotent patients with aging (14-17). Carroll and associates demonstrated low testosterone levels in older impotent men revealing a trend of increasing incidence of reproductive hormone endocrinopathy with age which may also be a factor of erectile dysfunction in older men. Banya and associates showed age-related changes of smooth muscle and collagen fibers in human corpus cavernousum of the penis(18). Moreira and associates have also found that the percentage of smooth muscle cells in the cavernous tissue decreased significantly with the age of the patient(19). Other investigators have shown that the penile extensibility is significantly correlated with patient age and erectile dysfunction (20,21). Donattuci and Lue have reported that cellular senescence and death lead to increased deposition of connective tissue, which leads to a decrease in penile distensibility.(22) On the other hand the role of the neurotransmitters in the mechanism of erection has become clearer with recent studies (23-24). Nitric oxide (NO) is believed to be the main neurotransmitter supplying erectile function (25-26). In an experimental study Carrier and Lue demontrated the decrease in the number of nitric oxide synthase (NOS), the enzyme that catalyses the synthesis of NO fibers with aging (unpublished data). Their findings correlated with a delay in initiating erection in older men to achieve and maintain an erection. A stronger stimulation seems also neccessary to obtain a good erection in older men.

Tunica albuginea of corpora cavernosa which acts like a fibrous frame that supports the arterious and venous microcirculation has intracavernous nerve endings within the corpora cavernosa. It is an important structure in maintaining potency (8,27-29) and is mainly composed of collogen and elastic fibers. The structural disorders of TA lead to impairement in erection. Elastic fibers give elasticity to the TA that allow streching under increased intracavernous pressure during erection and allow the bundles of collagen fibers to come back to non-distended position after being streched with erection(27). It has been shown that the reduction of the elastic fibers in TA results with reduced elasticity and therefore a greater compliance for overstreching under increasing intracavernosal pressure is needed for erection (9,10,29). In our study the concentration of the elastic fibers in men over 50 years of age is statistically reduced when compared to the men below 50.

Goto and associates presented a similar decrease of the elastic fibers of the tunica albuginea that occured with age but their study was done in cadavers(30). However, Iacono and associates had not found any correlation between the concentration of the elastic fibers and age in their study among Peyronie's patients whose elastic fiber concentration was markedly reduced (10).

The structural resilience of the TA can be reduced due to the decrease of the elastic fiber concentration causing its compressive function to impair. Decrease of corporal elasticity and lack of distension leads to failure of the veno-occlusive mechanism(22). The reduction of the elastic fibers of the TA with aging may be another reason why it is much easier to experience erectile dysfunction in the older men with slight hemodynamic alterations of intracavernous arterial and venous microcirculation, particularly in impairement of compression on subalbugineum and trans-albugineum venous flow, when compared to the younger men having similar pathologies.

Histologically we observed that unlike the elastic fibers of young men old men had short and broken elastic fibers and their longitudinal arrangements to the collagen fibers were impaired. These observations were similar to what Bitsch and associates reported in overstreched TA specimens(9). We did not observe a darker staining quality of the elastic fibers in younger patients as described by Gelbard(31). The reduction and the structural disorders of the elastic fibers might also be a predisposing factor for herniation of the tunica abluginea(9). It was suggested that chronic vascular insufficiency may cause some free oxygen radicals and other toxic particles to damage the cells within the corpora cavernosa(32). These toxic materials may also be present in older men with chronic vascular diseases causing deteriorating effects on the elastic fibres of the TA leading to irregularities in their structure.

This study have been performed on the elastic fibers of the potent men only. Therefore we do not claim that structural alterations of the elastic fibers of TA is "the" factor of erectile dysfunction in aging men. Our opinion is that reduction and irregularity in the structure of the elastic fibers of the tunica albuginea of the corpora cavernosa in older men may be an "additional" factor complicating the adverse effects of the multifactorial reasons on erectile mechanism, and can be attributed to the erectile dysfunctional complaints in aging men. Moreover it should be remembered that a comperative study including both potent and impotent men with various age groups will give a more significant idea of the role of the alterations of the elastic fibers of TA in the erection mechanism of aging men. Further studies are needed on not only the elastic fibers but also on the collagen fibers of the TA of aging men to have a definitive idea on the role of the tunica albuginea of the penis.

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