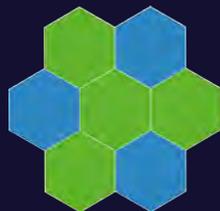


# Erectile Dysfunction

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## Novel Therapies for an Old Problem



**ANOVA**

Institute for Regenerative Medicine



# Dear reader,

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Erectile Dysfunction (ED), which is also known as impotence, is a type of sexual dysfunction which affects most men at some point during their lifetime. It is characterised by the inability to develop and/or maintain an erection of the penis during sexual activity.

Erectile Dysfunction can have significant psychological consequences, as it can burden relationships and result in a negative self-image. With increasing life expectancy an increasing number of men is affected by ED.

Although drugs such as Viagra and Cialis have alleviated the problem, they are far from perfect cures for the patho-physiology of ED.

In this brochure we explain the physiology behind erectile function and dysfunction and provide an overview of novel therapies for ED.

We present the latest therapeutic approaches, particularly the novel opportunities afforded by cellular medicine concerning metabolic and functional aspects.

***We hope to welcome you soon  
in our clinic.***

***Prof. Dr. mult. Michael K. Stehling  
Prof. Dr. med. Johannes Atta***



## Erectile Dysfunction – a Common Problem

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Erectile Dysfunction (ED) is a problem which affects approx. 50% of all men between the ages of 40 and 70 years<sup>1</sup>. ED is defined as the inability to have an erection of the penis that is sufficient for sexual intercourse<sup>2</sup>.

In about 80% of cases, a physical cause can be identified<sup>3</sup>, including cardiovascular disease, diabetes mellitus, drug side effects and neurological problems that may occur after surgical removal of the prostate or similar procedures. Physicians speak of psychological impotence when an erection or penetration is impossible or impaired due to thoughts or feelings; this problem occurs in approx. 10% of all ED cases.

Whilst many men afflicted with ED nowadays profit from treatment with PDE5i (phosphodiesterase type-5 inhibitors)-based medication such as Viagra or Cialis<sup>4</sup>, these drugs can cause unpleasant side effects, are contraindicated in some patients<sup>5</sup> and do not always provide the desired results.

Other treatments for ED include injections into the penis or the urethra, vacuum erection devices, and penile prosthesis implantation. These options are considered undesirable by most men because of their invasiveness, artificiality and unsatisfactory outcomes<sup>6</sup>.

All of these methods solely treat the symptoms of ED but do not cure the underlying disease process. This might now change with the availability of stem cell-based therapies<sup>7</sup>.

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<sup>1</sup> Feldman, Henry A., et al. "Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study." *The Journal of urology* 151.1 (1994): 54-61.

<sup>2</sup> Litwin, Mark S., Robert J. Nied, and Nasreen Dhanani. "Health-related quality of life in men with erectile dysfunction." *Journal of General Internal Medicine* 13.3 (1998): 159-166.

<sup>3</sup> Chowdhury SH, Cozma AI, Chowdhury JH. "Erectile Dysfunction. Essentials for the Canadian Medical Licensing Exam: Review and Prep for MCCQE" Part I. 2nd edition. Wolters Kluwer. Hong Kong. 2017

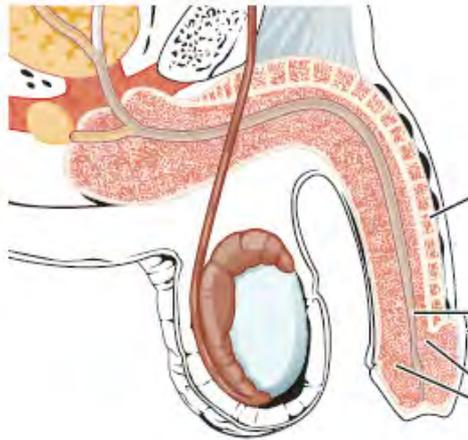
<sup>4</sup> Lue, Tom F., and Keith L. Lee. "Pharmacotherapy for erectile dysfunction." *CHINESE MEDICAL JOURNAL-BEIJING-ENGLISH EDITION*- 113.4 (2000): 291-298.

<sup>5</sup> Dorsey, Philip, et al. "Phosphodiesterase type 5 (PDE5) inhibitors for the treatment of erectile dysfunction." *Expert opinion on pharmacotherapy* 11.7 (2010): 1109-1122.

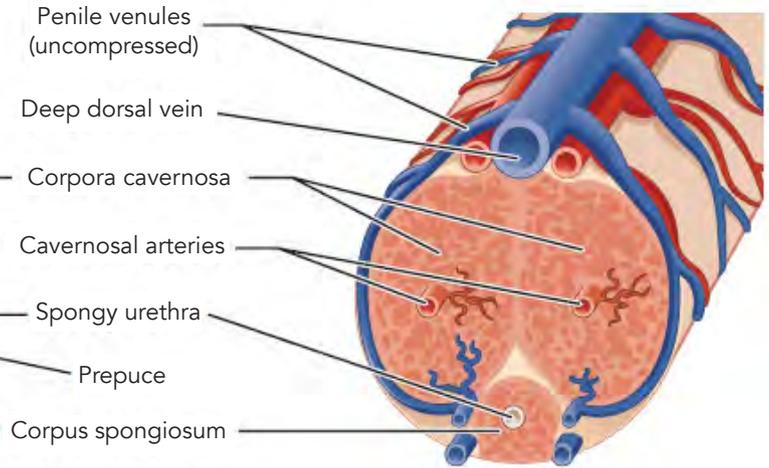
<sup>5</sup> Alwaal, Amjad, et al. "Prospects of stem cell treatment in benign urological diseases." *Korean journal of urology* 56.4 (2015): 257-265.

<sup>5</sup> Soebadi, M. Ayodhia, et al. "Advances in stem cell research for the treatment of male sexual dysfunctions." *Current opinion in urology* 26.2 (2016): 129-139.

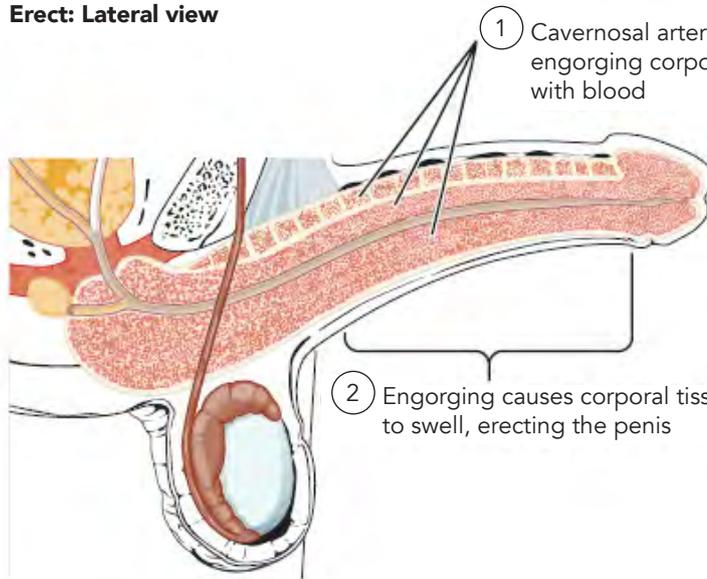
**Flaccid: Lateral view**



**Flaccid: Transvers view**



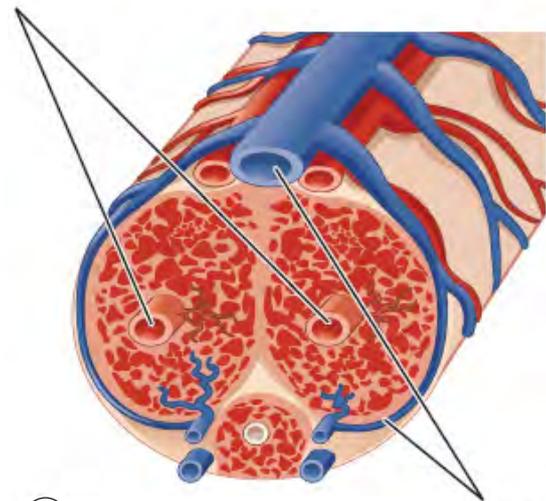
**Erect: Lateral view**



① Cavernosal arteries dilate, engorging corporal tissue with blood

② Engorging causes corporal tissue to swell, erecting the penis

**Erect: Transvers view**



③ Engorged corporal tissue compresses penile veins and venules, maintaining erection

## Physiology of Erection and Causes of Erectile Dysfunction

Erection of the penis is effected by filling of the erectile bodies of the penis<sup>8</sup> with blood. Triggered by psychological stimuli, nerve signals from the brain are sent via the spinal cord to the peripheral nerves, which then release nitric oxide (NO) in the erectile bodies. NO causes the smooth muscles of the erectile bodies to relax via the release of cGMP (cyclic guanosine monophosphate), and to engorge with blood. This is the trigger phase of an erection which requires the nerves to function normally.

The enlargement of the erectile bodies in turn compresses the draining veins, between the erectile bodies and the tunica albuginea of the penis, resulting in occlusion of venous outflow and full erection<sup>9</sup>. This is the mechanical phase of an erection.

Detumescence of the penis occurs when cGMP is degraded by an enzyme, called type 5 phosphodiesterase, leading to contraction of the smooth muscles of the erectile bodies, which results in decreased inflow of blood, a consequent reduction in the size of the erectile

bodies and a de-compression of the veins, effecting the drainage of blood from the erectile bodies<sup>10</sup>.

The key components of an erection are the endothelial cells (EC) and the smooth muscle cells of the erectile bodies, the corpora cavernosa (CSMC), and the release of NO from the cavernosal nerves (CN)<sup>11</sup>. Ageing and a variety of diseases can alter these essential anatomical and physiological components, resulting in ED.

After radical prostatectomy (RPE), the standard treatment for prostate cancer, the CN can be damaged<sup>12</sup>. Whilst the immediately resulting neurogenic ED might be reversible, the long-term consequences, such as diminished NO production, and death of CSMC can lead to atrophy and fibrosis of the erectile bodies, which might result in permanent ED<sup>13,14</sup>.

High blood glucose levels in diabetes mellitus<sup>15,16</sup> and increased blood cholesterol and hyperlipidemia<sup>17</sup> can also cause ED by similar mechanisms.

<sup>8</sup> <https://en.wikipedia.org/wiki/Erection>. Anatomy & Physiology, Connexions Web site. <http://cnx.org/content/col11496/1.6/>, Jun 19, 2013

<sup>9</sup> Lue, Tom F. "Erectile dysfunction." *New England journal of medicine* 342.24 (2000): 1802-1813.

<sup>10</sup> Prieto, D. "Physiological regulation of penile arteries and veins." *International journal of impotence research* 20.1 (2008): 17.

<sup>11</sup> Lin, Ching-Shwun, et al. "Stem cell therapy for erectile dysfunction: a critical review." *Stem cells and development* 21.3 (2011): 343-351.

<sup>12</sup> Mulhall, John P., et al. "Erectile function rehabilitation in the radical prostatectomy patient." *The journal of sexual medicine* 7.4 (2010): 1687-1698.

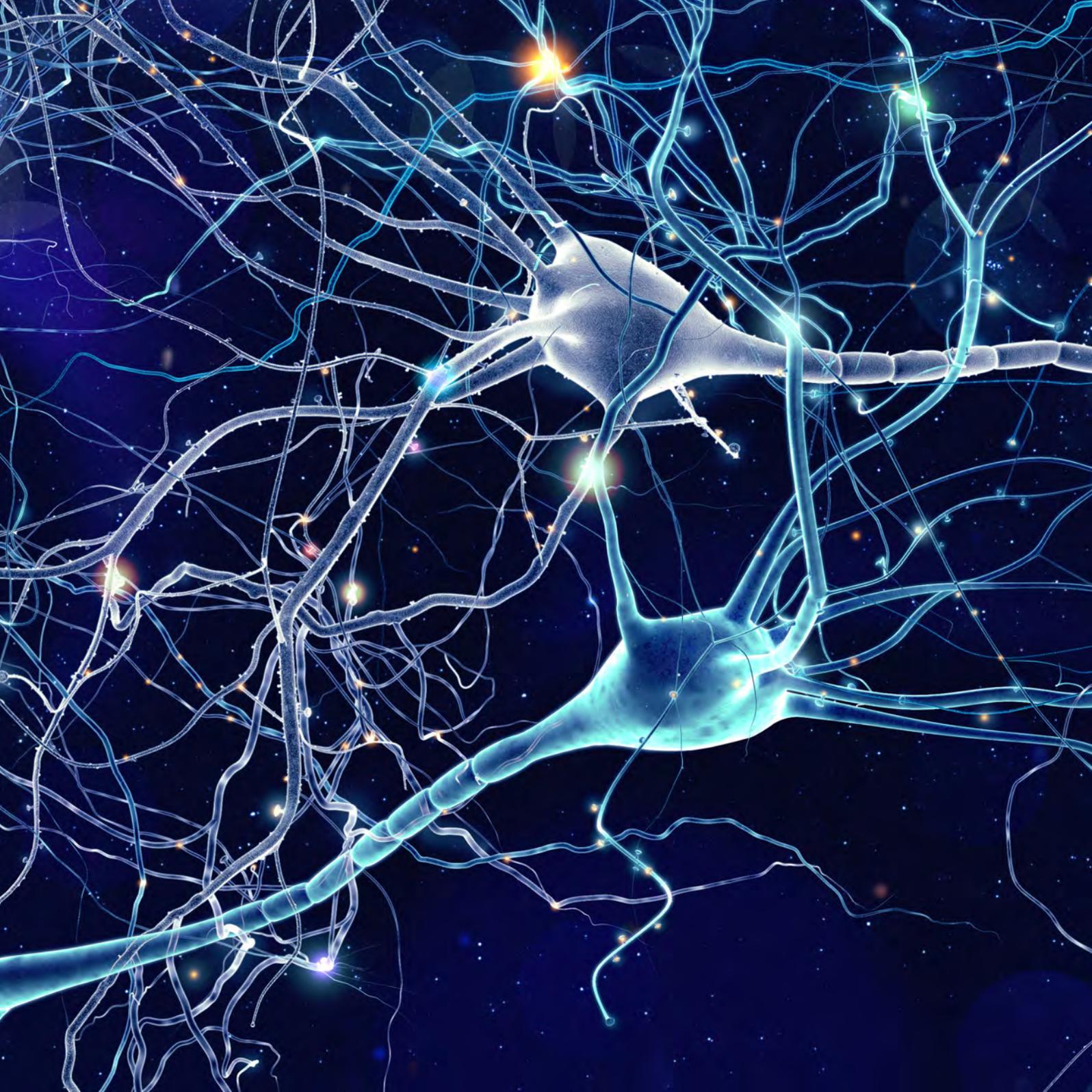
<sup>13</sup> Iacono, Fabrizio, et al. "Histological alterations in cavernous tissue after radical prostatectomy." *The Journal of urology* 173.5 (2005): 1673-1676.

<sup>14</sup> Fode, Mikkel, et al. "Penile rehabilitation after radical prostatectomy: what the evidence really says." *BJU international* 112.7 (2013): 998-1008.

<sup>15</sup> R Dashwood, Michael, et al. "Identification of neuronal nitric oxide synthase (nNOS) in human penis: a potential role of reduced neuronally-derived nitric oxide in erectile dysfunction." *Current pharmaceutical biotechnology* 12.9 (2011): 1316-1321.

<sup>16</sup> Gratzke, Christian, et al. "Anatomy, physiology, and pathophysiology of erectile dysfunction." *The journal of sexual medicine* 7.1 (2010): 445-475.

<sup>17</sup> Huang, Yun Ching, et al. "The effect of intracavernous injection of adipose tissue-derived stem cells on hyperlipidemia-associated erectile dysfunction in a rat model." *The journal of sexual medicine* 7.4pt1 (2010): 1391-1400.



## The Role of Stem Cells in the Treatment of Erectile Dysfunction

Stem cells are known to have anti-inflammatory, restorative, and immunomodulatory qualities. They have been effectively tested for the treatment of a variety of pathological conditions, including cardiovascular<sup>18</sup> and neurologic diseases such as stroke<sup>19</sup>, spinal cord injuries<sup>20</sup>, and Parkinson's disease<sup>21</sup>. Positive effects have also been shown in autoimmune diseases such as multiple sclerosis<sup>22</sup> and systemic lupus erythematosus<sup>23</sup>, as well as the healing of wounds<sup>24</sup> and the repair of cartilage defects<sup>25</sup> in osteoarthritis.

Over the past few years, particular enthusiasm has developed for Stem Cell-based Therapies in the urological field, especially for the treatment of Erectile Dysfunction<sup>26</sup>.

Several preclinical studies have researched the application of stem cells for urological conditions, particularly Bone Marrow Stem Cells (BMSC) and Adipose-Derived Stem Cells (ADSCs) for the treatment of ED in animal models, summarised by Soebadi et al.<sup>27</sup> in 2016.

In cases of acute ED, the mechanism of repair effected by stem cells is assumed to work on a paracrine level<sup>28</sup>. In chronic ED, however, the effect of stem cells may be mainly based on engraftment and cellular differentiation<sup>27</sup>. The exact mechanism of how stem cells improve erectile function in chronic ED is still not fully clarified<sup>29</sup>.

<sup>18</sup> Chen, Shaoliang, et al. "Intracoronary transplantation of autologous bone marrow mesenchymal stem cells for ischemic cardiomyopathy due to isolated chronic occluded left anterior descending artery." *The Journal of invasive cardiology* 18.11 (2006): 552-556.

<sup>19</sup> Bang, Oh Young, et al. "Autologous mesenchymal stem cell transplantation in stroke patients." *Annals of Neurology: Official Journal of the American Neurological Association and the Child Neurology Society* 57.6 (2005): 874-882.

<sup>20</sup> Pal, Rakhi, et al. "Ex vivo-expanded autologous bone marrow-derived mesenchymal stromal cells in human spinal cord injury/paraplegia: a pilot clinical study." *Cytotherapy* 11.7 (2009): 897-911.

<sup>21</sup> Venkataramana, Neelam K., et al. "Open-labeled study of unilateral autologous bone-marrow-derived mesenchymal stem cell transplantation in Parkinson's disease." *Translational Research* 155.2 (2010): 62-70.

<sup>22</sup> Harris, Violaine K., et al. "Phase I trial of intrathecal mesenchymal stem cell-derived neural progenitors in progressive multiple sclerosis." *EBioMedicine* 29 (2018): 23-30.

<sup>23</sup> Sun, Lingyun, et al. "Mesenchymal stem cell transplantation reverses multiorgan dysfunction in systemic lupus erythematosus mice and humans." *Stem cells* 27.6 (2009): 1421-1432.

<sup>24</sup> Dash, Nihar Ranjan, et al. "Targeting non-healing ulcers of lower extremity in human through autologous bone marrow-derived mesenchymal stem cells." *Rejuvenation research* 12.5 (2009): 359-366.

<sup>25</sup> Wakitani, Shigeyuki, et al. "Safety of autologous bone marrow-derived mesenchymal stem cell transplantation for cartilage repair in 41 patients with 45 joints followed for up to 11 years and 5 months." *Journal of Tissue Engineering and Regenerative Medicine* 5.2 (2011): 146-150.

<sup>26</sup> Khera, Mohit, Maarten Albersen, and John P. Mulhall. "Mesenchymal stem cell therapy for the treatment of erectile dysfunction." *The journal of sexual medicine* 12.5 (2015): 1105-1106.

<sup>27</sup> Soebadi, M. Ayodhia, et al. "Advances in stem cell research for the treatment of male sexual dysfunctions." *Current opinion in urology* 26.2 (2016): 129-139.

<sup>28</sup> Zhang, Haiyang, et al. "Adipose tissue-derived stem cells secrete CXCL5 cytokine with neurotrophic effects on cavernous nerve regeneration." *The journal of sexual medicine* 8.2 (2011): 437-446.

<sup>29</sup> Albersen, Maarten, Ching-Shwun Lin, and Tom Lue. "Stem-cell therapy for erectile dysfunction." *Arab journal of urology* 11.3 (2013): 237-244.

Publication (year)	No. of men	Cause of ED	Treatment	Assessment	Results
Bahk (2010) Korea	7	Diabetes	Umbilical blood Stem Cells	IIEF-5, SEP, GAQ	Improved rigidity in 2/7, able to penetrate with PDE5i
Levy (2016) France	8	Organic	Placental- Derived Stem Cells	GAQ PSV, IIEF-5	to penetrate with PDE5i 3/8 improved erection; IIEF
Haahr (2016) Denmark	17	5-18 months after RPE	Adipose- Derived Stem Cells	IIEF-5	change not significant 8/11 continent men and 0/6 incontinent men recovered erection
Yiou (2016) France	12	22 months after RPE	Bone Marrow Mononuclear Cells	IIEF-5, EHS, color doppler ultra- sound	1/12 hard erection; 9/12 needed ICI, PDE5i, or VCD. Improved EHS and IIEF-5

**Table 1: Results from clinical trials on Stem Cell Therapy for ED.**

**RPE:** Radical Prostatectomy  
**ED:** Erectile Dysfunction  
**SC:** Stem Cell  
**IIEF-5:** International Index of  
Erectile Function  
**SEP:** Sexual Encounter  
Profile  
**GAQ:** Global Assessment  
Question

**PSV:** Peak Systolic Velocity  
**EHS:** Erectile Hardness Score  
**PDE5i:** Phosphodiesterase  
type 5 inhibitor  
**ICI:** Intra-Cavernous  
Injection  
**VCD:** Vacuum Constriction  
Device

## Results from Clinical Trials Prove Effectiveness of Stem Cell Therapy for ED

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There are different possible methods of application. The intravenous injection of ADSCs has been shown to improve erectile function<sup>30</sup>. Injection of stem cells into the erectile bodies of the penis (intra-corporal) has also been applied, since it is both easy and appears logical<sup>31</sup>. Peri-prostatic injection, with or without a concurrent intra-corporal injection, has also been performed<sup>32,33</sup>. All of these applications can potentially help, as the regenerative effect of stem cells is mainly achieved either indirectly by secreting growth factors locally via paracrine mechanisms or by direct migration of the cells to the major pelvic ganglia<sup>34</sup>.

The safety, efficacy, and the mechanisms of both Bone Marrow (BM) and Adipose Tissue-Derived (ADSC) Stem Cells for the treatment of ED have been amply evaluated in several preclinical trials. A research group has summarised the data<sup>27</sup>. Almost all of the studies reported improved erectile function in various animal models of CN injury, vascular insufficiency, diabetes mellitus, hyperlipidemia, and ageing.

Whilst concerns about the possible promotion of malignant tumours remain whenever stem cells are being transplanted<sup>35</sup>, the use of cell-free solutions of the Stem Cell Secretome, the collection of paracrine factors with which stem cells effect repair, has solved this problem, since it avoids the transplantation of the actual stem cells.

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<sup>30</sup> Qiu, Xuefeng, et al. "Effects of intravenous injection of adipose-derived stem cells in a rat model of radiation therapy induced erectile dysfunction." *The journal of sexual medicine* 9.7 (2012): 1834-1841.

<sup>31</sup> Alwaal, Amjad, et al. "Prospects of stem cell treatment in benign urological diseases." *Korean journal of urology* 56.4 (2015): 257-265.

<sup>32</sup> You, Dalsan, et al. "Periprostatic implantation of human bone marrow-derived mesenchymal stem cells potentiates recovery of erectile function by intracavernosal injection in a rat model of cavernous nerve injury." *Urology* 81.1 (2013): 104-110.

<sup>33</sup> You, Dalsan, et al. "Comparative analysis of periprostatic implantation and intracavernosal injection of human adipose tissue-derived stem cells for erectile function recovery in a rat model of cavernous nerve injury." *The Prostate* 73.3 (2013): 278-286.

<sup>34</sup> Lin, Ching-Shwun, et al. "Stem-cell therapy for erectile dysfunction." *Expert opinion on biological therapy* 13.11 (2013): 1585-1597.

<sup>35</sup> Lin, Guiting, et al. "Effects of transplantation of adipose tissue-derived stem cells on prostate tumor." *The Prostate* 70.10 (2010): 1066-1073.

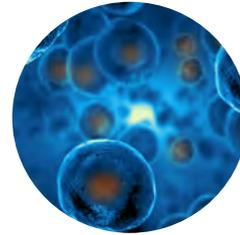
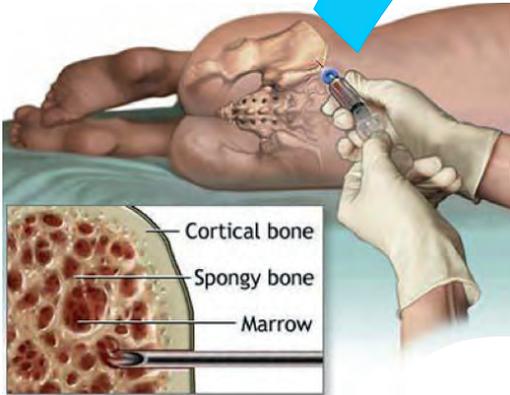


# ANOVA

Institute for Regenerative Medicine

## 1. HARVESTING OF BONE MARROW

- Minimally invasive procedure
- Natural cells from your own body



## 2. PRODUCTION OF THE STEM CELL THERAPEUTIC

- High concentration of haematopoietic and Mesenchymal Stem Cells
- Quality and safety approved by our German lab in compliance with German and European law

**TOTAL TIME  
= 2-3 HOURS**



## 3. APPLICATION OF THE STEM CELL THERAPY

- Intravenous application
- Safe, fast and effective
- Stimulation of regenerative processes in your body

## *ANOVA's Comprehensive Treatment Programmes for ED*

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Stem Cell Therapy is rapidly developing into an effective and safe treatment for ED. To obtain best results, however, Stem Cell Therapy has to be integrated into a comprehensive treatment programme for ED, which addresses all aspects of the condition, such as neurological, vascular, metabolic, endocrine and psychological factors, which can play a significant role in the aetiology of ED.

At ANOVA, our experts in Andrology and Sexual Medicine are uniquely qualified to address all of these issues to ensure optimal outcomes:

- Prescription of medication to improve, optimise and maintain erectile function
- Endocrinological analysis and hormone supplementation
- Metabolic testing and optimisation
- Choice of natural food supplements to support optimal sexual function
- Individual sports, exercise and physiotherapy programmes for healthy urogenital function

- Application of pulsed ultrasound for improved erectile function
- Demonstration of supportive devices for induction and maintenance of erection
- Counselling concerning penile surgery and implants

Our medical professionals, a team of dedicated physicians, patient care managers and scientists, are ready to provide you with the high quality medical care that you deserve.

## *ANOVA Scientific and Medical Advisory Board*

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We believe that an ideal treatment of any kind is based on the individual's needs and concerns. To be able to meet such high standards, a detailed diagnostic work-up is necessary.

At ANOVA Institute for Regenerative Medicine we offer full diagnostic work-ups with state-of-the-art technology, innovative laboratory diagnostics and the knowledge of trained and specialised physicians who will meet your needs.

With our potent Stem Cell Products, the Bone Marrow Concentrate and next generation Stem Cell Secretome, we can provide you with novel and innovative cellular therapy.



## *Enhancing the Effect of Stem Cell Therapy with Prostaglandins*

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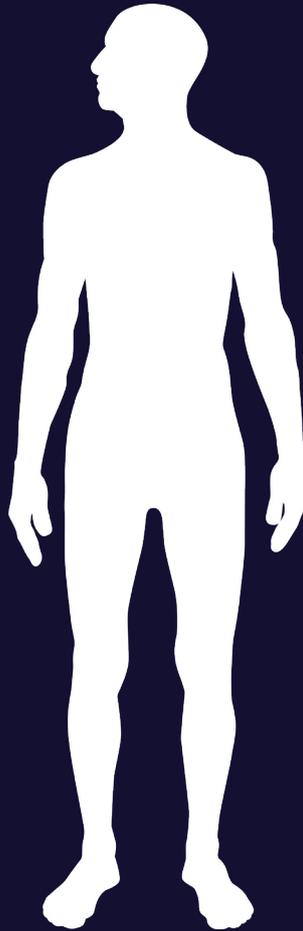
Prostaglandins are a group of physiologically active lipids called eicosanoids. They have many hormone-like effects, and type PGE1 can help with physiological functions linked to ED, such as vasodilatation of blood vessels in erectile tissues of the corpora cavernosa. They can also increase cavernosal artery blood flow, which is necessary for penile rigidity.

After its application, the onset of erection is within 5 to 30 minutes. The drug has a short half-life in men and improvement of erections may last from 1 to 2 hours.

The drug is applied to the tip of the penis and is available in two dosage strengths. It can be used as needed to achieve an erection.

Our expert physicians will guide you through the process in a consultation on-site.

## The Effects of Testosterone



### SKIN

Hair growth  
Collagen growth

### BRAIN

Increased sex drive  
Improved mood  
Confidence  
Memory function

### MUSCLES

Muscle growth  
Increased strength  
Increased endurance

### BONE MARROW

Red blood cell  
production

### BONES

Bone mass density  
maintenance

### SEX ORGANS

Sperm production  
Erectile function



## *Hypogonadism and Hormone Substitution with Testosterone*

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Hypogonadism is defined as a reduced functional activity of the gonads — the testes in men or the ovaries in women — which may result in declined production of sex hormones.

A low sex drive can be caused by imbalanced testosterone levels. Testosterone is one of the key players in a man's health and well-being. Many men with low serum testosterone levels have reported improved energy levels, sex drive, erection and mood after testosterone treatment.

There are many forms of Testosterone Replacement Therapy options, including intra-muscular injections and testosterone gel for a daily topical application.

At ANOVA Institute for Regenerative Medicine, we offer individualised treatments for our patients and compile treatment programmes which include all possible medical measures for maximum treatment success. Testosterone Replacement Therapy in combination with Stem Cell Therapy can be the most effective approach to improve your erectile function.

## *ANOVA's Comprehensive Treatment Programmes for ED:*

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Stem Cell Therapy is rapidly developing into an effective and safe treatment for ED. To obtain best results, however, Stem Cell Therapy has to be integrated into a comprehensive treatment programme for ED, which addresses all aspects of the condition, such as neurological, vascular, metabolic, endocrine and psychological factors, which can play a significant role in the aetiology of ED.

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- Application of pulsed ultrasound for improved erectile function
- Demonstration of supportive devices for induction and maintenance of erection
- Counselling concerning penile surgery and implants

Our medical professionals, a team of dedicated physicians, patient care managers and scientists, are ready to provide you with the high quality medical care that you deserve.

Meet the dedicated team of ANOVA Institute for Regenerative Medicine:  
Expert medical professionals and scientists, ready to provide you  
with the high quality medical care you deserve.



### *Michael K. Stehling*

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### *Johannes Atta*

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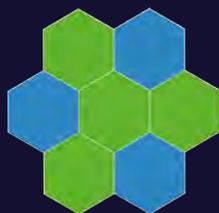
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