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Compression Stockings: Gentle Pressure, Powerful Medicine

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Abstract

Introduction and Definition: Compression stockings are specialized socks designed to improve blood circulation and reduce swelling in the legs. These socks date back to ancient Egyptian times when early forms of leg compression involved tight bandaging to alleviate leg swelling and pain, typically among soldiers. Over time, compression garments have evolved into graduated compression socks, where the pressure is the greatest at the ankle and gradually decreases moving up the legs. Today, compression stockings are used to treat venous disorders such as varicose veins, chronic venous insufficiency, and venous ulcers. Beyond treatment, compression stockings can be used in preventative therapy against conditions that can lead to blood clot formation, including deep vein thrombosis (DVT) and venous thromboembolism (VTE), which can affect millions worldwide, and be life-threatening if left untreated. Therefore, prioritizing the proper implementation of compression therapy for at-risk populations is critical for minimizing complications and improving patient outcomes.

Body: Compression stockings function by using a pressure gradient to help enhance blood flow. This gradient allows blood to flow upwards towards the heart, preventing it from refluxing downward into the foot or lateral superficial veins. The stockings can vary in their strength, style, length and area of use. While such stockings are designed to provide therapeutic benefits, they can also cause side effects, which can be mitigated by consulting a physician prior to use. Ongoing research within the field of compression stockings involves evaluating uniform pressure stockings, which maintain consistent pressure throughout the garment, relative to graduated socks. Recent studies also investigate what other conditions compression stockings can be used to treat, while the systematic reviews within the literature highlight gaps in long-term efficacy, compliance, and mechanism understanding.

Keywords: compression stockings; venous insufficiency; varicose veins; graduated pressure

Introduction and Definition

Definition

Compression stockings, also known as graduated hosiery, are specialized socks designed to "help improve the blood flow in the veins of the legs" [1]. They are mainly used as preventative therapy to treat disorders such as varicose veins, chronic venous insufficiency, venous ulcers, lymphedema, edema, and leg ulcers [1]. Globally, chronic venous insufficiency disorders affect 20-30% of adults, highlighting the need for an effective intervention [2]. Furthermore, if these conditions are left untreated, they can lead to blood clot formation, including deep vein thrombosis (DVT) and venous thromboembolism (VTE), which are life-threatening conditions that obstruct blood flow to the lungs [3]. DVT and VTE affect an estimated 45,000 patients in Canada, and 900,000 individuals in the United States. This further accentuates the need for raising awareness about compression therapy and ensuring its proper use for at-risk individuals to reduce severe complications [4, 5]. The use of compression stockings however is not limited to those with vascular disorders, but may also be beneficial to pregnant people, postoperative patients, those with limited leg mobility, workers that sit or stand all day at work, athletes, and long-distance air travelers [6]. This encyclopedia entry explores the history and mechanism behind compression therapy, outlines the different types of compression garments and explores current research surrounding compression stocking applications.

Origins and History

Like many medical devices, compression stockings have evolved significantly over time. The earliest known form of compression therapy is from ancient Rome and Egypt, where physicians used tight bandages made of linen to treat leg ailments such as pain, swelling, and cramping [7]. During the medieval era, doctors would recommend compression garments to treat conditions such as varicose veins. These garments were made from tight-fitting fabric so that they could improve blood circulation and reduce swelling [7]. By the 19th century, researchers began to experiment with elastic bandages and stockings to improve blood flow. These bandages were made from rubber, which

was a new material at the time, but were quickly deemed unsuccessful as they were difficult to wear for extended periods of time [7]. Later, during World War II, compression garments were used by soldiers to prevent the development of blood clots during combats. This was the first time that compression stockings were being manufactured on a large scale and marked a significant time in the history of compression stockings, as it led to the development of new material and technologies that helped make compression stockings more comfortable [7].

Today, compression stockings are used by a variety of individuals including travelers, athletes, and people with medical conditions that affect blood circulation. They are made from a range of materials including nylon, spandex, cotton, and other synthetic fibers, and manufactured by a series of companies, including Jobst, Sigvaris, and Bauerfeind. Compression stockings are also available in a wide range of styles, compressions, colours, and sizes, each helping to treat a specific condition.

Body

Mechanism of Action

Graduated hosiery can help reduce swelling and improve blood circulation, particularly in conditions such as venous insufficiency and varicose veins. The right atrium pumps deoxygenated blood to the lungs, where it receives oxygen [8]. After passing through the lungs, oxygenated blood returns to the left atrium and is then circulated to the rest of the body [8]. To maintain this cycle, blood must return to the heart and lungs for reoxygenation. This process occurs through a network of veins which are referred to as the venous system [8].

Blood can accumulate in the lower limbs when the walls and the valves of the veins in the legs do not function properly [8]. This impairs normal blood circulation, and leads to venous disorders, or other circulatory complications.

Compression stockings help counteract this effect by applying graduated pressure to the legs. The stockings are designed to be the tightest at the ankle, with pressure gradually decreasing as they extend up the leg. This gradient promotes the upward flow of blood from the feet back to the heart [6]. As a result, compression stockings support the veins and help prevent blood pooling and clot formation.

Types of Compression Stockings

Compression stockings differ in several ways, whether it be their compression level, length, or the area of the body that they serve. A key differentiator between most compression stockings is their compression grade or strength. Compression stockings are either non-medical or medical grade. Their grade is differentiated by the pressure, which is measured in millimeters of mercury (mmHg), typically ranging from 8-15 mmHg up to 40-50 mmHg [9]. Non-medical grade compressions do not require a prescription from a doctor and can be purchased over the counter from local pharmacies. Medical grade compressions are any stockings that are above 20 mmHg. These must be prescribed by a physician, who will recommend the appropriate grade of compression, as they are usually available in 20-30 mmHg, 30-40 mmHg, or 40-50 mmHg [9]. They are renewed on an annual basis and are usually covered by insurance [10].

Compression stockings also come in, three different lengths: knee-high, thigh-high and pantyhose/maternity garments. The length of knee-high compression stockings usually reaches up to the bottom of an individual's knee cap [10]. Thigh-high compression stockings, go up to the thighs, and are used when full compression is required on one or both legs. A special feature of thigh-high socks is silicone bands, which are included in the socks to minimize slippage [10]. Finally, pantyhose or maternity socks cover the whole leg, and are used by individuals who need bilateral full leg support [10]. All three socks come in different colours, and fabrics.

Finally, compression stockings are not just limited to the legs, but there are also compression sleeves that serve other parts of the body. This includes ankle sleeves, elbow sleeves, knee sleeves, calf sleeves, thigh sleeves, and arm sleeves which are available in medical and non-medical grades as well [11]. Compression stockings can also be customized to be individually tailored to an individual's unique limb measurements. This ensures a precise fit that is especially effective for managing complex conditions like lymphedema or asymmetric swelling. Unlike standard off-the-shelf options, these garments provide a consistent and medically accurate pressure profile that can be adjusted to specific clinical needs [10]. Table 1 highlights the different types of compression stockings, and their common applications.

Table 1. Types of Compression Stockings and Common Clinical Applications

Compression Level / Type	Pressure	Common Lengths	Typical Uses / Indications	Populations Who May Benefit
Non-medical grade compression	8–15 mmHg	Knee-high, calf sleeves	Mild support, prevention of leg fatigue, improved circulation during periods of inactivity	Long-distance air travelers, workers who sit or stand for prolonged periods, athletes during recovery
Mild medical compression	15–20 mmHg	Knee-high, thigh-high	Early prevention of venous disorders, mild swelling, minor varicose veins	Workers with prolonged standing/sitting occupations, athletes, individuals with mild venous symptoms
Moderate medical compression	20–30 mmHg	Knee-high, thigh-high, pantyhose/maternity	Management of moderate varicose veins, edema, early chronic venous insufficiency, prevention of DVT	Pregnant individuals, postoperative patients, individuals with limited leg mobility, patients with early vascular disease
Firm medical compression	30–40 mmHg	Thigh-high, pantyhose	Treatment of more severe venous insufficiency, significant edema, post-thrombotic syndrome	Patients with chronic venous insufficiency, vascular disease, severe swelling, postoperative vascular patients
Extra-firm medical compression	40–50 mmHg	Thigh-high, pantyhose	Severe venous disease, advanced edema, lymphedema management	Patients with advanced vascular disease, severe chronic venous insufficiency, or significant lymphedema
Full-leg garments (pantyhose / maternity)	Typically 20–30 mmHg	Full Leg (Pantyhose)	Bilateral compression for full-leg support and prevention of venous pooling	Pregnant individuals, individuals requiring bilateral compression, people with full-leg swelling
Compression sleeves (arm, knee, calf, ankle)	Varies	Localized sleeve	Targeted compression for specific joints or limbs	Athletes, individuals with localized swelling, patients with lymphedema or vascular disorders

Side Effects of Compression Stockings

In some cases, when compression stockings are not worn correctly, or are the wrong size, they may lead to side effects. The most common side effects include skin irritation, redness, pain and discomfort [6]. Some rare side effects are allergic reactions to the stocking material, bacterial or fungal infections, and soft tissue damage [6]. These side effects can typically be avoided if the compression socks are worn in the correct manner and are of the correct size. This can be prevented by talking to a physician before wearing the medical grade compression socks and thoroughly checking the manufacturer's sizes prior to ordering.

Current Research and Future Directions

Currently, there are many studies surrounding compression stockings, and how they can be improved to better treat its target populations. A comparative study evaluated the efficacy of uniform pressure compression stockings versus graduated compression stockings in managing edema and patient comfort. [12]. This was a randomized, controlled pilot trial that involved 25 patients with chronic venous disease. These participants were assigned to one of two groups: class I stockings with uniform, predetermined pressure or graduated class III stockings with higher pressure gradient [12]. The participants wore the stockings for 14 days, which were then evaluated with a follow-up visit. Participants in both groups reported significant improvements in leg heaviness, swelling, tightness, and tingling. Overall, it was reported that the unform compression stockings showed the same results and effectiveness as graduated compression stockings, but a greater sample size and more trials are needed [12]. Other primary studies on compression stockings have shown that its use can be extended beyond traditional venous outcomes. A 2024 study demonstrated that daily compression stocking use can help make significant improvements in restless legs syndrome and sleep quality [13]. Another study provided imaging evidence that compression stockings may enhance veno-lymphatic drainage and affect tissue morphology [14].

However, systematic reviews and meta-analyses continue to dominate the literature, often focusing on the prevention of DVT and post-thrombotic syndrome, while

noting limitations such as inconsistent outcome measures, patient compliance issues, and limited long-term follow-up [15–17]. Together, these studies highlight both the established role of compression stockings in venous disorders and the ongoing gaps in understanding their mechanisms, broader therapeutic applications, and optimal use.

Conclusion

Compression stockings have evolved from rudimentary bandages to carefully engineered medical garments that play a vital role in managing circulatory health. Rooted in centuries of practice and supported by modern science, these stockings work by applying graduated pressure to improve venous return and reduce edema, and have proven effective in treating and preventing a wide range of conditions, most notably varicose veins and chronic venous insufficiency. With a variety of types, styles, and pressure levels available, these garments can be tailored to meet individual needs and lifestyles, whether for clinical use, daily prevention, or athletic recovery. As technology advances and awareness grows, compression stockings remain a pillar of conservative venous care, bridging traditional practice with modern therapeutic potential. While on the outside, compression stockings may appear like ordinary socks that you wear, on the inside they serve a powerful medical purpose—quietly supporting circulation, reducing discomfort, and promoting overall leg health with every step we take.

List of Abbreviations

DVT: deep vein thrombosis
mmHg: millimeters of mercury
VTE: venous thromboembolism

Conflicts of Interest

The author(s) declare that they have no conflict of interests.

Authors' Contributions

LM: made substantial contributions to the design of the study, the collection of data as well as interpretation and analysis of the data, revised the manuscript critically, and gave final approval of the version to be published.

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