

Risk Factors Related to Lower Limb Edema, Compression, and Physical Activity During Pregnancy: A Retrospective Study

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Abstract

Objective: The aim of the article was to assess risk factors and to analyze methods applied in the prevention and treatment of lower limb edema in pregnant women with a particular focus on compression therapy and exercise.

Materials and Methods: Fifty-four women during the early 24-hour period following delivery were assigned to two groups—either to a group with swellings of lower limbs during pregnancy, located mostly in the region of feet and lower legs (Group A, $n=42$), or to a group without edema (Group B, $n=12$). Two subgroups, namely A1 and A2, were additionally distinguished in Group A. Compression therapy that consisted in wearing circular-knit compression garments, usually at compression level 1 (ccl1), with three cases of compression level 2 (ccl2) was applied only in Group A1 ($n=18$ women).

Results: The analysis has led to a conclusion that there is a link between the occurrence of edema during pregnancy on the one hand and the pregravidity episodes of venous conditions (vascular insufficiency and thrombosis, $p<0.05$) and the lack of physical exercise during pregnancy ($p=0.01$) on the other hand. However, interdependence between the occurrence of edema and the number of times a female had been pregnant, physical activity before gravidity, or body mass index before gravidity has not been identified. Only 33% of the analyzed women applied compression therapy during pregnancy; a half of them continued to apply compression during the postpartum period.

Conclusions: Compression therapy in combination with proper physical exercises appears to be an effective means to prevent and treat venous thrombosis and lower limb edema in pregnant women, yet further research in line with the principles of evidence-based medicine is required.

Keywords: edema, pregnancy, compression, physical activity, prophylaxis

Introduction

LOWER LIMB EDEMA can result from genetically determined venous malformation, which usually manifests itself between early childhood and the person's 20s or 30s, but the majority of edema cases in Europe are connected with chronic venous insufficiency; however, sedentary lifestyle and obesity are also common causes of leg edema.^{1,2} Lower limb edema has been increasingly frequent in gravid women during the third trimester of pregnancy.^{3,4} It occurs as a result of venous hypertension caused by insufficiency of the muscle pump and valvular regurgitation, as well as in connection

with venous thromboembolism.⁵ The risk factors linked to gravidity-related edema comprise the increased volume of circulating blood, the augmented uterus, increased body weight, and changes to hormonal turnover.⁴

The pathophysiology of pregnancy-related leg edema includes water and sodium retention, decreased plasma osmolality, and increased venous pressure due to inferior vena cava compression, as well as functional calf muscle pump insufficiency. Short time spans between the successive pregnancies, genetic conditions, and the application of cesarean section predispose to deep vein thrombosis (DVT), a condition that is four to five times more severe in pregnant

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women compared with their peers who have not been pregnant during the child-bearing age. The risk of thrombosis has been particularly high during the third trimester, labor and delivery, and the postpartum period.⁶ Its most serious complication—pulmonary embolism (diagnosed in 1 of 1000–3000 pregnancies)—has been the most frequent cause of death of gravid women.⁷

Pregnancy can also be a factor that triggers primary lymphedema (an idiopathic form of lymphedema) in women in the high-risk group in whom the transport reserves of the lymphatic system have been decreased and yet edema-related symptoms have not been observed in clinical conditions, and in whom the said reserves were exhausted (i.e., the lymphatic load exceeded the maximum transport capacity) due to a range of factors occurring during pregnancy (increased body weight, hormonal changes, venous stasis), resulting in damage to the lymphatic system.⁸ Additional risk factors include overweight and obesity, the lack of physical activity, and venous insufficiency in family history.

The basic and unquestionable method applied in the prophylaxis against and treatment of dysfunction of the venous–lymphatic system and corresponding complications consists in compression therapy involving compressive bandaging and the use of compression garments (CGs).^{9,10} Compression can be applied either individually or in combination with other methods, such as manual lymph drainage,¹¹ intermittent pump compression (IPC), or physical and breathing exercises. Compression therapy is part of complex physical therapy, also known as complex decongestive therapy.¹² The treatment involving compression should also be considered in pregnant women, especially in the cases where venous flow abnormalities were diagnosed before pregnancy. Pharmacological treatment is supplementary in alleviation of ailments and mitigation of symptoms related to chronic venous insufficiency, but it should not supplant other methods of treatment, in particular compression therapy.¹³

Even though lower limb edema with its accompanying conditions, including soreness, the feeling of heavy limbs, paresthesia, burning sensation, and nocturnal cramps, concerns as many as about 80% of pregnant women,^{5,14} while venous insufficiency affects over 40% of them,³ the articles describing the positive effect of compression on venous outflow in women during pregnancy have been few and far between.^{4,15} Literature concerning the application of comprehensive physical therapy is also scarce. Despite guidelines on the treatment of venous thrombosis in pregnant women,^{9,16} there has been a shortage of research into the effects of compression in both prophylaxis against and treatment of edema in pregnant women, and of studies concerning the quality of life of women with lower limb edema during pregnancy and the postpartum period.

The aim of this study has been to assess the risk factors and analyze the methods of prophylaxis against and treatment of lower limb edema in pregnant women with a particular focus on compression and physical activity.

Materials and Methods

The profile of analyzed cases

The study involved 54 women during the early 24-hour periods following physiological (32 females) and surgical (22 females) deliveries at the maternity ward of the Obstetrics

and Perinatology Teaching Hospital, a section of the University Hospital in Krakow, Poland. The protocol for the research project has been approved by the local Ethics Committee (No: 141/KBL/OIL/2016) and does not violate the policies and/or procedures established by the Journal of Obstetrics and Gynecology Research. The research was undertaken in compliance with the Declaration of Helsinki and the analyzed women had knowingly consented to being part of the study.

The women were divided into two groups, namely with and without lower limb edema: Group A ($n=42$) comprised females diagnosed with having edema during pregnancy, and Group B ($n=12$) consisted of females without the symptoms of edema during pregnancy.

The group of women diagnosed with having lower limb edema (Group A) was further divided into the following subgroups:

- Group A1—women who applied compression ($n=18$),
- Group A2—who did not apply compression ($n=24$).

More than 70% of the women in Group A and Group B lived in cities, while about one-third had rural background. University graduates prevailed in both groups (Group A—62%; Group B—68%), and the women who had completed only primary education were the least numerous (Group A—4.76%; Group B—8.33%).

The average age of the women (in years) was similar in both groups, namely 28.8 (16–37) and 29.8 (22–37) in Groups A and B, respectively. The average body mass index (BMI) in both groups was similar as well (Group A—22.8; Group B—22.3) (Table 1). The majority of women in both groups, namely 72% in Group A and 75% in Group B, had had proper BMI before pregnancy; underweight had been diagnosed in 14% of the women in Group A and 25% of the women in Group B. Overweight and obesity had mostly been observed in women in Group A, namely 12% (five cases) and 2% (one case), respectively. In Group A, 23 women (55%) were pregnant for the first time, 17 women (40%) for the second time, and 2 (5%) for the third time; in Group B, the corresponding numbers were 7 (58%), 3 (25%), and 2 (17%), respectively. Natural childbirth was the case with 63% of the newly delivered mothers in Group A and 42% of those in Group B. The remaining women had cesarean births (Table 1).

The study assumed the form of a questionnaire concerning risk factors related to lower limb edema and its accompanying physical ailments. The questionnaires took account of the women's age, BMI, type of birth, number of pregnancies, time spans between successive pregnancies, the occurrence of edema before pregnancy, and comorbid conditions, such as venous insufficiency, venous thrombosis, arterial hypertension, and diabetes. Also assessed were the type of physical activity before and during pregnancy, prophylaxis against thrombosis during pregnancy, and methods of preventing and treating venous and lymphatic flow abnormalities, with a particular focus on compression and physical exercises.

Edema prevention and treatment methods

Compression therapy applied in 18 women diagnosed with having lower limb edema consisted in wearing standard circular-knit CGs, usually at compression level 1 (cc1), with three cases of compression level 2 (cc2) based on

TABLE 1. THE PROFILE OF ANALYZED CASES

	Group A	Group B	p
Number of women	42	12	
Age (years)	28.8 (16–37)	29.8 (22–37)	
BMI (kg/m ²)	22.8 (17.4–29.4)	22.3 (19–28)	
First pregnancy	23	7	
Second pregnancy	17	3	
Third pregnancy	2	2	
Natural delivery	27	5	
Cesarean birth	15	7	
Numbers attending antenatal classes	13	2	
Conditions comorbid before pregnancy			
Venous insufficiency	11	0	<0.05
Lower limb edema	17	1	<0.05
Venous thrombosis	5	0	
Arterial hypertension	6	0	
Overweight	5	1	
Obesity	1	0	
The region where edema occurred during pregnancy			
Foot	42		
Foot + lower leg (shank)	36		
Whole limb	4		

BMI, body mass index.

recommendations of medical specialists (gynecologist, family doctor, angiologist). The most frequent type of garment, namely tights, was applied in 11 women (61%); knee socks were used by 4 women (24%) and stockings by 3 women (15%). The CGs used were products of different compression clothing manufacturers available on the market in Poland. The choice of CGs consisted in the measurement of the limb, usually carried out by the women themselves (only four females had their limbs measured by medical personnel), and the purchase of corresponding garments in a pharmacy. The period of applying compression usually spanned from 6 to 12 hours during the day. The women using CGs during the day were not provided with any recommendations regarding the application of physical activity.

Other methods of treating edema

Of other methods applied to decrease edema in both groups, the most popular one was the elevation of lower limbs (Group A1–61%, Group A2–54%) and pharmacotherapy, namely phlebotropic drugs recommended by a consultant obstetrician and gynecologist, in particular in the group of women using compression (33.3%) and less frequently (8.3%) in the group that did not apply compression (Table 2). Physical exercise was recommended less often, in particular in the group of women applying compression (Group A1–27.7%, Group A2–37.5%).

Prophylaxis against thrombosis

The methods recommended to prevent venous thrombosis of lower limbs included compression, but only with regard to

TABLE 2. METHODS TO DECREASE EDEMA IN THE GROUP USING COMPRESSION (A1, N=18) AND THE GROUP IN WHICH COMPRESSION WAS NOT USED (A2, N=24)

Method	Group A1	Group A2
Compression	18	0
Physical exercise	5	9
Pharmacotherapy	6	2
Elevation	11	10

the group of women diagnosed with edema (Group A = 42%). Other methods comprised antithrombotic drugs in the form of low-molecular-weight heparin—LMWH (Group A = 42% and Group B = 28%), prescribed by a consultant angiologist. Antithrombotic exercise, namely distal movements of parts of limbs, was applied in all the analyzed groups (Group A = 34%, Group B = 75%).

Statistical methods

The distribution of qualitative variables in the analyzed groups was presented in terms of the assessment of group size (*n*) and the frequency (%) of occurrence of particular categories. The analysis of the statistical significance of relationships between the independent and dependent variables, namely the type of birth, physical activity before pregnancy, physical activity during pregnancy, number of pregnancies, and BMI before pregnancy, was based on chi-squared tests (for nominal variables) and Spearman correlation (for ordinal and nominal variables). Statistical significance was adopted at $p < 0.05$. The data were processed in statistical terms by means of the Statistica Pl. 10.0 software.

Results

Of 54 women subjected to the analysis, 42 (Group A) were found to have symmetrical swellings of lower limbs, located mostly in the region of feet and lower legs, and less frequently on the whole limbs. In 16 women (38%), swellings had occurred during the first trimester; in 28 women (66.6%), during the second trimester; and in all of them, namely 42 women (100%) in Group A, during the third trimester. Edema was accompanied by subjective symptoms, namely the feeling of heaviness of limbs in 38 women (90%), pain (27 women, 64.2%), and bursting sensation in the limbs (17 women, 40%). Only five women (11.9%) did not complain about any of the above symptoms. The said conditions were less frequent in women who applied compression (Group A1) compared with the group that did not apply compression (Group A2).

Interdependence was observed between the occurrence of edema during pregnancy and such conditions before pregnancy as chronic venous insufficiency and DVT ($p < 0.05$). Seventeen of 42 women in Group A declared to have had edema before pregnancy, but with varying frequency: swellings had occurred often in 41% ($n = 17$), rarely in 35.7% ($n = 15$), and occasionally in 24% ($n = 10$). In Group B, only 1 woman had occasional swellings before pregnancy ($p < 0.05$).

Of the analyzed variables, the factor that had a significant impact on the occurrence of edema was the lack of physical activity during pregnancy ($r = -0.34$, $p = 0.01$). In Group A,

only 14 (33.3%) of the total of 42 women declared to have regularly carried out physical exercises during pregnancy; in Group B, the exercising females were in the majority (75%, $n=9$), ($p < 0.05$).

No significant interdependence was observed between the occurrence of edema and the number of pregnancies, physical activity before pregnancy, attendance at antenatal classes, and BMI before pregnancy. Neither was any significant relationship observed between the use of compression and the decrease in swelling, except for the subjective feeling of reduced swelling reported by women subjected to the study.

Discussion

The aim of the study was to assess risk factors and analyze the use of compression and physical activity in the prophylaxis against and treatment of lower limb edema in pregnant women.

Among the basic methods to treat venous-lymphatic disorders on any level of advancement in the course of venous thrombosis and post-thrombotic syndrome, the most effective one has been compression therapy. Despite its long history, most reports have focused on the application of compression in patients diagnosed with having chronic venous insufficiency^{2,9} or lymphedema of the limbs, for example, following breast cancer therapy.^{10,11}

Studies concerning the application of compression in gravid women have been scarce, even though pregnancy favors the development of lesions in the venous system. The unfavorable impacts on veins during gravidity include the increased volume of circulating blood; the augmented uterus; increased body weight; limited physical activity; and changes to hormonal turnover. The pressure of the expanding uterus on the iliac veins and the pelvic plexus, increased body weight, and limited physical activity contribute to the development of venous insufficiency.

Another important condition, known as Cockett's Syndrome, consists in increased venous abnormalities on the left-hand side of the body due to compression of the left iliac vein by the right common iliac artery.¹⁷ Impaired tension of the venous wall, caused in particular by the increased level of estrogens, results in blood flow abnormalities in the superficial system. Observations concerning microvasculature include damage to the endothelium and the release of inflammatory mediators, which affect both the venous and the lymphatic systems. Poorer performance of the muscle pump due to limited physical activity contributes to the development of venous stasis, predisposes to venous thrombosis, and consequently increases the risk of chronic venous insufficiency and its corresponding complications.^{4,14}

As venous insufficiency develops, changes are primarily concerned with the venous system—mostly as a result of damage to cardiac valves—and assume the characteristics of high-volume insufficiency. Still, even at the early stage of development of that insufficiency, the lymphatic system becomes a compensatory mechanism. As a consequence of increased hydrostatic pressure in blood vessels, the excess liquid cannot be transported back by means of the lymphatic system, leading to damage to the overburdened lymphatic system and a decrease in transport reserve over time, which in turn may result in the development of congestive lymphatic

insufficiency, an unfavorable condition for both the venous and lymphatic systems. The decreased performance of the muscle pump due to limited physical activity is contributory to stasis.

The tendency to develop edema in lower limbs, along with such subjective ailments as soreness and the feeling of heaviness of legs, has been observed in majority of pregnant women. This problem has been reported to affect anything between 50% and 80% of women,^{4,14,17} especially during the second and third trimesters, and to be particularly frequent in women with advanced venous insufficiency. Chronic venous insufficiency, arterial hypertension, and venous thrombosis diagnosed before pregnancy, as well as the lack of physical activity during pregnancy, contributed to development of lower limb edema in the analyzed group. The said edema and its accompanying soreness affected over 77% of women in the study.

In the majority of pregnant women, fluid accumulates mostly in the distal regions of the lower limbs, usually on both sides of the dorsal region of the foot and/or around the ankles,^{14,17} but in some cases, especially in women diagnosed with having chronic venous insufficiency, edema (of the venous-lymphatic type) affects the whole shank. In the analyzed group, the majority of women (36/42) developed swellings symmetrically in the shanks and the dorsal region of the feet.

Only 18 of the 54 women included in the study were using compression as a method of swelling reduction during pregnancy, and in as few as 9 cases, compression was recommended as an antithrombotic measure in spite of the guidelines for the prevention and treatment of venous thrombosis. The said guidelines lay down the principles of antithrombotic prophylaxis in women at risk of impeded blood circulation in the veins of lower limbs and the pelvis minor due to pressure from the fetus and debilitated performance of the muscle pump, as well as poorer venous pressure due to hormonal disorder.¹⁴ With regard to all of these women, the authors of the consensus have suggested that properly tailored graded compression be applied both during pregnancy and at the time of delivery and the postpartum period. In the women who have had cesarean births and have been at risk of venous thrombosis, graded compression or IPC has been recommended during postnatal inpatient care.¹⁶ In women who have recently undergone symptomatic thrombosis of the lower limbs, the immediate recommendation has been to apply compression in the form of short-stretch bandaging, and once edema has abated, to use 30–40 mmHg compression products on the ankle.^{9,16}

The chronic consequences of venous thrombosis may include valvular regurgitation with long-lasting venous hypertension that triggers post-thrombotic syndrome,⁷ resulting in a decline in the women's quality of life compared with the quality of life of women who have not been diagnosed with venous thrombosis and subsequent complications.¹⁸ The women in whom compression had been applied in combination with immediate mobilization in the course of acute venous thrombosis experienced greater reduction in swelling and soreness compared with the group of women in whom passive rest with compression had been administered.¹⁹

Among the women included in the study, 50% of Group A1, diagnosed with having edema and using compression during pregnancy, continued to apply compression after the delivery. In Group A2, compression was used neither as a

method to prevent thrombosis nor as a way to reduce swelling. Antithrombotic exercise was in use in the latter group; unfortunately, such cases were infrequent. Because of a very liberal use of LMWH in our country, such medication was frequently prescribed in both groups of women as a safety feature without considering the mentioned strict indications (42% patients in Group A and 28% in Group B).

CGs, namely tights, knee socks, and stockings, were applied mostly at compression grade 1 (ccl1, 18–21 mmHg); however, diagnosed venous insufficiency requires stronger compression, that is, at least at grade 2 (ccl2, 23–32 mmHg), and CGs have to be selected based on measurement carried out by qualified medical professionals. ccl1 has been reserved for patients in risk groups and for healthy individuals. A report, concerning the assessment of how compression in the form of knee socks at pressure range from 10 to 20 mmHg stimulates the decrease in the risk of developing lower limb edema and impacts on the quality of life of healthy women, shows that the said quality of life has improved.²⁰

In the analyzed group, significant interdependence between the wearing of CGs during the day and a decrease in swelling was not observed. Such ineffectiveness of compression could have been due to a number of factors, such as the insufficiently low grade of compression applied (ccl1) and the failure to objectively assess limb size, as well as the lack of information concerning both the application of compression before pregnancy and the week of pregnancy in which the use of CGs had commenced.

Other forms of compression therapy, such as bandaging and IPC, were not used by any of the women in the studied group.

The factors that enhance the risk of venous insufficiency and edema of the lower limbs in pregnant women comprise limited physical activity or lack thereof. The interdependence between the occurrence of edema and the lack of physical activity during pregnancy was observed in the studied group of women. The females in Group A carried out physical exercise less frequently than those in the group without lower limb edema (Group B); even though Group A applied compression during the day, they did not exercise with CGs on. In the women in Group B, who regularly carried out physical exercises during pregnancy and had proper BMI, edema and its accompanying ailments were not observed. There have been several reports on the favorable effects of aquatic exercise or massage in the region of feet on reduction of swelling, yet the methodology behind these treatments has not been described in detail.^{21,22}

It is beyond question that regular physical exercise constitutes an important measure to prevent several conditions, especially concerning the vascular system, and helps maintain proper body mass. Overweight and obesity predispose to abnormalities in the venous–lymphatic circulation even though no interdependence has been observed between the occurrence of edema and BMI before pregnancy in the studied group of women. Higher BMI in the group of females diagnosed with having edema during pregnancy (Group A) could also result from limited physical activity in the course of gestation.

Based on the available literature, recommendations from experts in lymphology and phlebology,^{9,23} and the analysis ensuing from the study described in this article, it can be concluded that compression therapy with the use of production garments as a way to prevent venous thrombosis and lower limb lymphedema in pregnant women as well as the

application of pneumatic compression and bandaging in combination with physical activity in women with clinical symptoms of edema apparently prove effective, yet these methods require prospective research in line with the principles of evidence-based medicine.

One limitation of this study consists in a small sample of the analyzed population of women. Another limitation pertains to the lack of assessment of limb size (the calculation of limb volume based on circumference measurements) at the beginning of gestation, before the selection of CGs (Group A1), as well as in the group without compression (A2), and the fact that these volumes were not monitored during pregnancy, after the delivery, and during the postpartum period. Yet another limitation concerns the failure to apply uniform CGs at the same compression grade that would be used according to measurements and sourced from the same manufacturer and the absence of accurate recommendations as to how these garments should be worn during the day, what physical exercise should be carried out with CGs on, and how to properly take care of CGs.

In summary, an early diagnosis of the above abnormalities in the venous system and comorbid conditions, preferably before pregnancy, the monitoring of limb size, and application of compression in combination with an optimal physical activity program may be relevant aspects of prophylaxis concerning lower limb edema and ensuing complications during pregnancy and the postpartum period. Still, this subject requires further research in line with the principles of evidence-based medicine.

Author Disclosure Statement

No competing financial interests exist.

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