REVIEW ARTICLE

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Stretch marks during pregnancy: a review of topical prevention*

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Summary

Striae gravidarum (SG), or stretch marks developing during pregnancy, affect up to 90% of women. While not medically dangerous, SG can be disfiguring, causing emotional and psychological distress. However, studies specifically addressing the prevention of SG, especially during pregnancy, are sparse. Furthermore, the molecular pathogenesis of SG is unclear and may differ from that of striae from other causes. Considering these factors, we review topical modalities that have been used specifically for preventing SG during pregnancy. We identify two major strategies (end points) addressed by these modalities, namely (i) preventing the *de novo* development of SG and (ii) reducing the severity of SG that have recently developed. We also identify risk factors for the development of SG and suggest that pregnant women with these risk factors are an appropriate target population for prevention. In reviewing the literature, we find that there is limited evidence that centella, and possibly massage with bitter almond oil, may prevent SG and/or reduce their severity. There is weak evidence that hyaluronic acid prevents SG. Tretinoin holds promise for reducing the severity of new-onset SG, but its use is limited by its pregnancy category. Finally, cocoa butter and olive oil are not effective for preventing SG or reducing the severity of lesions. We conclude that reliable methods for preventing SG are scarce. Furthermore, available topical modalities generally lack strong evidence from rigorous, well-designed, randomized controlled trials with ample numbers of subjects. Thus, further research is necessary to elucidate SG pathogenesis, which may lead to effective prevention modalities.

What's already known about this topic?

- Striae gravidarum (SG), or stretch marks developing during pregnancy, can be disfiguring, causing emotional and psychological distress.
- Studies specifically addressing the prevention of SG during pregnancy are sparse.

What does this study add?

- We review topical modalities that have been used specifically for preventing SG during pregnancy.
- We conclude that reliable methods for preventing SG are scarce, and that topical modalities generally lack strong evidence from rigorous, well-designed trials with ample numbers of subjects.

The term striae distensae (SD) refers to stretch marks from various causes, including pregnancy, weight gain, obesity, growth spurts and corticosteroid excess.[1–3] Striae gravidarum (SG) are stretch marks specifically developing during pregnancy. SG affect up to 90% of women.[4] They appear in the second or third trimester, typically on the abdomen and breasts, and less commonly on the buttocks, hips and thighs.[2] Initially, lesions are pink to violaceous and may be oedematous

or pruritic (striae rubra). Over months to years, the lesions mature into white, shiny, atrophic, crinkly streaks that are permanent (striae alba).

Although SG are common, their pathogenesis remains unclear. Mechanical tension may play a pathogenic role by damaging dermal connective tissue, as the long axis of lesions is usually oriented perpendicularly to the direction of greatest skin stretching.[3,5] However, this possibility remains controversial, as increased maternal weight gain during pregnancy, baseline maternal body mass index and infant birthweight are not consistently associated with SG development.[3,4,6,7]

At the molecular level, disruption of dermal connective tissue, including collagen fibrils and elastic fibres, likely leads to decreased strength and elasticity of lesions.[5,8] Indeed, early, erythematous SG exhibit focal loss and thinning of collagen bundles.[8,9] Variable reduction, thinning and disorganization of elastic fibres are seen at this stage and may result from elastolysis mediated by infiltrating mast cells and macrophages.[6,8–10] Additionally, elastic fibre disorganization may result, in part, from reduction of fibrillin microfibrils in early SG.[9] Increased hormones during pregnancy, such as glucocorticoids, may suppress fibroblast production of collagen fibrils and elastic fibres, thereby hindering complete 'repair' of disrupted connective tissue.[1,3]

In mature SG, the synthetic capacity of fibroblasts remains reduced, which likely promotes persistence of disrupted connective tissue components and, hence, permanency of lesions.[11] Histologically, mature SG can resemble scars, with collagen bundles and elastic fibres appearing thin or decreased, and oriented parallel to the epidermis, which appears atrophic.[6,8,9,11]

While not medically dangerous, SG are disfiguring, causing emotional and psychological distress.[2,12] Thus, women remain interested in preventing SG and/or reducing their severity. However, most published studies address the treatment of established SD from a variety of causes. Studies specifically addressing the prevention of new-onset SG or reduction of their severity during pregnancy are sparse. Considering that the molecular pathogenesis of SG may differ from that of SD from other causes,[13,14] we focus specifically on SG in this review. Our review differs from recently published ones[3] in that we discuss SG apart from other types of SD and limit our analysis to topical agents that have been used specifically in the pregnant population.

Additionally, we identify two major strategies (end points) for the prevention of SG, namely (i) preventing the *de novo* development of SG and (ii) reducing the severity of SG that have recently developed. To provide clinicians with an evidence-based review aimed at pregnant women, this report discusses topical modalities with these end points in mind (Table 1).

Methods

A systematic PubMed and Google Scholar search was performed using the terms 'striae', 'striae gravidarum', 'stretch marks', 'pregnancy', 'lifestyle', 'diet', 'exercise', 'centella', 'Trofolastin', 'oil', 'cocoa butter', 'massage', 'hyaluronic acid', 'Alphastria', 'Verum' and 'tretinoin'. Review articles, observational studies, case series and cohort studies published from 1950 to 2014 were included. Articles published in non-English languages that were able to be translated were included. The following article types were excluded: conference proceedings, abstracts, and publications in non-English languages that were unable to be translated.

Risk factors

An important aspect of SG prevention is predicting their development, so that lifestyle modifications or prophylactic therapies can be initiated. Identifying risk factors is central to this goal, but recognizing those consistently associated with SG development remains challenging. Pregnant women with one or more of the attributes listed in Table 2 could be at increased risk for developing SG and would be an appropriate target population for prevention strategies.[4,14–23]

Lifestyle modifications

- Evidence for diet and exercise in preventing SG is lacking.

As indicated in Table 2, increased maternal body mass index and weight gain during pregnancy may be associated with SG development. Accordingly, a healthy diet and regular exercise may play a role in SG prevention. Indeed, some clinicians suggest that stretching exercises, such as aerobics, may be beneficial in this regard. However, there is a lack of data supporting the efficacy of lifestyle modifications in preventing SG or reducing their severity during pregnancy. In one study of 80 nonpregnant individuals, 79% of whom had SD, a 3-month weight-loss programme did not improve the severity of lesions, regardless of the intervention (diet alone, diet plus aerobic exercise, or diet plus resistance exercise).[24,25]

Topical modalities for preventing striae gravidarum

Centella

- Creams containing centella, a medicinal herb, may be effective for preventing SG and reducing their severity.
- As centella is often combined with other ingredients, its specific role in SG prevention requires further investigation.

Centella asiatica, commonly known as centella, is a plant found in South Asia that has been studied for treating leprosy, lupus, venous stasis ulcers and eczema.[26] Trofolastin is a proprietary product containing centella extract, α-tocopherol and collagen–elastin hydrolysates. Another proprietary product contains centella triterpenes formulated in a cream with hydroxyprolisilane-C, rosehip oil and vitamin E. While the mechanism of action of centella is unclear, this ingredient may stimulate fibroblasts and inhibit glucocorticoid activity.[27,28]

Table 1 Topical prevention of striae gravidarum (SG) during pregnancy

Study and intervention	Formulation (if applicable)	Application details (if known)	Method of clinical assessment	Number of subjects analysed	End point 1: prevented new SG?	End point 2: reduced severity of new SG?	Limitations
Centella							
Mallol (1991)[1]	Trofolastin cream (centella extract, α-tocopherol and collagen–elastin hydrolysates)	Daily massage to the abdomen, breasts, buttocks and hips from the 12th week of pregnancy until delivery	Presence of new SG, and severity score designed by authors: 0, no striae; 1, few and thin striae; 2, many thin striae or few thick striae; 3, many thick striae	80 (41 treatment, 39 placebo)	Yes, especially in women with a history of puberty-associated striae; 34% in treated group vs. 56% in placebo group developed SG	Yes; severity score was 1·42 for treated group vs. 2·13 for placebo group	Cream had other ingredients, small study
García Hernández (2013)[31]	Cream with centella triterpenes, hydroxyprolisilane-C, rosehip oil and vitamin E	Twice a day to the abdomen, thighs, hips, buttocks and breasts starting in the 12th week of pregnancy	Presence of new SG, severity score designed by Mallol *et al.* (see above)[1]	183 (93 treatment, 90 placebo)	Yes, but only for women without a history of striae distensae (in these women, SG developed in 6% with treatment vs. 35% with placebo)	Yes (severity remained stable with treatment and worsened with placebo)	Cream had other ingredients
Almond oil							
Timur Tashan (2012)[33]	Bitter almond oil	Massage for 15 min to the abdomen, breasts and thighs every other day in weeks 19–32 of pregnancy, followed by daily until delivery	Presence of new SG, and severity score based on number of SG in a specific anatomical area: mild, 1–3 lesions; moderate, 4–6 lesions; severe, > 6 lesions	141 (47 oil + massage, 48 oil alone, 46 no treatment)	Yes; SG developed in 16/47 with oil + massage, 31/48 with oil alone and 33/46 with no treatment	Yes; on the abdomen, 'severe' lesions did not develop with oil + massage, vs. 3/28 for oil alone and 11/30 for control	Nonrandomized comparative study, massage alone was not studied
Soltanipour (2014)[35]	Saj cream (almond oil, lanolin, stearin, triethanolamine, bizovax glycerin amidine)	Three days per week (twice each day) to the abdomen without massage from gestational weeks 18–20 to weeks 38–40	Presence of SG, and scoring system adapted from Davey.[13] Each abdominal quadrant was scored: 0, no striae; 1, quadrant partly affected by lesions; 2, quadrant completely affected by lesions. Scores were added to determine overall severity: 1–3, mild; 4–6, moderate; 7–8, severe	150 (50 Saj cream, 50 olive oil 1 ml applied identically, 50 no treatment)	No	No	Almond oil alone was not studied (cream had other ingredients), study was not blinded

(continued)

Table 1 (continued)

Study and intervention	Formulation (if applicable)	Application details (if known)	Method of clinical assessment	Number of subjects analysed	End point 1: prevented new SG?	End point 2: reduced severity of new SG?	Limitations
Hyaluronic acid							
de Buman (1987)[36]	Alphastria cream (hyaluronic acid, allantoin, vitamin A, vitamin E and calcium pantothenate)	Massage gently for a few minutes daily to the thighs, abdomen and chest, starting the 3rd month of pregnancy and ending 3 months after childbirth	Presence of new SG	90 (30 treatment, 30 cream with vitamins and excipients, 30 placebo with only excipients)	Yes; 10% in treated group, 40% in the vitamin group, and 37% in the placebo group developed SG	Not specifically addressed	Small study, hyaluronic acid alone was not studied, massage alone was not studied
Wierrani (1992)[34]	Verum cream (vitamin E, essential fatty acids, panthenol, hyaluronic acid, elastin and menthol)	Massage onto the abdomen, thighs and breasts starting the 20th week of pregnancy (frequency not stated)	Presence of new SG	50 (24 treatment, 26 no treatment)	Yes; 29% in treated group vs. 62% in placebo group developed SG	Not specifically addressed	Small number of subjects, no placebo (therefore no blinding possible), poorly randomized, cream had other ingredients, massage alone was not studied
Tretinoin							
Elson (1990)[38]	0·1% cream	Daily in nonpregnant subjects	Observation of lesions during treatment	16	Not specifically addressed	Not specifically addressed	Observational study, small number of subjects, striae were of varying aetiologies (SG during pregnancy not specifically studied), striae were mature
Pribanich (1994)[39]	0·025% cream	Daily for 7 months to the abdomen in nonpregnant subjects who mostly had SG	Severity score of selected target area: no striae; mild, 1 lesion; moderate, 1–2 lesions; moderate–severe, 3–4 lesions; severe, > 4 lesions	11 (6 treatment, 5 placebo)	Not specifically addressed	Not specifically addressed	Small number of subjects, striae were in different stages of development

(continued)

Table 1 (continued)

Study and intervention	Formulation (if applicable)	Application details (if known)	Method of clinical assessment	Number of subjects analysed	End point 1: prevented new SG?	End point 2: reduced severity of new SG?	Limitations
Kang (1996)[40]	0·1% cream	Nightly for 6 months to erythematous striae in nonpregnant subjects	Severity score of lesions: none, mild, moderate, severe. Rating of global response to therapy: −3, much worse; −2, worse; −1, slightly worse; 0, no change; 1, slightly improved; 2, improved; 3, markedly improved; 4, cleared. Length and width of a target lesion	22 (10 treatment, 12 placebo)	Not specifically addressed	Yes, for striae distensae from a variety of causes, including previous pregnancy; 80% in treatment group had marked or definite improvement vs. 8% in control; length and width of target lesions decreased by 14% and 8%, respectively	Small number of subjects, striae were of varying aetiologies (SG during pregnancy were not specifically studied)
Ash (1998)[41]	20% glycolic acid/0·05% tretinoin vs. 20% glycolic acid/10% L-ascorbic acid	Daily in nonpregnant subjects to the abdomen or thighs for 12 weeks (each regimen applied to half the treatment area)	Observation of lesions, photography, profilometry, histopathological examination	10	Not specifically addressed	Not specifically addressed	Small number of subjects, SG were not specifically studied
Rangel (2001)[42]	0·1% cream	Nightly to half the abdomen starting 1 week after delivery for 12 weeks (other half of the abdomen acted as control)	Rating of global response to therapy: −1, worse; 0, no change; 1, slightly improved; 2, improved; 3, markedly improved; 4, cleared. Length and width of a target lesion	20	Not specifically addressed	Yes; 80% had moderate to marked improvement; length and width of target lesions decreased by 20% and 23%, respectively	Small number of subjects, study was not blinded
Cocoa butter							
Osman (2008)[43]	Lotion containing cocoa butter and tocopheryl acetate (vitamin E)	Daily to the abdomen, breasts and thighs from week 12–18 of pregnancy until delivery	Presence of SG. Number of body sites involved. Severity score of each site was rated: 1, mild; 2, moderate; 3, severe	175 (91 treatment, 84 placebo)	No	No	Lotion had other ingredients
Buchanan (2010)[32]	Cream containing 25% cocoa butter and vitamin E oil	Daily from 16th week of pregnancy to delivery	Presence of SG, photography, and scoring system adapted from Davey[13]	300 (150 treatment, 150 placebo)	No	No	Cream had other ingredients

(continued)

Table 1 (continued)

Study and intervention	Formulation (if applicable)	Application details (if known)	Method of clinical assessment	Number of subjects analysed	End point 1: prevented new SG?	End point 2: reduced severity of new SG?	Limitations
Olive oil							
Poidevin (1959)[14]		Nightly application with massage	Presence of SG	116 (50 treatment, 66 no treatment)	No	Not specifically addressed	Observational study
Davey (1972)[13]		Application with massage, duration unclear	Scoring system devised by author. Each quadrant of the abdomen was scored: 0, no lesions; 1, moderate number of lesions; 2, many lesions. Subjects were stratified into groups by their total score: no striae, score of 1–2, score of 3–6	74 (35 treatment, 41 no treatment)	Yes; 26% in treated group vs. 68% in control group developed SG	Not specifically addressed	Retrospective observational study, small number of subjects
Taavoni (2011)[45]		Twice daily to the abdomen without massage from week 18–20 of pregnancy for 8 weeks only	Presence of SG	70 (35 treatment, 35 no treatment)	No	Not specifically addressed	Small study
Soltanipoor (2012)[44]		Twice-daily application of 1 ml to the abdomen without massage from week 18–20 of pregnancy until delivery	Presence of SG, scoring system devised by Davey[13]	100 (50 treatment, 50 no treatment)	No	No	Small study

Table 2 Risk factors potentially associated with development of striae gravidarum

Maternal factors prior to pregnancy
Family history of striae
Personal history of breast or thigh striae
Young age
Baseline weight
Body mass index > 26
Alcohol intake
Light skin colour
Race[a]
Maternal factors during pregnancy
Increased weight gain
Increased body mass index at delivery
Increased abdominal and hip girth
Low serum vitamin C level
Low serum relaxin level
Low water intake
Neonatal factors
Increased gestational age at delivery
Increased birthweight
Increased height and head circumference

[a]Depending on the study, both nonwhite and white race have been associated with increased risk.

Topical application accelerates wound healing and improves the tensile strength of scars.[28] It is possible that centella may improve SG by similar means, as lesions demonstrate clinical and histological features that overlap with scars.[29]

In a randomized, double-blind, placebo-controlled trial involving 80 women, Mallol *et al.* showed that daily massage with Trofolastin cream to the abdomen, breasts, buttocks and hips from the 12th week of pregnancy until delivery was associated with decreased SG incidence.[1,30] Whereas 56% (22 of 39) of women in the placebo group developed SG, 34% (14 of 41) in the treatment group developed lesions. The cream was effective for preventing SG in subjects with a history of puberty-associated SD, but not in subjects with a history of SG from preceding pregnancies. In subjects who developed SG, the cream reduced the severity of lesions, compared with placebo.

In a randomized, double-blind, placebo-controlled trial, García Hernández *et al.* enrolled 183 women, who applied the cream containing centella triterpenes twice a day to the abdomen, thighs, hips, buttocks and breasts starting in the 12th week of pregnancy.[31] The incidence of SG was similar between the treatment and placebo groups (38% vs. 33%, respectively). However, among women who developed SG, the severity of lesions remained stable with treatment, while worsening with placebo. In women without a history of SD, 6% of subjects (one of 17) undergoing treatment developed SG, compared with 35% (seven of 20) in the control arm. The authors concluded that the cream reduced the severity of SG developing during pregnancy, while decreasing the incidence of new SG in women without a history of SD.

Centella is thought to be the active agent in these creams.[1] As this ingredient is often combined with others, well-designed controlled studies are required to determine the specific efficacy of centella for SG prevention. This ingredient may not be readily available in certain countries.[32] In the U.S.A. it is available over the counter and potentially costly.

Almond oil

- There is weak evidence that massage with bitter almond oil may be effective for preventing SG and reducing their severity.
- Other products containing almond oil have not shown similar benefit.

Oils have moisturizing properties, and massage may stimulate blood flow to the skin.[33] It is unclear how the combination of massage with oils may prevent SG or lessen their severity. Bitter almond oil has been used for SG because it reportedly does not pose a risk to the mother and foetus during pregnancy.[33]

In a nonrandomized, comparative study of 141 women with no history of SG, Timur Tashan and Kafkasli divided subjects into three groups.[33] The first group applied bitter almond oil with a 15-min massage every other day during weeks 19–32 of pregnancy, followed by daily application until delivery. The second group applied the oil identically without massage. The third applied nothing. The development of abdominal SG was significantly reduced in the oil plus massage group (16 of 47), compared with oil alone (31 of 48) and the control group (33 of 46). Additionally, if women had developed SG in the abdominal area, lesions were less severe in the oil plus massage group. As bitter almond oil alone was ineffective and massage alone was not studied, further investigation is necessary to clarify which component may be more beneficial for preventing SG. Other studies discussed here have suggested that massage, along with emollients/creams, may be effective for preventing SG.[1,34]

In a more recent randomized controlled trial, almond oil was ineffective as part of a proprietary cream (Saj) containing lanolin, stearin, triethanolamine and bizovax glycerin amidine.[35] Soltanipour *et al.* analysed 150 nulliparous women in the second trimester and observed no difference in the incidence or severity of abdominal SG between no intervention, olive oil without massage, or Saj cream without massage (50 subjects in each group). Lesions developed in 60%, 64% and 64% of participants, respectively.

Hyaluronic acid

- There is weak evidence that creams containing hyaluronic acid, including Alphastria and Verum, can prevent SG.

Alphastria is a proprietary cream containing hyaluronic acid, allantoin, vitamin A, vitamin E and calcium pantothenate. Verum is another proprietary cream containing vitamin E, essential fatty acids, panthenol, hyaluronic acid, elastin and menthol. The active ingredient in both is hyaluronic acid, which is thought to improve tensile resistance to mechanical

forces and counteract atrophy by stimulating fibroblast activity and collagen production to increase skin volume.[25] The exact mechanism of hyaluronic acid in preventing SG is unclear.

Two small studies suggest that hyaluronic acid-containing compounds may prevent SG during pregnancy. In a double-blind study involving pregnant women, de Buman *et al.* demonstrated that Alphastria cream reduced the incidence of SG, compared with placebo (three of 30 vs. 11 of 30 subjects, respectively).[36]

Wierrani *et al.* enrolled 50 pregnant women at 20 weeks' gestation, and found that SG developed in 29% (seven of 24) of women who applied Verum to the abdomen, thighs and breasts with massage, compared with 62% of control subjects (16 of 26), who performed no massage or topical application.[34] This study was not placebo controlled and was poorly randomized.[30] Parity of participants was also unclear, making it difficult to ascertain whether participants had SG from earlier pregnancies.[37] Therefore, further investigation of this preparation for SG prevention is needed, and the specific effects of the ingredients vs. massage need clarification.

Tretinoin

- Tretinoin shows promise for decreasing the severity of erythematous SG.
- Tretinoin is a pregnancy category C drug, and therefore patients should wait until the postpregnancy/lactation period to apply it.

Topical tretinoin partially restores decreased collagen formation in photoaged skin by stimulating the synthetic activity of dermal fibroblasts. As damage of structural proteins such as collagen may also occur in SG, topical tretinoin has been studied for the treatment of this condition. In this context, its exact mechanisms remain unclear.

Early studies produced conflicting results. In an observational study by Elson, tretinoin led to 'significant improvement' of SD from a variety of causes in 15 of 16 patients.[38] In a double-blind, placebo-controlled study by Pribanich *et al.*, tretinoin cream 0·025% was applied daily for 7 months to abdominal SG at various stages of development, with six subjects assigned to treatment and five to placebo.[39] No improvement occurred with treatment compared with placebo.

More recently, in a double-blind, randomized controlled study by Kang *et al.*, 22 patients with early (erythematous) SD from a variety of causes, including pregnancy, applied a higher strength of tretinoin cream (0·1%) or vehicle nightly.[40] After 6 months, eight of 10 subjects in the tretinoin group demonstrated marked or definite improvement of lesions, compared with one of 12 subjects in the vehicle group. Lesions treated with tretinoin showed a mean decrease in length and width by 14% and 8%, respectively, whereas lesions treated with vehicle increased by 10% and 24%, respectively. In a small study of 10 subjects by Ash *et al.*, the appearance of mature white SD on the abdomen or thighs improved with either 20% glycolic acid/0·05% tretinoin or 20% glycolic acid/10% L-ascorbic acid.[41] Finally, in an open-label, prospective study by Rangel *et al.*, tretinoin 0·1% cream was applied nightly to pregnancy-related abdominal SG starting 1 week after delivery.[42] After 12 weeks of application, 16 of 20 subjects demonstrated moderate to marked improvement, and the mean length and width of target lesions decreased by 20% and 23%, respectively.

Of the studies discussed, only three enrolled subjects with pregnancy-related SG,[39,40,42] and only one examined tretinoin use specifically for new-onset SD.[40] The most common side-effects in the studies were localized erythema, scaling, itching and burning, all of which were mild and easily treated with emollients. Topical tretinoin is a pregnancy category C drug, and its use during pregnancy and lactation is not generally recommended.

Cocoa butter

- Studies suggest that cocoa butter, which is often combined with vitamin E, is not effective for preventing SG or reducing their severity.

Cocoa butter is a natural fat derived from cocoa beans, which grow on the tree *Theobroma cacao*. It is often combined with vitamin E oil. Some medical providers suggest applying topical cocoa butter before, during and after pregnancy to prevent SG development.[43] Cocoa butter has emollient properties, although its mechanism of action is not known. Furthermore, the role of vitamin E in preventing SG is unclear.

In a double-blind, randomized, placebo-controlled trial, Osman *et al.* studied 175 nulliparous pregnant women, 91 of whom applied a lotion containing cocoa butter and vitamin E daily to the abdomen, breasts and thighs from 12–18 weeks' gestation until delivery.[43] The remaining subjects applied a placebo lotion lacking cocoa butter and vitamin E. There was no difference in SG development between the intervention and control groups. If SG developed, the severity of lesions was similar between the two groups.

Buchanan *et al.* conducted a similar randomized, double-blind, placebo-controlled study in 300 pregnant Afro-Caribbean women with no previous history of SD.[32] Of these subjects, 150 applied a cream containing 25% cocoa butter and vitamin E oil daily from 16 weeks' gestation to delivery, while the remaining applied a placebo cream. No statistically significant difference was noticed in the development of SG between the treatment and placebo groups, with lesions developing in 44% vs. 55% of subjects, respectively. The intervention cream did not reduce the severity of new SG compared with placebo.

Olive oil

- Studies suggest that olive oil is not effective for preventing SG or reducing their severity.

The use of olive oil for preventing SG is popular. Olive oil is rich in vitamin E and has emollient properties.[44]

Early research produced conflicting results. In an observational study of 116 primagravid women, Poidevin noted that 36 of 50 pregnant women who applied olive oil nightly developed abdominal SG, compared with 36 of 66 pregnant women who did not.[14] These observations suggested that olive oil was not effective as prophylaxis for SG development. In another early observational study, Davey found that the incidence of SG was reduced by up to 42% in primiparous women who had used olive oil during pregnancy, compared with those who did not (26% vs. 68%, respectively).[13] The duration of olive oil use was unclear. These data were obtained retrospectively from questions asked of 76 women in the postpartum period and, therefore, are subject to recall bias.

In a more recent randomized controlled trial, Taavoni *et al.* studied the use of olive oil for a short duration in 70 nulliparous pregnant women.[45] Participants at 18–20 weeks of gestation were randomized to no treatment or application of olive oil to the abdomen without massage twice a day for 8 weeks. Although the incidence of SG was 46% (16 of 35) in the intervention group vs. 63% (22 of 35) in the control group, this difference was not statistically significant. The authors concluded that initiation of olive oil in the second trimester did not prevent SG onset.

In the second phase of the same randomized controlled trial, Soltanipoor *et al.* followed 100 nulliparous pregnant women, who applied either nothing or 1 ml of olive oil to the abdomen without massage twice daily from 18–20 weeks' gestation until delivery.[44] This intervention did not reduce the incidence or severity of SG. Overall, SG developed in 64% (32 of 50) of the intervention group and 60% (30 of 50) of the control group.

Recommendations

There is limited evidence that centella and possibly massage with bitter almond oil may prevent SG and/or reduce the severity of lesions. There is weak evidence that hyaluronic acid can prevent SG. Tretinoin holds promise for reducing the severity of erythematous SG, but its use is limited by its pregnancy category. Cocoa butter and olive oil do not demonstrate efficacy for preventing SG or reducing their severity.

Conclusions

Reliable methods for preventing SG during pregnancy are lacking.[30] Compounds that potentially prevent new-onset SG or reduce their severity lack evidence from rigorous, high-quality, well-designed, randomized controlled trials with ample subject numbers.[37] Additionally, methods of assessing SG severity or response to therapy vary considerably among published studies (Table 1).

Importantly, SG can cause significant distress.[2,12,15] Yet, major barriers exist to conducting rigorous research on SG prevention. For instance, the medical and scientific community remains reluctant to devote substantial research to this condition, likely because the lesions are not physically harmful. Accordingly, the pathogenesis of SG remains unclear, hampering the development of rational therapies. The development of lesions also remains difficult to predict, hindering subject recruitment for prospective studies. In this respect, high-risk groups that tend to develop lesions in predictable anatomical locations, such as pregnant women, may not only be a suitable population for SD prevention trials, but also stand to benefit greatly from positive findings.

Additionally, numerous questions remain regarding the use of prophylactic agents for SG during pregnancy. For instance, if a topical agent is initiated for prophylaxis against SG development, when should a pregnant woman begin to use it? How long should she use it? If a topical agent is used to reduce the severity of recently developed SG, how soon should treatment commence after lesions have formed? Does the age of the subject or multiple gestations impact the efficacy of topical agents? Do combinations of the topical agents discussed above hold promise? What is the safety of various topical modalities during pregnancy and lactation? Finally, what is the cost–benefit ratio of preventative therapies used for SG? These concerns will be important to address in future studies.

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