Title

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Journal

Journal of Alternative and Complementary Medicine, 24(2)

ISSN

1075-5535

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Publication Date

2018-02-01

DOI

10.1089/acm.2017.0145

Peer reviewed

THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE
Volume 00, Number 00, 2017, pp. 1–7

DOI: 10.1089/acm.2017.0145

ORIGINAL ARTICLE

The Effect of Yoga on Arm Volume, Strength, and Range of Motion in Women at Risk for Breast Cancer-Related Lymphedema

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Abstract

Objectives: To assess the feasibility, safety, and initial estimates of efficacy of a yoga program in post-operative care for women at high risk for breast cancer-related lymphedema (BCRL).

Design: Single-group pretest–post-test design.

Settings/Location: Patients were recruited from the University of California, San Francisco Carol Franc Buck Breast Care Center.

Subjects: Twenty-one women were enrolled in the study. Women were >18 years of age, had undergone surgical treatment for breast cancer, and were at high risk for BCRL.

Intervention: The women participated in an Ashtanga yoga intervention for 8 weeks. Sessions consisted of once/week instructor-led practice and once/week home practice. Particular attention was given to poses that emphasized upper body strength and flexibility, while avoiding significant time with the upper extremity (UE) in a dependent position.

Outcome measures: UE volume was assessed through circumferential forearm measurement, which was converted to volume using the formula for a truncated cone. Range of motion (ROM) was assessed for the shoulders, elbows, and wrists, using a standard goniometer. UE strength was assessed for shoulder abduction, elbow flexion, wrist flexion, and grip using a dynamometer.

Results: Twenty women completed the yoga intervention, with 17 returning for final assessment. Mean age was 52 (±9.1) years and body mass index was 24.8 (±5.1) kg/m^2. Postintervention, mean volume in the at-risk UE was slightly reduced ($p = 0.397$). ROM for shoulder flexion ($p < 0.01$) and external rotation ($p < 0.05$) significantly increased bilaterally. Shoulder abduction ROM significantly improved for the unaffected limb ($p = 0.001$). Following intervention, strength improved on the affected side for shoulder abduction and grip strength, and bilaterally for elbow flexion ($p < 0.05$ for all).

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Conclusions: These preliminary findings suggest that yoga is feasible and safe for women who are at risk for BCRL and may result in small improvements in shoulder ROM and UE strength.

Keywords: breast cancer, lymphedema, yoga, exercise

Introduction

Breast cancer-related lymphedema (BCRL) is a complication of breast cancer treatment that can occur as a result of axillary lymph node surgery and/or external beam radiation therapy (XRT).[1] BCRL is defined as the accumulation of interstitial fluid in the upper extremity (UE), breast, or torso as a result of impaired lymphatic function secondary to damage incurred from cancer treatment.[2] BCRL is associated with pain, heaviness, tightness, and decreased range of motion (ROM), all of which negatively impact daily functioning[3] and quality of life (QOL).[3–6] While the exact incidence of BCRL is unknown, estimates range from 5% to 21%.[1,7] These varied rates depend on both individual and treatment-related factors. Increased BCRL rates are associated with receipt of axillary lymph node dissection (ALND), higher number of lymph nodes removed, surgery plus adjuvant XRT, axillary and subclavicular XRT, postoperative seroma, infection, and a higher body mass index (BMI).[8–11] With the large and growing population of breast cancer survivors, the number of women potentially affected by this condition is significant. Given the number of women at high risk for developing BCRL, the mixed effectiveness of prevention strategies for BCRL,[10] and promising safety and efficacy findings for exercise-based therapy,[12,13] identification of feasible exercise strategies for women at high risk for BCRL is warranted.

Early clinical guidelines for patients at risk for developing BCRL included postoperative restrictions on UE exercise and use, which were thought to reduce the risk of developing BCRL. However, these activity restrictions may lead to UE weakness and deconditioning, potentially increasing the risk of injury to the involved extremity.[14] Moreover, there is a growing body of evidence in support of the safety and benefit of upper body strength training in women after treatment for breast cancer, including those with or at risk for BCRL.[12,13] These exercise-based programs may provide women with an opportunity to experience the health benefits of regular exercise that is safe and effective, with the potential for decreasing their risk of developing BCRL.[11,12]

In a systematic review and meta-analysis of 15 randomized controlled trials (RCTs) that evaluated the safety and efficacy of progressive resistance training in women with breast cancer,[15] the pooled odds ratio for the incidence/exacerbation of BCRL (five studies) was 0.53 (95% confidence interval [CI]: 0.31, 0.90), favoring the exercise intervention. In addition to increasing muscular strength,[16] upper body exercises have been shown to increase lymphatic clearance rates in the UEs of women with and without BCRL.[17] Based on current evidence,[12,13,15,18] slowly progressive resistance exercise has been deemed beneficial and safe for women with or at risk for BCRL and may actually reduce the risk of developing BCRL.

However, not all women at risk for BCRL may wish to or be able to participate in a conventional progressive resistance exercise regimen. Yoga is a mind/body medicine approach that can include physical postures (asana), breathing practices (pranayama), and meditation. Yoga postures have been studied for their application in cancer and are one of the more common exercise interventions used by women treated for breast cancer, including those with BCRL, who are pursuing nontraditional treatment options.[19] Patients with breast cancer who have participated in yoga programs demonstrate high levels of adherence to and enthusiasm for the classes, as well as continued independent yoga practice at the completion of formal sessions.[20,21] Yoga practice may also assist in the function of the lymphatic system, resulting in additional benefits to women at risk for BCRL. Extrinsic forces may alter lymphatic flow by a combination of compression and negative pressure. These extrinsic forces can be generated by nearby muscle stretch or contraction, arterial pulsations, and respiratory movements. A yoga intervention focused on upper body strength postures and breath may be a feasible and beneficial exercise program for women at risk for developing BCRL.

Although yoga is a commonly used exercise intervention for women treated for breast cancer, there are limited studies that evaluate the impact of yoga on BCRL.[22–25] Fisher et al.[22] conducted a pilot study to evaluate the effects of yoga on arm volume, UE function, and QOL in six women with BCRL. Women participated in an 8-week modified Hatha yoga program. Statistically significant decreases were found in UE volume, measured with volumetry, following the intervention ($p = 0.02$). An RCT of women with stage I BCRL,[24] compared an 8-week yoga intervention ($n = 15$) to a usual care wait list control group ($n = 13$). UE volume was assessed with circumference measurement and bioimpedance spectroscopy (BIS). After the 8-week intervention, no between-group differences were found in UE volume or BIS. However, at 4 weeks postintervention, there were between-group differences in UE volume changes from 8 to 12 weeks (35.20 mL; 95% CI 3.09, 67.32; $p = 0.032$), representing an increase in volume in the intervention group and a decrease in volume in the control group. QOL outcomes were improved postintervention, but differences did not reach statistical significance, possibly due to the small sample sizes.

In a study of 16 women with and without BCRL following treatment for breast cancer, Lai et al.[23] evaluated responses to a 12-week aerobic yoga program. UE volume was measured via volumetry. Differences in volume at baseline ranged from −5% to 12%. The mean UE volumes were slightly lower from pre- to postintervention, but the reductions were not statistically significant (affected $p = 0.658$; unaffected $p = 0.496$).

No studies have specifically investigated the safety and benefit of yoga interventions for women who do not have

but are at high risk for BCRL. Therefore, the aims of this study were to assess the feasibility of incorporating a yoga program into postoperative care for breast cancer patients at high risk for BCRL and to collect pilot data on the safety and efficacy of the yoga program in these women. The authors hypothesize that yoga will result in improved upper body strength and ROM without increases in UE volume. The results of this study will provide a foundation for a larger RCT and may assist healthcare providers in guiding their patients at risk for BCRL toward appropriate exercise practices.

Materials and Methods

Study design

This study utilized a single-group pretest–post-test design. The study was approved by the University of California San Francisco (UCSF) Institutional Review Board.

Participants

Participants were recruited from the UCSF Carol Franc Buck Breast Care Center. Inclusion criteria were women >18 years of age, who had undergone surgical treatment for breast cancer, and who were at high risk for BCRL due to the existence of one or more of the following: sentinel lymph node dissection with 5 or more lymph nodes removed, ALND, or axillary XRT. Participants were excluded if they had a pre-existing clinical diagnosis of BCRL (arm girth difference >10%), or had participated in yoga or strength training in the prior year, or were unable to comply with an exercise program due to significant mental health disorders, severe medical comorbidities, or other extenuating social or medical situations. All participants provided written informed consent.

Outcomes

Participants completed demographic and health history questionnaires at enrollment. Self-report questionnaires and objective outcomes were evaluated at baseline and at 8 weeks.

Volume. UE girth was assessed bilaterally using a flexible, nonstretch tape measure beginning at the ulnar styloid (marked as 0 cm) and at 4-cm intervals proximally to 40 cm. Circumference measurements were converted to a volume measurement using the formula for a truncated cone,[26] where V is the volume of the segment, $C1$ and $C2$ are the circumferences at the ends of the segment, and h is the distance between them (segment length).

$$V = h(C_1^2 + C_1C_2 + C_2^2)/12\pi.$$

Strength. UE strength was assessed bilaterally, using the MicroFet dynamometer (Hoggan MicroFET2 Muscle Tester; ProMed Products, Atlanta, GA) for shoulder abduction, elbow flexion, and wrist flexion. The Jamar grip dynamometer (North Coast Medical, Morgan Hill, CA) was used to evaluate grip strength, bilaterally. Strength tests were performed twice and a mean was calculated for each.

Range of motion. Bilateral UE ROM was assessed with a standard goniometer using the testing procedures outlined by Norkin and White[27] for shoulder flexion, abduction, internal rotation and external rotation, elbow flexion and extension, and wrist flexion and extension.

Safety analyses involved the examination of the incidence, severity, and type of treatment-emergent adverse events, including any treatment-related falls, injuries, increased pain, or treatment-related increase in UE volume, from enrollment to 8 weeks.

Intervention

The women participated in a twice-weekly 60-min Ashtanga-based yoga practice for 8 weeks. The yoga sessions consisted of a once per week instructor-led practice and a once per week home session with an illustrated instruction manual. The in-person yoga sessions were led by one of two yoga instructors with specific training in working with patients with cancer. The yoga protocol was developed by a yoga therapist, in collaboration with faculty members from the UCSF Osher Center with experience in yoga interventions for patients with breast cancer, and medical personnel from the UCSF breast surgery clinic. The yoga practice was designed to incorporate poses that were safe, with particular attention to poses that emphasize upper body strength and flexibility, while avoiding significant time with the UEs in a dependent position. The asanas used in the program were based on Surya Namaskar A and B sequences, and were gently progressive in nature.

The Surya Namaskar A asanas, listed in order of sequence, included the following: Samasthiti (standing erect); Urdhva Hastasana (lifting arms above head); Uttanasana (forward fold); Ardha Uttanasana (head and chest lift with flat spine); slowly stepping back into Chatturanga Dandasana (plank pose) with bent knees for modification; Urdhva Mukha Svanasana (upward facing dog with slight backbed); and Adho Mukha Svanasana (downward dog). The Surya Namaskar B asanas include all of the listed asanas from Surya Namaskar A with the addition of Virabhadrasana I (bent knee lunge with arms above head). The asanas were paired with breathing patterns of inhaling and exhaling with each sequential pose. Women were encouraged to modify each pose as needed. Limitations were placed on UE weight-bearing poses (i.e., downward-facing dog/Adho Mukha Svanasana was practiced judiciously and modified as needed; head and handstands were not done, nor were shoulder inversions). The overall aim of the intervention was to provide a gentle Ashtanga yoga approach.

Data analysis

Descriptive statistics were calculated for demographic and clinical characteristics, and for study outcomes. For parametric data, paired t-tests were performed to evaluate differences between upper extremities, as well as changes from baseline to 8 weeks. For ordinal or non-normally distributed continuous data, related-sample Wilcoxon test was used. Statistical analyses were performed using SPSS version 22 (IBM Corp., Armonk, NY).

Results

Twenty-one women were enrolled in the study. Twenty women completed the yoga intervention. However, only 17 returned for the final 8-week assessment due to scheduling conflicts. Participant demographic and clinical characteristics are presented in Table 1. The women were, on average, 52 (±9.1) years old with an average BMI of 24.8 (±5.1) kg/m^2. Most of the women were white, had a college degree, and were working at the time of the study. BMI ranged from 19.2 to 37.2, with a mean of 24.8. Baseline and 8-week objective outcomes are presented in Table 2.

Volume

There were no pre- to postintervention changes in limb volume in either UE. Average volume change in the at-risk (affected) UE was −21.68 mL (95% CI −75.45, 32.09; $p=0.397$), indicating a small, nonstatistically significant reduction. Average volume change in the unaffected limb was 5.92 mL (95% CI −29.87, 41.71, $p=0.725$).

Range of motion

For shoulder flexion, the affected limb ROM increased from pre- to postintervention an average of 4.50° (95% CI 1.59, 7.41, $p=0.005$), while the unaffected limb increased an average of 3.24° (95% CI 1.05, 5.42, $p=0.006$). For shoulder external rotation ROM, the affected limb increased an average of 4.65° (95% CI 1.70, 7.59, $p=0.004$), while the unaffected limb increased an average of 2.85° (95% CI 0.05, 5.65, $p=0.046$). The increases in shoulder abduction ROM were not statistically significant for the affected limb (5.59°, 95% CI −2.37, 13.54, $p=0.156$), but were statistically significant for the unaffected limb (7.18°, 95% CI 3.50, 10.86, $p=0.001$).

There were no significant pre- to postintervention changes in elbow flexion ROM in the affected (−1.44°, 95% CI −3.51, 0.63, $p=0.159$) and unaffected (1.21°, 95% CI −0.28, 2.69, $p=0.105$) limbs. There were also no significant changes seen in elbow extension ROM for both the affected (−0.44°, 95% CI −2.04, 1.16, $p=0.566$) and unaffected limbs (−0.18°, 95% CI −1.67, 1.32, $p=0.805$).

There were no significant pre to postintervention differences in wrist flexion ROM in the affected (0.82°, 95% CI −1.00, 2.65, $p=0.352$) and unaffected (1.82°, 95% CI −2.29, 5.93, $p=0.361$) limbs. There were also no significant changes in wrist extension ROM in the affected (0.82°, 95% CI −1.83, 3.48, $p=0.520$) and unaffected (1.62°, 95% CI −1.02, 4.25, $p=0.212$) limbs.

Table 1. Demographic and Clinical Characteristics ($N=21$)

Characteristics	*Mean (SD)*
Age (years)	52.0 (9.1)
Number living in household	2.5 (1.2)
Body mass index (kg/m^2)	24.8 (5.1)
Months since diagnosis	25.9 (13.9)
	% (n)
Children living at home (% yes)	33.3 (7)
Currently working for pay (% yes)	76.2 (16)
Education (highest degree)	
High school diploma	19.0 (4)
College degree	42.9 (9)
Postgraduate degree	38.1 (8)
Lives alone (% yes)	25.0 (5)
Married/partnered (% yes)	61.9 (13)
Race and ethnicity	
Asian	19.0 (4)
Black or African American	4.8 (1)
Hispanic	9.5 (2)
White	66.7 (14)
Right side dominant (% yes)	90.5 (19)
At-risk limb same as dominant limb (% yes)	42.9 (9)
Chemotherapy	57.1 (12)
Radiation therapy	76.2 (16)
Breast cancer treatment combinations	
Surgery and chemotherapy	23.8 (5)
Surgery and radiation	42.9 (9)
Surgery, chemotherapy, and radiation	23.8 (7)

SD, standard deviation.

Strength

Shoulder abduction strength increased from pre- to postintervention an average of 2.44 pounds (lbs) in the affected limb (95% CI 0.58, 4.29, $p=0.013$). Changes in shoulder abduction strength in the unaffected limb were not statistically significant (1.16 lbs, 95% CI −0.55, 2.87, $p=0.170$). Increases in elbow flexion strength were statistically significant bilaterally, with an average increase of 2.70 lbs in the affected limb (95% CI 1.19, 4.22, $p=0.002$) and 2.33 lbs in the unaffected limb (95% CI 0.84, 3.83, $p=0.004$). There were no significant changes in wrist flexion strength in the affected limb (1.45 lbs, 95% CI −0.46, 3.36, $p=0.126$), but statistically significant improvements were seen in the unaffected limb (2.23 lbs, 95% CI 1.07, 3.39, $p=0.001$). Grip strength increased an average of 3.56 lbs in the affected limb (95% CI 1.15, 5.97, $p=0.007$), but changes were not statistically significant for the unaffected limb (2.44 lbs, 95% CI −0.17, 5.06, $p=0.065$).

Adverse events

No treatment-emergent adverse events were reported during or at the conclusion of the yoga intervention. One participant experienced a mild increase in the at-risk limb volume and withdrew from the study. She was referred back to her breast surgeon and a lymphedema therapist, and the increase was deemed unrelated to participation in the yoga intervention but rather to activities outside of the supervised class.

Discussion

This single-group pilot study is the first of its kind to evaluate the feasibility of incorporating a yoga program into postoperative care for breast cancer patients at high risk for BCRL and to collect pilot data on the safety and efficacy of a yoga program in preventing BCRL. Consistent with this hypothesis, the results of this study provide preliminary support for a yoga practice that is feasible and safe for women at high risk for UE BCRL. Moreover, this practice

Table 2. Pre- Versus Postintervention Differences in Arm Volume, Range of Motion, and Strength ($N = 17$)

	Preintervention (baseline), mean (SD)		*Postintervention (8 weeks), mean (SD)*		*Postintervention/preintervention within-limb difference, mean (95% CI)*	
Arm measurements	*Affected arm*	*Unaffected arm*	*Affected arm*	*Unaffected arm*	*Affected arm*	*Unaffected arm*
Volume (mL)	1928.63 (411.75)	1895.30 (361.45)	1906.95 (342.05)	1901.22 (328.20)	–21.68 (–75.45, 32.09)	5.92 (–29.87, 41.71)
Range of motion (°)						
Shoulder flexion	165.56 (10.37)	168.88 (7.22)	170.06 (7.06)	172.12 (5.75)	4.50 (1.59, 7.41)**	3.24 (1.05, 5.42)**
Shoulder abduction	150.62 (24.77)	160.18 (19.6)	156.21 (18.74)	167.35 (15.94)	5.59 (–2.37, 13.54)	7.18 (3.50, 10.86)**
Shoulder external rotation	90.53 (14.20)	97.00 (15.38)	95.18 (13.91)	99.85 (14.86)	4.65 (1.70, 7.59)**	2.85 (0.05, 5.65)*
Elbow flexion	149.47 (6.03)	147.74 (6.03)	148.03 (4.77)	148.94 (5.18)	–1.44 (–3.51, 0.63)	1.21 (–0.28, 2.69)
Elbow extension	1.91 (4.27)	0.85 (5.51)	1.47 (5.01)	0.68 (5.52)	–0.44 (–2.04, 1.16)	–0.18 (–1.67, 1.32)
Wrist extension	71.74 (8.90)	73.18 (7.53)	72.56 (10.13)	74.79 (7.78)	0.82 (–1.83, 3.48)	1.62 (–1.02, 4.25)
Wrist flexion	77.38 (7.76)	76.74 (9.64)	78.21 (7.90)	78.56 (6.58)	0.82 (–1.00, 2.65)	1.82 (–2.29, 5.93)
Strength (pounds)						
Shoulder abductors	26.65 (5.36)	28.31 (5.12)	29.09 (5.31)	29.47 (5.88)	2.44 (0.58, 4.29)*	1.16 (–0.55, 2.87)
Elbow flexors	40.41 (6.40)	41.34 (5.08)	43.12 (6.33)	43.68 (5.15)	2.70 (1.19, 4.22)**	2.33 (0.84, 3.83)**
Wrist flexors	24.28 (5.13)	24.21 (3.54)	25.74 (4.17)	26.44 (4.25)	1.45 (–0.46, 3.36)	2.23 (1.07, 3.39)**
Grip	64.68 (15.17)	64.47 (9.95)	68.24 (12.86)	66.91 (9.83)	3.56 (1.15, 5.97)**	2.44 (–0.17, 5.06)

Statistics: paired *t* tests and related-sample Wilcoxon test statistic for normally distributed and non-normally distributed variables, respectively.
*$p < 0.05$; **$p < 0.01$.
CI, confidence interval; lbs/F, pounds of force; PIP, proximal interphalangeal; SD, standard deviation.

emphasizes upper body strength and flexibility while minimizing UE dependency.

Following an 8-week trial of a combined supervised and home-based yoga exercise program, there were statistically significant increases in bilateral shoulder flexion and unaffected-side shoulder abduction ROM. However, these improvements were small. Similarly, increases in UE strength following the intervention were also small. Importantly, limb volume did not increase in the at-risk UE. While there was a small decrease in affected limb volume, this small average reduction did not reach statistical significance. However, clinical improvements noted in the affected limb, in this high-risk population, may be significant in reducing the symptomatic effects of BCRL. For example, increasing shoulder ROM and/or strength might allow a person at risk for BCRL to participate in more functional activities or exercises, which would help in the activation of muscle pump activity, which in turn would aid in lymphatic fluid drainage. Future larger RCTs of longer duration and with longer term follow-up are necessary to confirm this finding and to evaluate the potential for risk reduction.

Current guidelines for all cancer survivors include regular performance of an exercise program as a strategy for maintaining a healthy weight and decreasing cancer recurrence.[28,29] Although evidence points to improvement in QOL and symptoms with physical exercise, the majority of breast cancer survivors do not adhere to regular physical activity regimens after treatment.[30] One obstacle to adherence may be a lack of exercise options. For example, patients may not wish to engage in regular resistive exercise, or may lack access to equipment and supervision. The low attrition rate (i.e., <5%; 1 out of 21 women) found in this study suggests that yoga may offer an alternative exercise regimen, which promotes patient adherence and provides physiologic and mental health benefits.[31] Previous findings from yoga intervention trials also suggest similar benefits in women with a history of breast cancer. For example, breast cancer survivors with[32] and without[33] BCRL reported improvements in well-being, body awareness, fatigue, depression, sleep disturbance, anxiety, and empowerment associated with yoga practice. Although sufficient data were unavailable to report QOL and sleep outcomes in this study, the yoga therapist leading the classes reported positive feedback from the women in the program with regard to decreases in stress levels and improvements in ability to relax. Given these positive outcomes, the current limitations of BCRL prevention and treatment, and the previous findings for the safety of yoga in women with[34] and at risk for BCRL, clinicians should consider incorporating yoga as part of their survivorship care plan. The asanas from Namaskar A and B used in this study synchronize breath and movement to promote circulation and strength in the upper and lower extremities. Prior studies demonstrate that these movements improve pain, stiffness, swelling, and strength[35] and are safe in women after breast cancer treatment.[18]

The preliminary evidence provided by this pilot study supports further evaluations of the safety and efficacy of yoga interventions for women at risk of developing BCRL. Future RCTs are needed to compare outcomes with usual care and alternate exercise interventions. Moreover, future trials should include objective and subjective BCRL measures and evaluate associated QOL and symptom-related outcomes. Findings from future studies may assist healthcare providers in making recommendations regarding the incorporation of yoga practice into a cancer rehabilitation program.

There are study limitations that warrant consideration. This single-group pilot study did not include a control or comparison group to control for confounding variables. In addition, the small sample size may also have limited the power of the study to detect a true change when one was present (type 2 error). However, while increasing sample size may increase the precision of the estimate, a larger sample size may not have an impact on the magnitude of the effects seen in this study, which were quite small. Most of the women in this study were white, well educated, and able to work, minimizing generalizability. In addition, the intervention was provided for only 8 weeks, which may not be of sufficient duration to develop significant improvements in strength or reductions in limb volume.

Conclusion

This study provides preliminary data to assist with design of a larger RCT to evaluate the efficacy of yoga in preventing BCRL or reducing UE volume, and improving UE strength and ROM in women at risk for or with BCRL. In addition, these preliminary findings suggest that yoga is safe for women who are at risk for BCRL and may result in small improvements in shoulder ROM and strength. Future studies are warranted to determine if yoga can provide safe, effective, and feasible long-term exercise options for women that can promote health and prevention of future morbidities.

Acknowledgment

This study was funded by a Resource Allocation Program grant from the University of California San Francisco Mount Zion Health Fund.

Author Disclosure Statement

No competing financial interests exist.

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