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To cite this article: Kyla Z. Donnelly, Kate Linnea, Daya Alexander Grant & Jonathan Lichtenstein (2016): The feasibility and impact of a yoga pilot programme on the quality-of-life of adults with acquired brain injury, *Brain Injury*, DOI: [10.1080/02699052.2016.1225988](https://doi.org/10.1080/02699052.2016.1225988)

To link to this article: <http://dx.doi.org/10.1080/02699052.2016.1225988>



Published online: 12 Dec 2016.



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ORIGINAL ARTICLE

The feasibility and impact of a yoga pilot programme on the quality-of-life of adults with acquired brain injury

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ABSTRACT

Objective: This pilot study measured the feasibility and impact of an 8-week yoga programme on the quality-of-life of adults with acquired brain injury (ABI).

Methods: Thirty-one adults with ABI were allocated to yoga ($n = 16$) or control ($n = 15$) groups. Participants completed the Quality of Life After Brain Injury (QOLIBRI) measure pre- and post-intervention; individuals in the yoga group also rated programme satisfaction. Mann-Whitney/Wilcoxon and the Wilcoxon Signed Rank tests were used to evaluate between- and within-group differences for the total and sub-scale QOLIBRI scores, respectively.

Results: No significant differences emerged between groups on the QOLIBRI pre- or post-intervention. However, there were significant improvements on overall quality-of-life and on Emotions and Feeling sub-scales for the intervention group only. The overall QOLIBRI score improved from 1.93 (SD = 0.27) to 2.15 (SD = 0.34, $p = 0.01$). The mean Emotions sub-scale increased from 1.69 (SD = 0.40) to 2.01 (SD = 0.52, $p = 0.01$), and the mean Feeling sub-scale from 2.1 (SD = 0.34) to 2.42 (SD = 0.39, $p = 0.01$).

Conclusion: Adults with ABI experienced improvements in overall quality-of-life following an 8-week yoga programme. Specific improvements in self-perception and negative emotions also emerged. High attendance and satisfaction ratings support the feasibility of this type of intervention for people with brain injury.

ARTICLE HISTORY

Received 11 February 2016
Revised 1 July 2016
Accepted 15 August 2016
publisher online 13
December 2016

KEYWORDS

Traumatic brain injury; rehabilitation; community based rehabilitation; mindfulness; community integration

Introduction

Each year in the USA, over 3 million individuals experience an acquired brain injury (ABI), one of the leading causes of death and disability [1,2]. These injuries are most often caused by trauma, stroke and brain haemorrhage or infections that occur after birth [3]. Individuals affected by ABI often experience physical [4–6], cognitive [7] and psychological challenges [8,9] that compromise quality-of-life. For example, over 60% of individuals with brain injury develop anxiety, depression or another psychiatric disorder within the first year following their injury [10]. They also often have challenges resuming education, employment and independent living [11–14]. Despite the variety of poor outcomes related to ABI, there is no consensus on the best practises for delivering effective, well-coordinated rehabilitation [15,16]. Thus, not surprisingly, individuals experience dissatisfaction with their quality-of-life both acutely and long after their injury [17,18].

Yoga is being increasingly introduced as an alternative rehabilitation modality for a broad array of clinical populations (e.g. breast cancer [19,20], depression [21], cardiovascular disease [22]). The practise of yoga integrates physical movement (*asana*), breathing exercises (*pranayama*) and meditation practices [23]. The purpose of these components is to build strength, flexibility and coordination, in addition to promoting stress reduction and self-regulation [23,24]. Recently, yoga interventions have been utilized for people with neurological conditions because of

their potential to benefit several aspects of the rehabilitation process [25]. For example, yoga has been shown to address some of the key symptoms and sequelae of ABI, notably promoting quality-of-life [26] as well as building self-esteem [27] and reducing stress [28] and anxiety [29].

A small number of studies have examined the benefits of yoga for individuals with brain injury. The results have been promising as improvements in both physical and psychological wellbeing emerged [30–35]. For example, a recent study found that 47 ABI survivors (i.e. stroke) who were randomized to a yoga programme significantly improved their strength, mobility and dexterity, while no changes occurred in the control group [30]. Garrett et al. [35] found that nine individuals with ABI (i.e. stroke) experienced increased calm and improved awareness of bodily sensations following a 10-week yoga programme. Some studies also found that yoga improved the quality-of-life of individuals with traumatic brain injury [33,36,37]. Importantly, however, these studies have used generic quality-of-life measures (e.g. Perceived Quality of Life Scale and Short Form-36) that may not adequately capture specific impairments related to brain injury [38]. This study sought to address this gap by examining the impact of yoga on the quality-of-life of adults with ABI utilizing a disease-specific measure [39].

The aim of the study was to examine the feasibility and impact of a yoga pilot programme among adults with ABI.

Specifically, a pre–post study design with a comparison group was utilized to examine the effects of an 8-week programme on the quality-of-life of adults with ABI. It was hypothesized that individuals who participated in the programme would experience improvements in quality-of-life, whereas individuals who did not participate in the programme would not. As this represents a relatively novel rehabilitation approach within the ABI population, particularly in rural communities where services are limited [40], no predictions were made regarding programme feasibility. The results will inform the implementation of a larger scale yoga programme for people with brain injury.

Methods

Participants

To be eligible for this study, individuals had to be at least 18 years old, perceive themselves as able to participate in gentle physical movement, able to read, write and speak English and have a history of ABI. Thirty-one individuals were eligible for study participation. These participants included 11 males and 20 females who ranged in age from 23–72 years.

Procedure

Recruitment efforts targeted local ABI support groups, ABI rehabilitation facilities, a Veterans Affairs medical centre, media outlets in the local community (i.e. list-serves, mailing lists), and social media (e.g. Facebook). Prospective participants were instructed to visit the website of the LoveYourBrain Foundation (www.loveyourbrain.com), a non-profit that works to improve the quality-of-life of people affected by traumatic brain injury. The website provided information about the pilot programme and a link to sign up electronically. All interested participants received an electronic information sheet, which described the programme, its duration, and eligibility requirements. Individuals provided informed consent by clicking ‘next’ on this information sheet, which then allowed them to enter a Qualtrics survey. Eligible participants ($n = 31$) were assigned to the treatment group or to the control group if travel distance prevented their participation in yoga classes. This project was approved by the Dartmouth College Institutional Review Board.

Intervention

Four certified yoga teachers were trained in a gentle yoga curriculum designed for individuals with brain injury. This curriculum was created by a certified yoga instructor affiliated with the LoveYourBrain Foundation. Teachers were trained to offer modifications to poses for individuals with neck pain, balance challenges, and limited strength, which are common consequences of ABI. These modifications included the use of chairs and blocks. The curriculum emphasized using simple, slow, and repeated pose sequences and integrated class themes (e.g. acceptance, positive thinking, resilience) to address potential challenges experienced during the ABI recovery process.

The yoga programme was offered at a wellness centre in a rural community in New Hampshire, USA for 8 weeks in October through December. During this time, participants attended 1-hour classes that were offered twice a week (four classes were cancelled due to weather and holiday conflicts). Teachers used a variety of slow sequences designed to improve balance, strength, and stamina, and incorporated meditation and breathing exercises (sitting or supine) to promote concentration and relaxation.

Data collection

Surveys were collected before, during, and following the yoga programme. Individuals in both intervention and control groups were required to complete an electronic pre-intervention survey within 2 weeks of the first yoga class. This survey included questions that screened for eligibility, and measured demographic information, ABI history, yoga and meditation experience and quality-of-life. At the end of the programme, all participants were invited to complete an electronic post-visit survey, which again included a quality-of-life measure.

Individuals in the intervention group were asked to complete brief paper-based questionnaires after each class to describe what they liked and what could be improved. They also completed a questionnaire after the last class to rate their satisfaction with the programme as a whole and to share feedback about their experience.

Measures

Within the online survey, the frequency of ongoing symptoms that could compromise participation in yoga classes, including seizures, balance issues, fatigue and uncontrolled blood pressure, were assessed using a 3-point Likert scale (i.e. 1 = ‘never’, 2 = ‘occasionally’, 3 = ‘very frequently’). Participants were asked to indicate their age at the time of injury and describe in open-text format their type of ABI, previous modes of treatment and rehabilitation and yoga and meditation experience. Individuals with traumatic brain injury provided the severity classification of their injury (i.e. 1 = ‘mild’, 2 = ‘moderate’, 3 = ‘severe’). Satisfaction with the programme was measured using two self-developed questions: ‘How would you rate this programme?’ (1 = ‘worst’ to 10 = ‘best’) and ‘Would you recommend this program to a friend?’.

An adapted version of the Quality-of-Life After Brain Injury instrument (QOLIBRI) was used to assess quality-of-life across several domains including: Cognition, Self, Daily life and Autonomy, Social Relationships, Emotions and Physical Problems [41,42]. Modifications to this measure were made in an attempt to reduce participant burden [43]. Specifically, a 3-point Likert scale was utilized instead of a 5-point Likert scale and items from the Social Relationships domain were omitted. Anchors indicated the degree to which the individual is satisfied (i.e. 1 = ‘not at all’, 2 = ‘moderately’, 3 = ‘very’) or bothered, which was reverse scored to correspond with the satisfaction items. Mean ratings were calculated for each sub-scale and for overall quality-of-life.

Data analysis

Descriptive statistics, including independent samples Mann-Whitney/Wilcoxon test and Fisher's exact tests, were used to examine the demographic and ABI characteristics of the intervention and control group at baseline (Table I). Due to the limited sample size, the non-parametric independent samples Mann-Whitney/Wilcoxon test was used to compare the total and sub-scale scores for the adapted QOLIBRI between groups in the pre- and in the post-intervention periods. This study also compared the differences in means of these scores between groups over the study period. Lastly, the non-parametric paired sample Wilcoxon Signed Rank test was conducted to evaluate differences within groups for the total and for each sub-scale of the adapted QOLIBRI between the pre- and post-intervention periods.

Results

Participants in the control and treatment groups were compared on demographic and brain injury characteristic variables (see Table I). With one exception, results indicated no significant differences between groups. Specifically, age at the time of ABI was significantly younger in the control, relative to the treatment group (Mann-Whitney/Wilcoxon test, $p = 0.02$).

The majority of participants in the intervention and control groups had a history of traumatic brain injury ($n = 26$) and a smaller cohort had a history of stroke ($n = 1$), brain aneurysm ($n = 1$), brain tumour ($n = 1$), brain surgery ($n = 1$) or hypoxia ($n = 1$). Across control and treatment groups, individuals were an average of 5 years post-injury and had participated in a range of rehabilitation activities (e.g. cognitive behavioural therapy, physical therapy, support groups, acupuncture, occupational therapy and speech therapy).

The overall mean participation rate for the intervention was 75%. In the intervention group, one participant discontinued the programme after taking the first class and three failed to complete post-intervention measures. In the control group, six participants were lost to follow-up. Figure 1 describes the participant flow in both groups.

Quality-of-life

No statistically significant differences emerged between groups on the total and individual adapted QOLIBRI sub-scales at pre- or post-intervention. However, a significant improvement was found in the total and Emotions and Feeling sub-scales for the intervention group between the pre- and post-intervention (Table II). As shown in Figure 2, the total QOLIBRI score improved from 1.93 (SD = 0.27) to 2.15 (SD = 0.34, $p = 0.01$), but the control group did not significantly improve. The Emotions sub-scale increased from 1.69 (0.40) to 2.01 (0.52, $p = 0.01$), indicating that participants felt more satisfied with their level of energy, motivation, self-esteem, self-perception, appearance, achievements since their ABI and/or future prospects relative to pre-intervention. The Feeling sub-scale increased from 2.10 (SD = 0.34) to 2.42 (SD = 0.39, $p = 0.01$), indicating that participants felt less bothered by negative emotions including feeling lonely, bored, anxious, sad or depressed and/or angry or aggressive relative to pre-intervention. In contrast, within the control group, no significant differences emerged on any QOLIBRI sub-scales between pre- and post-intervention periods. There were also no significant differences in the differences in the group mean scores over the study period.

Overall, 83% of individuals in the intervention group ($n = 10$) experienced increases in the mean total QOLIBRI score, whereas only 33% of individuals in the control group ($n = 3$) experienced increases.

Table I. Demographic and brain injury history characteristics.

	Intervention ($n = 16$)	Control ($n = 15$)	p -value
Age (years), mean (SD)	52.3 (11.4)	44.2 (14.5)	NS
Sex, n (%) male	6 (54.6)	5 (45.5)	NS
Age at the time of brain injury (years), mean (SD)	48.7 (11.3)	37.0 (15.2)	0.02
Age since brain injury (years), mean (SD)	3.6 (3.0)	6.9 (10.9)	NS
Brain injury severity, n (%) [§]			NS
Mild	3 (21.4)	4 (36.4)	
Moderate	8 (57.1)	2 (18.2)	
Severe	3 (21.4)	5 (45.4)	
Experience with yoga, n (%)	8 (53.3)	10 (71.4)	NS
Experience with meditation, n (%)	8 (53.3)	9 (64.3)	NS
Balance issues, n (%)			NS
Never	4 (28.6)	2 (13.3)	
Occasionally	7 (50.0)	10 (66.7)	
Very frequently	3 (21.4)	3 (20.0)	
Fatigue, n (%)			NS
Never	2 (13.3)	1 (6.7)	
Occasionally	7 (46.7)	3 (20.0)	
Very frequently	6 (40.0)	11 (73.3)	
Seizures, n (%)			NS
Never	11 (78.6)	13 (92.9)	
Occasionally	3 (21.4)	1 (7.1)	
Very frequently	0 (0)	0 (0)	
Uncontrolled blood pressure, n (%)			NS
Never	14 (100)	10 (71.4)	
Occasionally	0 (0)	3 (21.4)	
Very frequently	0 (0)	1 (7.1)	

Note: Numbers differed across analyses due to occasional missing data. Sample sizes ranged from 25–31.

[§] Only includes participants with traumatic brain injury.

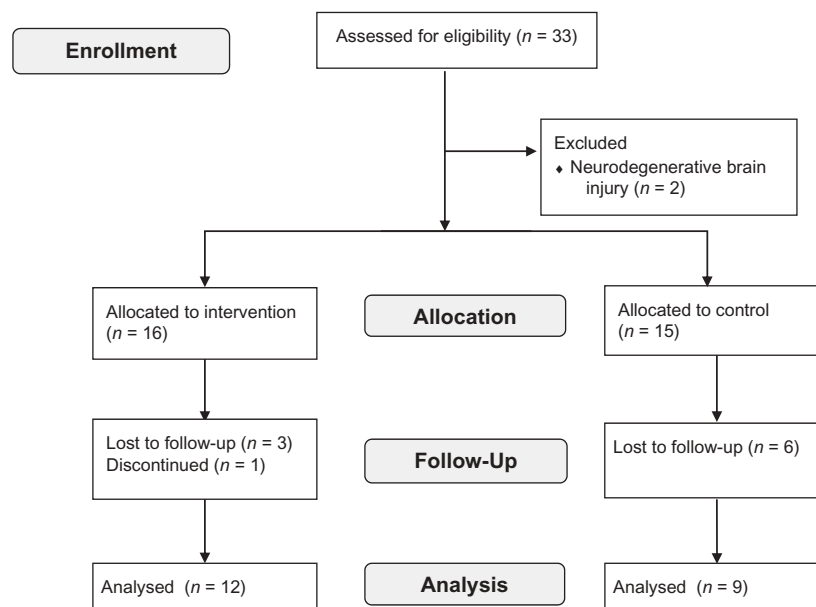


Figure 1. Participant flow in intervention and control groups.

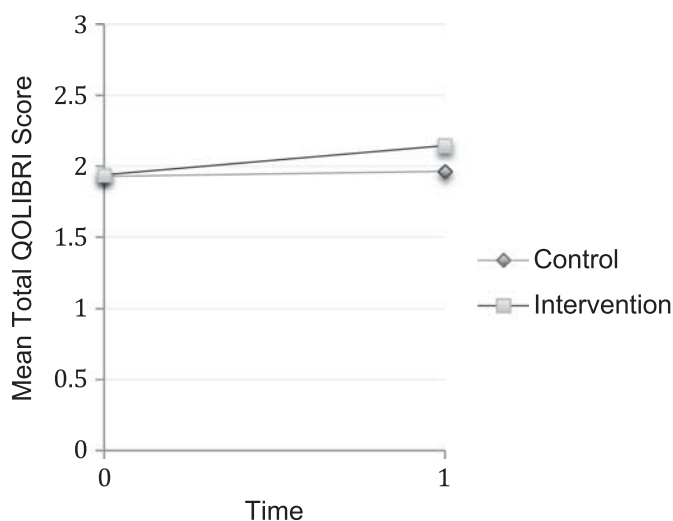


Figure 2. Mean total QOLIBRI scores by intervention and control groups. 0 = pre-intervention, 1 = post-intervention.

Programme satisfaction

At the end of the study, the mean programme satisfaction rating was 9.2 out of 10. In addition, 100% of participants reported that they would recommend the programme to a friend. The qualitative feedback suggested that participants experienced myriad psychological and physical benefits; improvements in overall wellbeing, sleep quality, emotional state and concentration were among the benefits listed.

The programme has already made a big difference in how I feel. My mind feels clearer and I feel more calm. I am getting more sleep at night and waking up less in the middle of the night.

One participant who struggled with hemiparesis described how he felt the yoga practise improved his awareness of bodily sensations.

Waking up different muscles and feeling the nerves get activated. Many of which aren't normally used in my day-to-day movements. Switching it up keeps new sensations to the brain.

Furthermore, being a part of a community of people with similar experiences was also perceived as beneficial.

I appreciate the positive intentions and so many other people in the class. Makes me realize I am not alone in coping with brain injury.

The main suggestion for how to improve the programme was to create handouts with information about yoga poses and terminology that participants could take home to review between classes. This likely reflects the additional support needed for difficulties with memory, which was indicated by several participants. Many participants also shared the importance of keeping a slow pace, instructing clearly and simply to prevent left and right confusion, maintaining low lighting and avoiding music with words.

Discussion

This pilot programme provides preliminary evidence that yoga may benefit aspects of the quality-of-life of people with ABI. Although there were no differences between groups' perceived quality-of-life following the intervention, participants in the yoga programme did experience significant improvements in their overall quality-of-life, emotional wellbeing, and self-perception over the study period, whereas those in the control group did not.

These results have important implications on the design and implementation of rehabilitation efforts for brain injury. First, a positive sense of self and the future, as reflected by the constructs of the Emotional sub-scale (e.g. motivation, self-esteem, self-achievement, self-perception, future outlook), are aspects of resilience [44]. Resilience—the ability to bounce back from adversity and adapt to changing demands of stressful experiences—[45] is often low among individuals with ABI

Table II. Mean QOLIBRI scores by total and sub-scale for intervention and control groups in pre- and post-intervention periods.

QOLIBRI item	Intervention (n = 12)			Control (n = 9)		
	Pre mean (SD)	Post mean (SD)	p	Pre mean (SD)	Post mean (SD)	p
<i>How satisfied are you with your:</i>						
Thinking abilities	1.94 (0.32)	2.05 (0.36)	NS	1.89 (0.53)	1.84 (0.54)	NS
Emotions and view of yourself	1.69 (0.40)	2.01 (0.52)	0.01	1.59 (0.29)	1.87 (0.61)	NS
Independence and how you function in daily life	1.96 (0.36)	2.20(0.55)	NS	2.19 (0.52)	1.98 (0.57)	NS
<i>How bothered are you by your:</i>						
Feelings	2.10 (0.34)	2.42 (0.39)	0.01	2.09 (0.60)	2.20 (0.50)	NS
Physical problems	2.02 (0.45)	2.11 (0.44)	NS	2.0 (0.65)	2.0 (0.50)	NS
<i>Overall</i>	1.93 (0.27)	2.15 (0.34)	0.01	1.93 (0.40)	1.96 (0.48)	NS

and contributes to their psychological distress and psychosocial maladjustment [46]. Additionally, increased resilience has been associated with less post-concussive symptoms including fatigue, insomnia and depressed mood in individuals with traumatic brain injury [47]. There is also evidence that improvements in emotional health, including feeling less anxious and depressed, correlates with improved speed of thinking and executive abilities [48] and ability to return to work [48,49] among people with brain injury. Given these benefits, yoga may be a useful avenue for generating clinically important rehabilitation outcomes.

The group-based format of the yoga programme was also seen as beneficial and supported community integration, one of the major goals of ABI rehabilitation [18,50]. Specifically, the classes offered a valuable opportunity for social engagement, an aspect of community integration that individuals with ABI significantly value [50–52]. For example, a randomized controlled trial of a yoga intervention for 22 individuals with ABI (i.e. stroke) found that participants appreciated the group format and, at its conclusion, were concerned that no similar services were available in their community [53]. Moreover, the classes were offered within participants' community as opposed to a clinical context. Both people with ABI [50] and their caregivers [54] prioritize community-based services in long-term rehabilitation, in part because they have the advantages of being sustainable [55], normalizing [50] and cost-effective [56]. In conjunction with participants' high attendance, these results suggest the acceptability and feasibility of adapting yoga for the brain injury community.

In light of several promising findings, a number of study limitations deserve mention. First, adapting the QOLIBRI to have three answer categories was intended to simplify the measure to address challenges with obtaining valid and reliable self-reported outcomes among individuals with cognitive impairment, a recognized concern with brain injury [43]. Although including two or three answer categories has helped other populations with cognitive function limitations reliably report on quality-of-life [57], this resulted in a loss of sensitivity. Also, omitting the Social Relationships questions from the QOLIBRI prevented us from assessing the impact of the intervention in an area relevant to the ABI population. Indeed, given the feedback from several participants (e.g. feeling a sense of community and belonging), it is likely that improvements on this scale, specifically, may have been revealed. Although this study was able to calculate an overall quality-of-life score as less than one third of the items were missing [42], it should be noted that the missing items

originated from a single domain, Social Relationships. Given the multi-faceted nature of yoga, certain components of the programme, such as physical movement, meditation exercises or the group-based setting, may have mediated the positive trends in quality-of-life. However, a randomized trial of Qigong, an exercise practice similar to yoga, for a group of 20 individuals with TBI similarly found that mood and self-esteem improved in the Qigong group, but not among those who only participated in social activities, suggesting that the combination of movement, meditation and socialization may be important [58]. Nevertheless, as proposed by several evidence summaries [24,59], larger and more rigorous research is needed to examine the components of yoga interventions (e.g. type, setting) to better understand the mechanisms underlying change. Although this study did not yield improvements in physical problems, these findings are not necessarily inconsistent with the literature pointing to improved physical functioning following yoga intervention [30,32]. Specifically, these studies typically utilized objective measures of physical functioning, whereas this study assessed self-reported physical problems as rated by participants on the QOLIBRI. Future studies interested in capturing physical functioning outcomes should consider utilizing both types of measures. Future studies should also consider using more reliable data collection methods for brain injury severity, such as neuropsychological tests, in-depth interviews and medical record review, which would have been impractical in this study design [60]. Although group comparisons did not suggest significant differences between treatment and control group characteristics, future studies should consider applying random assignment to allow for inferences around causality.

These limitations notwithstanding, this study provides important methodological improvements to several previous studies in this area. Notably, the use of the adapted QOLIBRI, which was designed to capture areas of impairment often experienced by individuals with traumatic brain injury, is novel and allows for more detailed insight into rehabilitation outcomes for individuals who have sustained a brain injury. Second, the few studies examining the impact of yoga for ABI rehabilitation generally have had smaller samples [33] and/or comprised case studies that do not have comparison groups [32,35].

Conclusion

Yoga interventions have the potential to benefit multiple aspects of ABI survivors' quality-of-life and contribute to rehabilitation goals, including a positive sense of self,

psychological wellbeing, and community integration. Larger and more rigorous comparative studies that investigate the components, frequency, duration and intensity of such interventions are needed to determine best practises.

Acknowledgements

The authors are grateful to the LoveYourBrain Foundation for their assistance in recruitment and supporting teachers' participation. The authors also appreciate the in-kind support given by Jennifer Poljacik and her team at the River Valley Club.

Declaration of interest

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: KD and DG have done consultancy for the LoveYourBrain Foundation and have received financial support for business travel; KD is married to the Executive Director of the LoveYourBrain Foundation; JL and KL have no relationships or activities that could appear to have influenced the submitted work. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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