



## Research Article

## Sensory threshold for defecation and its correlation with pelvic organ prolapse: An exploration of related factors

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## ARTICLE INFO

## Keywords:

Anorectal function  
Defecation sensory threshold  
Pelvic organ prolapse

## ABSTRACT

**Objectives:** This research aimed to investigate changes in defecation sensory threshold and related factors in patients with posterior vaginal wall prolapse.

**Methods:** A total of 214 patients with pelvic organ prolapse were recruited between October 2019 to January 2021. All patients underwent a defecation sensory threshold examination, physical examination, and pelvic floor ultrasound examination. Factors related to the defecation sensory threshold were analyzed.

**Results:** (1) Among the participants, 57 patients (26.6%) had a defecation sensory threshold of more than 90 ml. Patients with a threshold > 90 ml showed higher scores of defecation dysfunction in the Constipation Scoring System (CSS) score ( $p=0.003$ ) and higher scores of constipation in the Colorectal-anal Distress Inventory 8 (CRADI-8) score ( $p=0.002$ ). (2) The defecation sensation threshold positively correlated with the Ap point ( $r=0.448$ ,  $p < 0.001$ ), the Bp point ( $r=0.345$ ,  $p=0.009$ ), the area of the levator-ani hiatus measured by transvaginal ultrasound ( $r=0.403$ ,  $p=0.002$ ), and parity ( $r=0.355$ ,  $p=0.007$ ).

**Conclusions:** Patients diagnosed with pelvic organ prolapse commonly experience an increased threshold of defecation sensation. Elevated thresholds were associated with more frequent constipation symptoms. Additionally, the severity of posterior pelvic prolapse positively correlated with the defecation sensory threshold.

## 1. Introduction

Defecation disorder is a common symptom in patients diagnosed with pelvic organ prolapse (POP).<sup>1</sup> Chronic constipation leads to increased abdominal pressure, which is a significant contributing factor in the pathogenesis of POP.<sup>2</sup> Simultaneously, POP causes changes in the supporting structure of the pelvic floor, impacting the anorectal emptied function of patients and contributing to the development of defecation disorders.<sup>3</sup> In clinical practice, the balloon expulsion test is used for the preliminary diagnosis of constipation, while rectal balloon dilation facilitates the examination of rectal sensation and rectum wall contraction, serving as a routine method for assessing anorectal function for over three decades.<sup>4</sup> The threshold of defecation sensation, representing the volume of the balloon when the patient first experiences the desire to

defecate, is a crucial indicator of anorectal function. An increased threshold can be a symptom of rectal hyposensitivity.<sup>5</sup> A recent cohort study has indicated that alterations in the anatomical structure of the posterior vaginal wall play a role in the development of defecation disorders.<sup>1</sup> Despite this, there is a lack of research data concerning the threshold of defecation sensation in patients with POP, particularly in cases of posterior vaginal wall prolapse. The present study aims to explore changes in the defecation sensory threshold in patients with posterior pelvic prolapse and investigate related influencing factors. The findings will contribute valuable insights for physical and functional examinations in evaluating posterior pelvic prolapse.

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## 2. Materials and methods

### 2.1. Patient selection

The Ethics Committee of Peking University People's Hospital approved this cross-sectional study (Ethics Number: 2019PHB273-01). Patients with POP admitted to Peking University People's Hospital between May 2019 and January 2021 were recruited for the study. The following inclusion and exclusion criteria were applied:

**Inclusion Criteria:** 1) Patients diagnosed with POP-Q stage II or above, based on the POP-Q diagnostic criteria. This indicates that any of the three compartments, including the anterior vaginal wall, uterus or fornix, and posterior vaginal wall, reached POP-Q stage II or above. 2) Willingness to undergo relevant pelvic organ prolapse examinations.

**Exclusion Criteria:** 1) Patients who had previously undergone surgery for POP. 2) Patients diagnosed with "colon slow transit constipation". 3) Previous diagnosis of ulcerative colitis, Crohn's disease, or colorectal malignancy.

### 2.2. Research methods

We included a total of 214 eligible patients with POP-Q stage II and above. Each patient underwent a comprehensive evaluation, which included a detailed medical history investigation, questionnaire assessment, physical examination, defecation sensory threshold examination, and pelvic floor ultrasound examination. The physical examination involved POP-Q measurement. For the questionnaire assessment, we used the Roman III standard for functional constipation, as well as the Constipation Scoring System (CSS) and the Colorectal-anal Distress Inventory 8 (CRADI-8) to evaluate constipation-related symptoms.

**Defecation sensory threshold examination:** During this examination, the patient was positioned in lithotomy. A No. 16 catheter was prepared, and its end was cut off to allow insertion into a balloon made from a condom, which was then securely tied with a thread. The balloon was gently introduced into the rectum, and a 50 ml syringe was used to inject water into the balloon. The researcher asked the patient if she experienced the desire to defecate. Once the volume of water reached the minimum required to induce the urge to defecate, the researcher ceased the injection and recorded the defecation sensation threshold. Currently, there is no well-established definition of the defecation sensation threshold in healthy adult women. While the conventional balloon expulsion test typically uses 50 ml of water or air to inflate the balloon, this volume does not necessarily represent the cut-off point of the defecation sensation threshold. Therefore, based on the latest literature,<sup>6</sup> we set the cut-off point for our study at 90 ml. By employing these research methods, we aimed to gain valuable insights into the defecation sensory threshold and its association with pelvic organ prolapse in our patient cohort.

### 2.3. Statistical analysis

For data analysis, we utilized SPSS 24.0 statistical software, and GraphPad Prism 8.0 software was employed for data visualization. Measurement data were presented as either mean ± standard deviation ( $\bar{x} \pm s$ ) or median (25th and 75th percentiles) (M (P<sub>25</sub>, P<sub>75</sub>)), based on the distribution characteristics of the data. Categorical data were expressed as frequency and percentage. To assess the correlation of measurement data between the two groups, we employed Spearman correlation analysis. For comparisons of independent measurement data between the two groups, the Mann-Whitney *U* test for two independent samples was utilized. Statistical significance was set at  $p < 0.05$ .

By performing these statistical analyses, we aimed to identify any significant associations and differences in the defecation sensory threshold and related factors in patients with posterior pelvic prolapse, providing valuable insights into the impact of pelvic organ prolapse on anorectal function.

## 3. Results

### 3.1. Sociodemographic characteristics of the participants

A total of 214 patients were enrolled in this study, and their socio-demographic characteristics are presented in Table 1. Among the participants, 57 patients (26.6%) had a defecation sensory threshold greater than 90 ml. We categorized the patients into two groups based on whether their defecation sensory threshold was greater than 90 ml. There was a significant difference in age between the two groups, with the average age of patients in the ≤90 ml group being higher ( $p = 0.002$ ). However, no statistical difference was observed in body mass index (BMI) and the number of pregnancies between the two groups.

### 3.2. Comparison of symptoms in patients with different defecation sensory thresholds

Regarding defecation symptoms, the CSS and CRADI-8 scores of patients in the two groups are presented in Table 2. Patients with a defecation sensory threshold > 90 ml had median CSS and CRADI-8 scores of 3 (1, 6) and 2 (1, 5), respectively. On the other hand, patients with a defecation sensory threshold ≤ 90 ml had median CSS and CRADI-8 scores of 3 (1, 6) and 1 (0, 4), respectively. While there was no significant difference in the total CSS and CRADI-8 scores between the two groups ( $p = 0.678$ ,  $p = 0.099$ ), two individual items in the scores showed notable differences. The item showing a significant difference in CSS was "difficulty in defecation" ( $p = 0.003$ ), while in CRADI-8, the item was "constipation" ( $p = 0.002$ ). This indicates that patients with a defecation sensory threshold > 90 ml had more severe symptoms of defecation disorders. However, we found no significant correlation between having a defecation sensory threshold > 90 ml and meeting the Roman III criteria for functional constipation ( $\chi^2 = 0.853$ ,  $p = 0.356$ ). Additionally, the expulsion time of the 90 ml balloon did not significantly differ between the two groups ( $p = 0.541$ ). Based on the balloon expulsion test results, patients were classified into positive and negative groups, and the defecation sensory threshold did not significantly differ between the two groups ( $p = 0.105$ ).

By analyzing the data on pelvic organ prolapse in the two groups of patients, it was observed that the measurement results of the C point significantly differed between the groups ( $p < 0.001$ ). Patients with a defecation sensory threshold > 90 ml had a median C point of 2 (0, 4.5), while patients with a threshold ≤ 90 ml had a median C point of 0 (−3.25, 3). The group with a higher sensory threshold exhibited less severe middle pelvic prolapse. Furthermore, pelvic floor ultrasound measurements revealed that the median area of the levator-ani hiatus was 30.18 (26.35, 33.87) cm<sup>2</sup> in patients with a threshold ≤ 90 ml and 26.16 (21.55, 32.49) cm<sup>2</sup> in patients with a threshold > 90 ml. The measurement results significantly differed between the two groups ( $p = 0.002$ ). However, there was no significant association between having a defecation sensory threshold greater than 90 ml and levator-ani

**Table 1**  
Threshold of defecation sensation and demographic data.

	Threshold ≤ 90 ml (n=157)	Threshold > 90 ml (n=57)	<i>p</i> value
Age (years), $\bar{x} \pm s$	65.30 ± 10.73	61.02 ± 9.72	0.002 <sup>a</sup>
Height (m), $\bar{x} \pm s$	1.59 ± 0.04	1.59 ± 0.05	0.831
Weight (kg), $\bar{x} \pm s$	63.09 ± 8.57	62.57 ± 7.37	0.779
BMI (kg/m <sup>2</sup> ), $\bar{x} \pm s$	24.89 ± 3.18	24.61 ± 2.52	0.810
Number of pregnancies (times), M (P <sub>25</sub> , P <sub>75</sub> )	3 ( 2, 4 )	3 ( 2, 4 )	0.122
Number of births (times), M (P <sub>25</sub> , P <sub>75</sub> )	2 ( 1, 2 )	2 ( 1, 3 )	0.621

$\bar{x} \pm s$  refers to mean ± standard deviation, M (P<sub>25</sub>, P<sub>75</sub>) refers to median (25th percentile, 75th percentile).

<sup>a</sup> indicates significant correlation at level 0.01 (double-tailed).

**Table 2**  
Threshold of defecation sensation and symptoms of patients.

	Threshold ≤90 ml (n=157)	Threshold >90 ml (n=57)	p value
CSS	3 (1, 6)	3 (1, 6)	0.678
Frequency	0 (0, 0)	0 (0, 0)	0.543
Difficulty	0 (0, 1)	1 (0, 2)	0.003 <sup>b</sup>
Completeness	1 (0, 2)	1 (0, 1)	0.614
Pain	0 (0, 0)	0 (0, 0)	0.476
Time	0 (0, 1)	0 (0, 1)	0.779
Assistance	0 (0, 1)	0 (0, 0)	0.422
Failure	0 (0, 1)	0 (0, 1)	0.333
History	0 (0, 1)	0 (0, 1)	0.757
CRADI-8	1 (0, 4)	2 (1, 5)	0.099
Constipation	0 (0, 1)	1 (0, 2)	0.002 <sup>b</sup>
Evacuation	0 (0, 1)	0 (0, 1)	0.069
Incontinence 1	0 (0, 0)	0 (0, 0)	0.701
Incontinence 2	0 (0, 0)	0 (0, 0)	0.743
Exhaust	0 (0, 0)	0 (0, 0)	0.700
Pain	0 (0, 0)	0 (0, 0)	0.140
Urgent	0 (0, 1)	0 (0, 1)	0.690
Prolapse	0 (0, 0)	0 (0, 0)	0.752
POP-Q			
Aa	2 (0, 3)	1 (0, 3)	0.027 <sup>a</sup>
Ba	3 (2, 5)	3 (0, 4)	0.005 <sup>b</sup>
C	2 (0, 4.5)	0 (-3.25, 3)	< 0.001 <sup>b</sup>
Gh	5 (5, 6)	5 (4, 6)	0.163
Pb	2.5 (2, 3)	2.5 (2, 3)	0.910
Tvl	8 (7, 8)	7.5 (7, 8)	0.160
Ap	-1 (-2, 1)	-1 (-1.5, 1)	0.560
Bp	0 (-2, 2)	0 (-1.5, 2)	0.971
D	-2 (-4, 0)	-3 (-5, -1)	0.04 <sup>a</sup>
Area of the Levator-ani hiatus	30.18 (26.35,33.87)	26.16 (21.55,32.49)	0.002 <sup>b</sup>
50 ml BET time (seconds), M (P <sub>25</sub> , P <sub>75</sub> )	22.00 (8.55,45.50)	18.40 (9.45,120.50)	0.541
Levator-ani injury			0.124
Yes	53	9	
No	116	36	
Rectocele			0.151
Yes	15	8	
No	154	37	

CSS: Constipation scoring system; CRADI-8: Colorectal-anal Distress Inventory 8; BET: Balloon expulsion test; POP-Q: Pelvic organ prolapse Quantification.

<sup>a</sup> indicates a significant correlation at level 0.05 (double-tailed);

<sup>b</sup> indicates a significant correlation at level 0.01 (double-tailed).

injury ( $\chi^2=2.368, p=0.124$ ) or rectocele ( $\chi^2=2.059, p=0.151$ ) (Table 2). These findings suggest that the defecation sensory threshold may have an impact on certain aspects of pelvic organ prolapse, specifically middle pelvic prolapse. However, it does not appear to be directly related to levator-ani injury or rectocele. Further research is needed to explore the complex relationship between defecation sensory threshold and various aspects of pelvic organ prolapse in greater detail.

### 3.3. Factors related to increased defecation sensory threshold

We conducted a correlation analysis for the threshold of defecation sensation in 57 patients with POP who had a threshold greater than 90 ml, considering demographic information, constipation symptoms, and pelvic organ prolapse degree. The detailed results are presented in Table 3.

Regarding demographic information, the threshold of defecation sensation showed a positive correlation with parity (n=57, r=0.355, p=0.007). However, there was no significant correlation observed with age, BMI, height, weight, or the number of pregnancies. Moreover, there was no significant correlation between the threshold of defecation sensation and CSS or CRADI-8 scores, reflecting defecation symptoms.

In POP-Q measurements, the threshold of defecation sensation exhibited a significant positive correlation with the indicator points Ap

**Table 3**  
Factors related to threshold of defecation sensation.

	Spearman correlation coefficient	p value
Demographic information		
Age (years)	0.135	0.317
Height (m)	0.143	0.290
Weight (kg)	0.025	0.854
BMI (kg/m <sup>2</sup> )	-0.052	0.700
Number of pregnancies (times)	0.012	0.932
Number of births (times)	0.355	0.007 <sup>a</sup>
CSS	0.056	0.679
Frequency	0.080	0.552
Difficulty	-0.025	0.856
Completeness	0.065	0.629
Pain	-0.186	0.166
Time	0.106	0.435
Assistance	0.097	0.472
Failure	-0.065	0.632
History	0.132	0.328
CRADI-8	0.124	0.357
Constipation	-0.026	0.850
Evacuation	-0.062	0.647
Incontinence 1	0.134	0.322
Incontinence 2	0.259	0.051
Exhaust	0.244	0.068
Pain	-0.014	0.920
Urgent	0.080	0.556
Prolapse	0.067	0.620
POP-Q		
Aa	0.088	0.516
Ba	0.037	0.785
C	-0.022	0.869
Gh	0.134	0.321
Pb	-0.085	0.532
Tvl	0.024	0.857
Ap	0.448	0.000 <sup>a</sup>
Bp	0.345	0.009 <sup>a</sup>
D	-0.052	0.709
Area of the Levator-ani hiatus	0.403	0.002 <sup>a</sup>
The time of the 50 ml balloon expulsion test	0.238	0.075
The time of the threshold of defecation sensation balloon expulsion test	0.116	0.391

CSS: Constipation scoring system; CRADI-8: Colorectal-anal Distress Inventory 8; POP-Q: Pelvic organ prolapse Quantification.

<sup>a</sup> indicates significant correlation at level 0.01 (double-tailed).

and Bp of posterior pelvic prolapse (n=57, r=0.448, p < 0.001; n=57, r=0.345, p=0.009). This suggests that the severity of posterior pelvic prolapse is associated with an increased defecation sensory threshold. Additionally, in ultrasound results, the threshold of defecation sensation showed a significant positive correlation with the area of the levator-ani hiatus (n=57, r=0.403, p=0.002). This finding indicates that changes in the levator-ani hiatus are related to alterations in the defecation sensory threshold.

On the other hand, no significant correlation was observed between the threshold of defecation sensation and the time of 50 ml balloon expulsion test or the time of the threshold of defecation sensation balloon expulsion test (n=57, r=0.238, p=0.075; n=57, r=0.116, p=0.391). These results suggest that the increased threshold of defecation sensation in patients with pelvic organ prolapse is associated with parity, the severity of posterior pelvic prolapse, and changes in the area of the levator-ani hiatus. However, no significant correlation was found with the time of balloon expulsion tests. Further studies are needed to elucidate the underlying mechanisms linking these factors to defecation sensory threshold changes in pelvic organ prolapse patients.

## 4. Discussion

The provided text discusses the symptoms of defecation disorders in POP and the analysis of sensory thresholds of defecation in the POP population. The study uses three indicators to evaluate rectal sensory

function: first constant sensation volume (FCSV), the desire to defecate volume (DDV), and maximum tolerated volume (MTV). The international anorectal physiology working group (IAPWG) recommends that the diagnosis of rectal hyposensitivity requires abnormalities in two or more sensory parameters.<sup>5</sup> The text mentions that the optimal sensory threshold for diagnosing rectal hyposensitivity has not been determined. In normal, healthy women without POP, the threshold of defecation sensation is typically between 35 ml and 120 ml.<sup>7</sup> However, studies in different populations, such as the Chinese population and the healthy Indian population, suggest that normal thresholds may differ, with thresholds ranging from 50 to 80 ml<sup>8</sup> and 90 ml,<sup>6</sup> respectively. For the current study on POP patients, a threshold of 90 ml was used as the cutoff point to diagnose rectal hyposensitivity.

The study found that 26.6% of the patients with POP had a defecation sensory threshold greater than 90 ml. Among these patients, those with a higher sensory threshold tended to experience more severe constipation symptoms. However, it is noteworthy that for 57 patients with a threshold greater than 90 ml, the severity of constipation symptoms did not increase with an increase in the defecation sensory threshold. This result aligns with findings from previous studies,<sup>9</sup> which also suggest that elevated defecation sensory thresholds are common in patients with POP, and those experiencing constipation are more likely to have increased defecation sensory thresholds.

Overall, the study sheds light on the prevalence of defecation disorders and altered rectal sensory thresholds in the POP population. By identifying the connection between elevated sensory thresholds and constipation symptoms, it provides valuable insights for future research and potential interventions to address these issues in patients with POP.

It is important to note that this discussion is a brief summary of the provided text, and further context and information may be needed for a comprehensive understanding of the study's implications and findings. Additionally, without access to the full study, it is not possible to assess the methodology, sample size, statistical analyses, and potential limitations of the research.

In the context of pelvic organ prolapse, the results of pelvic floor ultrasound indicate that there is no significant correlation between the threshold of defecation sensation and levator-ani injury or the area of the levator-ani hiatus. However, it was observed that patients with a defecation sensory threshold greater than 90 ml had a smaller levator-ani hiatus ( $p=0.002$ ). Additionally, the degree of uterus or fornix prolapse was less severe (C point was minor;  $p < 0.001$ ) in these patients. This suggests an interesting observation, where an increased defecation sensory threshold might be associated with a bias, leading patients to visit the clinic due to severe uterus or fornix prolapse before experiencing constipation symptoms.

Among the 57 patients with a defecation sensory threshold greater than 90 ml, there was no significant correlation between the defecation sensory threshold and the C point. However, a positive correlation was found between the threshold and the Ap point ( $r=0.448$ ,  $p < 0.001$ ), the Bp point ( $r=0.345$ ,  $p=0.009$ ), the area of the levator-ani hiatus ( $r=0.403$ ,  $p=0.002$ ), and parity ( $r=0.355$ ,  $p=0.007$ ). These findings suggest that the increase in the defecation sensory threshold is related to anatomical changes in patients with posterior pelvic prolapse. Patients with more severe posterior pelvic prolapse tend to have elevated defecation sensory thresholds, with the severity of prolapse being positively correlated with the threshold. This highlights the importance of diagnosing defecation dysfunction in the pelvic organ prolapse population for effective clinical management.

The study's findings underscore the significance of timely examinations of defecation dysfunction in patients with severe posterior vaginal wall prolapse. By recognizing the relationship between defecation sensory threshold and anatomical changes in POP patients, healthcare professionals can improve diagnostic accuracy and provide appropriate interventions for those experiencing defecation disorders. Identifying and addressing these issues early on can lead to better management and treatment outcomes for patients with pelvic organ prolapse.

As with any study, it is crucial to consider potential limitations, the study's methodology, and the generalizability of the findings to a broader population. Nonetheless, the presented information offers valuable insights into the relationship between defecation dysfunction and pelvic organ prolapse, contributing to the overall understanding of this condition in clinical practice.<sup>10</sup>

The evaluation of anorectal sensation plays a crucial role in assessing the severity of fecal incontinence and defecation disorders. Several measurement methods are available to assess rectal sensory function, including anorectal manometry, rectal barostat, evacuation proctography, and magnetic resonance defecography. Anorectal manometry is a widely used and straightforward method that directly assesses the function, pressure, and coordination of pelvic floor muscles during simulated defecation. Due to its ease of implementation and popularity with patients, it is considered the most mature technology.<sup>11</sup> However, interpreting the results can be complicated because of the wide variability of the reference range.<sup>12</sup> The rectal barostat is another valuable tool that allows for more accurate measurement of the patient's rectal sensory threshold and calculation of rectal compliance. It is commonly employed in cases of fecal incontinence and chronic constipation. Magnetic resonance defecography (MRD) and evacuation proctography are specifically used to evaluate evacuation disorders. MRD, with its high soft-tissue resolution, is particularly effective in identifying anatomical abnormalities.<sup>13</sup>

For patients with posterior pelvic prolapse experiencing defecation symptoms, a straightforward method to obtain the threshold of defecation sensation is injecting water into a balloon. This low-cost test can serve as a screening or exclusion option for patients with constipation. Those with abnormal threshold screening results can then undergo further examinations of anorectal function, enabling them to receive timely and effective treatments such as drugs, biofeedback therapy, or other therapies as needed.<sup>10</sup>

By employing these various assessment methods, healthcare professionals can gain valuable insights into anorectal sensation and tailor appropriate treatment plans for patients with fecal incontinence and defecation disorders. This comprehensive approach ensures that patients receive the most suitable interventions to improve their condition and overall quality of life.

Limitations: There are some limitations to our study that need to be acknowledged. Firstly, we recognize that pressure measurement is a more accurate method than volume in evaluating rectal sensation. Any abnormalities in rectal sensation are better reflected by abnormal pressure values rather than the volume change required to produce a given level of sensation.<sup>14</sup> Unfortunately, our study lacked anorectal manometric analysis, which would have provided more comprehensive data on patients' rectal sensations. Secondly, we do not have data on the changes in the threshold of defecation sensation after postoperative anatomical improvement in patients. This aspect could have a significant impact on understanding the relationship between posterior pelvic prolapse and defecation sensation threshold. Further research is needed to explore this area.

## 5. Conclusion

In conclusion, this research serves as a preliminary study investigating the influence of posterior pelvic prolapse on anorectal evacuation function. Our findings indicate that an increased defecation sensation threshold is common in patients with POP. Those with abnormal thresholds often experience constipation. Moreover, the severity of posterior pelvic prolapse positively correlates with the defecation sensation threshold.

## Funding

Special Fund for Prevention and Treatment of Pelvic Floor Dysfunction in Chinese Women. (Fund Approval number: 2019-Z-01)

## Availability of data and material

The data sets used in this study are available upon reasonable request.

## Authors' contributions

All authors have made significant contributions to the study design and manuscript modification. LY and TM were responsible for project execution, data collection, analysis, and manuscript writing. TC and YX played key roles in project development and manuscript editing. All authors have reviewed and approved the final draft of the manuscript.

## Ethics approval

This study has been approved by the Ethics Committee of Peking University People's Hospital (Ethics Number: 2019PHB273-01).

## Consent to participate (from patients)

All patients participating in the study provided informed consent and agreed to undergo the relevant examinations.

## Consent for publication (all authors)

All authors have actively participated in revising the manuscript and have given consent for its publication.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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