

# Traditional Gymnastic Exercises for the Pelvic Floor Often Lead to Bladder Neck Descent – a Study Using Perineal Ultrasound

## Traditionelle Beckenbodengymnastik führt häufig zum Blasenhalodeszensus – eine Untersuchung mit perinealem Ultraschall

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### Key words

pelvic floor training, pelvic floor rehabilitation, bladder neck, perineal ultrasound, pelvic floor contraction

### Schlüsselwörter

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### ABSTRACT

**Background** The aims of physiotherapy in stress incontinent women are to improve pelvic floor function and the continence mechanism including bladder neck support and urethral closure pressure. In Germany, traditional conservative treatment often includes gymnastic exercises with unclear effects on the bladder neck. The aim of this study was to sonographically assess bladder neck movements during selected exercises.

**Methods** Fifteen healthy, continent women without previous vaginal births, who were able to voluntarily contract their pel-

vic floor muscles performed the shoulder bridge, the abdominal press, tiptoe and the Pilates clam exercises. The first set was performed without any additional instructions. During the second set directions were given to activate the pelvic floor before beginning each exercise and to maintain the contraction throughout the exercise. Bladder neck movement was measured on perineal ultrasound using a validated method with the pubic symphysis as a reference point.

**Results** The median age of participants was 32 years, median BMI was 23. Eight women were nulliparous and seven had given birth to 1–2 children via caesarean section. When exercises were performed without voluntary pelvic floor contraction the bladder neck descended on average between 2.3 and 4.4 mm, and with pelvic floor contraction prior to the exercise only between 0.5 and 2.1 mm ( $p > 0.05$  except for abdominal press  $p = 0.007$ ). The Pilates clam exercise and toe stand stabilised the bladder neck most effectively.

**Discussion** Bladder neck descent often occurs during pelvic floor gymnastic exercises as traditionally performed in Germany, and a voluntary pelvic floor contraction during the exercises does not necessarily prevent this.

### ZUSAMMENFASSUNG

**Hintergrund** Das Ziel der physiotherapeutischen Behandlung der Belastungsinkontinenz ist die Verbesserung der Beckenbodenmuskulatur und damit des Kontinenzmechanismus, deren Hauptfaktoren die Blasenhalstabilität und der urethrale Verschlussdruck sind. Die Beckenbodengymnastik in Deutschland beinhaltet häufig unspezifische gymnastische Übungen, deren Wirkungen auf Beckenboden und Blasenhal nicht geklärt sind. Das Ziel dieser Studie ist es, perineal-sonografisch zu untersuchen, welche Auswirkungen ausgewählte Beckenbodenübungen auf die Blasenhalposition haben.

**Methoden** Fünfzehn gesunde kontinente Frauen ohne vaginale Geburten, die den Beckenboden willkürlich anspannen konnten, führten Schulterbrücke, Bauchpresse, Zehenspitzenstand und Pilates-Muschelübung aus. Eine 1. Übungsreihe erfolgte ohne Hinweise zum Beckenboden, die 2. mit Anleitung zur Beckenbodenkontraktion vor und während der Übung. Mittels perinealem Ultraschall wurden die Blasenhalbewegungen mit einem validierten Verfahren mit der Symphyse als Referenzpunkt ausgemessen.

**Ergebnisse** Die Frauen waren im Median 32 Jahre alt und hatten einen medianen BMI von 23. Acht Frauen waren nullipar, 7 hatten 1–2 Kinder via Sectio caesarea geboren. Während der Übungen ohne willkürliche Beckenbodenkontraktion des-

zendierte der Blasenhalshals im Mittel zwischen 2,3 und 4,4 mm; mit Beckenbodenkontraktion vor der Übung nur zwischen 0,5 und 2,1 mm ( $p > 0,05$  bis auf Bauchpresse  $p = 0,007$ ). Die Pilates-Muschelübung und der Zehenspitzenstand stabilisierten den Blasenhalshals am besten.

**Diskussion** Bei Übungen der traditionellen deutschen Beckenbodengymnastik deszendiert der Blasenhalshals häufig und kann nicht immer durch eine willkürliche Beckenbodenkontraktion vor der Übung stabilisiert werden.

## Introduction

Urethral closing pressure, precontraction of the pelvic floor and bladder neck stability are factors that ensure urinary continence [1–4]. It is known that the bladder neck (BN) descends further on coughing in women with stress urinary incontinence compared to continent women [5]. In contrast, correct pelvic floor contraction (PFC) elevates the bladder and bladder neck (ventro-cranial movement) [5–8]. The bladder neck is stabilised and descends significantly less if PFC is performed before and maintained during coughing [9]. Both bladder neck descent and elevation can be well documented on two-dimensional perineal ultrasound and can be quantified using validated methods [7, 8, 10].

Pelvic floor contraction before coughing or other exertions that cause an increase in intraabdominal pressure has been termed “The Knack” or pelvic floor precontraction [11]. Learning this skill is part of modern pelvic floor rehabilitation and is specifically taught in international programs [11–14]. However traditional pelvic gymnastics training in Germany is mostly comprised of nonspecific exercises. In healthy women these nonspecific exercises may lead to pelvic floor contraction through coactivation of abdominal or gluteal and pelvic floor muscles [15–17], however it is not known whether the desired bladder neck elevation or at least stabilisation is achieved. In addition, this automatic co-contraction can only be expected in healthy subjects [17] and not in incontinent women: In healthy, continent women pelvic floor precontraction occurs before a potentially destabilising activity and/or actions leading to increased intraabdominal pressure. In contrast, this precontraction may be lost in incontinent women [18–21]. There are no data on the efficacy of traditional pelvic floor gymnastics as currently performed in Germany.

The pelvic floor is increasingly being integrated into yoga and Pilates programs, which are offered for both treatment and prophylaxis. The fact that 20–43% of women cannot tighten their pelvic floor musculature on command, or worse even bear down [22–24], is not sufficiently taken into consideration by fitness or traditional pelvic floor gymnastic programs on offer.

The aim of this study was to determine the position of the bladder neck using perineal ultrasound during selected exercises from traditional German pelvic floor gymnastic exercises and Pilates in healthy women.

## Materials and Methods

### Subjects, inclusion and exclusion criteria

Fifteen healthy women without pelvic floor symptoms (screening using a validated pelvic floor questionnaire) [25] and no previous vaginal births or urogynaecological operations were consecutively recruited via notice boards and informational events. All women gave written, informed consent. The measurements were part of a multilevel DFG (German Research Foundation) funded project that was approved by the Charité ethics commission. Women with previous vaginal births were excluded, since vaginal birth may lead to permanently altered bladder neck position [6, 26], and the effects of levator avulsion (muscle disruption from the inferior pubic rami), which occurs commonly, are uncertain [27]. The ability to voluntarily contract the pelvic floor musculature was a further inclusion criterion and was tested by palpation and perineal ultrasound. All examinations were performed by the same investigator (BJ) at a bladder volume of 150 to 300 ml for optimal visualisation of the bladder neck [10] without subjects having an urge to urinate.

### Exercises

Study subjects performed the following exercises, all of which are possible with simultaneous application of the perineal ultrasound probe (abdominal probe) (► Fig. 1): the shoulder bridge, the abdominal press, tiptoe and the Pilates clam exercise. The first set of exercises was performed without any instructions regarding the pelvic floor. For the second set, women were instructed to voluntarily contract their pelvic floor muscles prior to starting each exercise (pelvic floor precontraction = PF-preC) and to maintain the contraction throughout each exercise. A physiotherapist with Pilates experience gave the instructions. Each exercise lasted for 3–7 seconds. We purposely omitted repetitions when the quality of the measurement was deemed satisfactory. There were not more than three repetitions to improve study quality for any of the exercises. Averages were not calculated.

### Ultrasound measurements

Bladder neck movements during the exercises were recorded on perineal ultrasound (abdominal probe RAB 4–8-D, 5 MHz, Voluson E8, GE) and saved as videos in a computer program (Tele Myo “Human performance measurements solutions” MR 3.0; Noraxon USA Inc). The analysis was conducted offline by one investigator (KB) using a validated digital tracking system [28]. Standardisation was performed according to Dietz with the distal pole of the pubic symphysis used as the reference point for both the x- and y-axis [29]. A prerequisite for this is that the ultrasound probe



► **Fig. 1** Study exercises: shoulder bridge (a), abdominal press (b), standing on tiptoe (c) and Pilates clamshell (d).

with its outgoing cable remain strictly in line with the body axis since changes in the tilt angle would result in false measurements [30] (► **Fig. 2**). Visible “shifting” of the symphysis, e.g. through increased intraabdominal pressure during an exercise, was corrected in analogy to the validation according to Reddy et al. [28]. The minimal detectable change in bladder neck movement on perineal ultrasound was established at 3 mm [7].

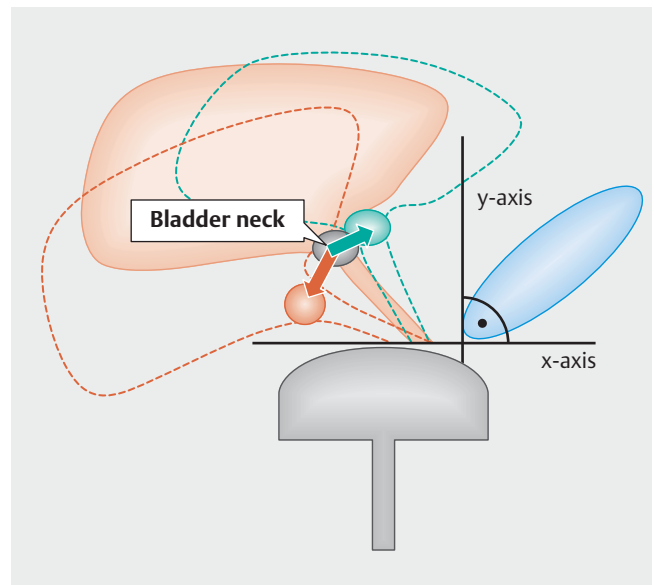
### Analysis

All acquired data were analysed using the statistics program SPSS 22. Paired t-tests were used to compare bladder neck movements between exercises for normally distributed variables.

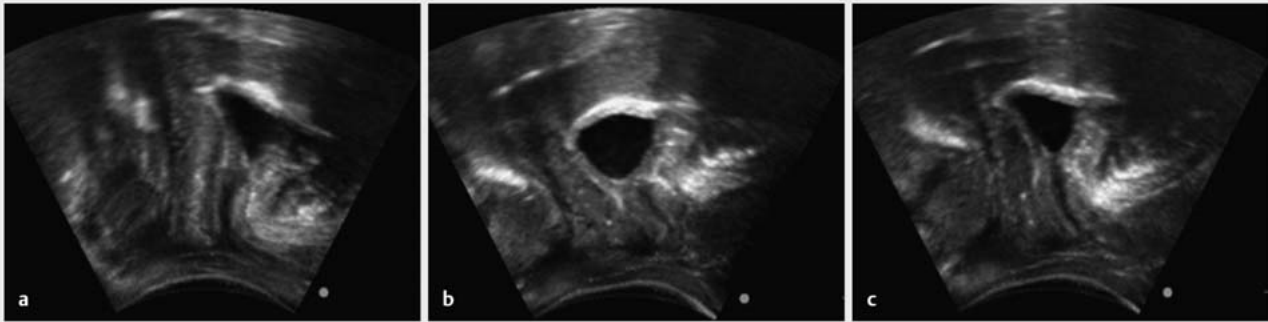
## Results

### Study subjects

Participants were aged between 21 and 45 years (median 32 years) with a median BMI of 23 (18–31 kg/m<sup>2</sup>). Eight women were nulliparous and seven had given birth to one or two children via caesarean section. All women were able to perform bladder neck elevating pelvic floor contractions that were palpable and demonstrable on ultrasound.



► **Fig. 2** Schematic depiction of the bladder neck, the coordination system and correct application of the ultrasound probe. Typical position during bladder neck descent (red) and bladder neck elevation (green).



► **Fig. 3** Typical perineal ultrasound images before, during and after the shoulder bridge exercise from a woman with significant BN descent: a at rest, b obvious bladder neck descent during the exercise, c almost complete return to normal position after exertion.

### Exercises without pelvic floor precontraction

Results are summarised in ► **Table 1**. Bladder neck (BN) movement during the exercises was highly variable and not identical among all women for any of the exercises. When performed without voluntary pelvic floor precontraction all exercises were associated with BN descent between 2.3 and 4.4 mm on average. In contrast to the shoulder bridge and abdominal press (BN descent – 3.2 and – 4.4 mm respectively), the Pilates clam and tiptoe exercise stabilised the bladder neck best (– 2.3 and – 2.6 mm respectively), however, differences between individual exercises were not statistically significant. ► **Fig. 3 a to c** shows the typical progression of bladder neck descent on perineal ultrasound in a woman with BN descent during the exercise.

### Exercises with pelvic floor precontraction

Pelvic floor contraction prior to the exercises temporarily elevated the bladder neck in all women, however there was subsequent BN descent of 0.5 to 2.1 mm on average during execution of the shoulder bridge, the abdominal press and, to the smallest amount, the clam exercise. The original BN elevation of 2.7 mm was maintained while standing on tiptoe, though there were no statistically significant differences between the exercises. ► **Fig. 4 a to c** shows an example of stable BN position with the pelvic floor contraction maintained for the entire duration of an exercise.

### Comparison of bladder neck descent for exercises with and without pelvic floor precontraction

There was less BN descent for exercises with PF precontraction than without, however the difference was only statistically significant for the abdominal press ( $p = 0.007$ ).

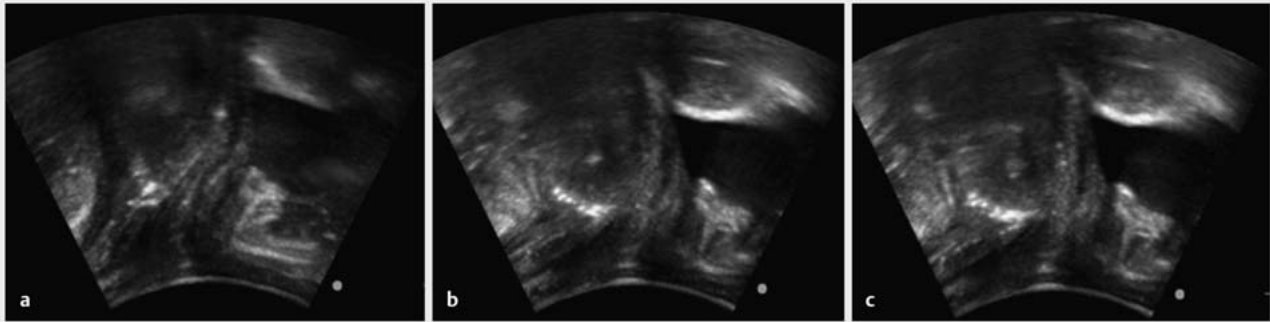
### Discussion

This study in a small number of healthy, continent women shows that traditional gymnastic exercises for the pelvic floor do not necessarily stabilise or elevate the bladder neck. This also applies when women contracted their pelvic floor muscles – with bladder neck elevation demonstrated on ultrasound – prior to performing the exercises. Although a specific pelvic floor contraction initially lead to BN elevation in all the women, this bladder neck position was rarely maintained for the entire duration of the exercise. The Pilates clam exercise and standing on tiptoe achieved the best bladder neck stabilisation. BN descent was most marked with the abdominal press, however a voluntary pelvic floor precontraction significantly reduced this descent.

Our study subjects were all able to evidently contract their pelvic floor muscles on command. However, this ability can neither be assumed for all healthy women, nor for incontinent women. A significant proportion of incontinent women is not able to contract their pelvic floor muscles [22–24] and physiological pelvic floor precontraction is not always present [19]. Our results imply

► **Table 1** Average bladder neck descent in mm (standard deviation) for series of exercises without and then with pelvic floor precontraction (PF-preC). Negative values represent bladder neck descent, positive values bladder neck elevation. Paired t-test for comparison.

	Without PF-preC	With PF-preC	p
Shoulder bridge	– 3.2 (2.8)	– 2.1 (4.8)	0.574
Abdominal press	– 4.4 (1.9)	– 2.2 (4.2)	0.007
Tiptoe	– 2.3 (3.9)	2.7 (3.2)	0.086
Clam	– 2.6 (1.9)	– 0.5 (4.8)	0.580



► **Fig. 4** Typical perineal ultrasound images of a woman able to stabilise the BN for the duration of the shoulder bridge exercise: a at rest, b pelvic floor precontraction prior to exercise causes BN elevation, c bladder neck stabilised with elevation held until exercise end.

that the studied exercises can not provide the desired effects for many incontinent women, since not all physiotherapists (or gynaecologists) in Germany test the status of the pelvic floor musculature by palpation e.g. before physiotherapy. It can be presumed that in many women with pelvic floor disorders the bladder and urethra descend even further during these traditional exercises, especially when women are unable to voluntarily tighten their pelvic floor muscles. Although gymnastic exercises and Pilates or yoga certainly can achieve a coactivation of the pelvic floor, this does not automatically translate into BN elevation or stabilisation. Also, the principles of the actually intended muscle training are neglected: specificity, overload and reversibility [31]. The first of these involves specific contraction of the pelvic floor, which internationally is most often assessed on vaginal palpation by the therapist. The second, overload, is achieved through purpose-specific contractions at a much higher intensity than the involuntary contractions occurring in day-to-day life e.g. through co-contraction. The third characteristic of a muscle training program, reversibility, shows up the limitations of an otherwise internationally successful pelvic floor training program based on increasing the muscle strength [32]. Physiotherapy studies that increase pelvic floor muscle strength attribute decreasing continence rates after a number of years to reduced adherence and discontinuation of training. It is currently being investigated whether a pelvic floor rehabilitation program conceptually based specifically on coordination, BN elevation and pelvic floor integration into everyday life [13] could provide long-term success. From work on the multifidus muscles, which, like the pelvic floor, are predominantly composed of type 1 (slow-twitch) fibres, rehabilitation for back pain is known to be effective in the long-term without further training [33].

Stabilising the bladder neck, which is partly achieved by sufficient pelvic floor contraction, is essential for ensuring continence [1,34,35]. Perineal ultrasound allows good visualisation and quantification of bladder neck elevation and descent. It is thus suitable for use as a biofeedback instrument and is increasingly being used by physiotherapists for pelvic floor rehabilitation [8, 13,36–38]. Vaginal and/or rectal palpation do however appear to be essential for assessing the pelvic floor anatomically and functionally, enabling the development of individualised rehabili-

tation programs. Pelvic floor palpation is currently not part of physiotherapy training in Germany and appropriate skills have to be acquired at palpation courses.

It can be assumed that bladder neck descent occurs during many other exercises and sports, especially among women with pelvic floor disorders. A comparative study on this subject is currently in progress. Further studies are needed to define physiological ranges, to investigate whether sport can worsen pelvic organ prolapse and whether e.g. pelvic floor precontraction before exertion or other bladder neck supporting measures such as pessaries can prevent pelvic organ prolapse.

Limitations of this study are the small number of study participants and the difficulty performing perineal ultrasound for all the study exercises. The minimal detectable change in bladder neck movement on perineal ultrasound is 3 mm [7], which was achieved in our study for most of the exercises. Strengths of the study are the use of validated measurement techniques including questionnaires and ultrasound assessment and interpretation. In addition, the acquisition of data from healthy women contributes to the establishment of normal values and the planning of future studies.

## Conclusion

Traditional gymnastic exercises for the pelvic floor frequently lead to bladder neck descent in continent women. The bladder neck descends less when the pelvic floor is contracted prior to, and held for the duration of an exercise. Since the ability to voluntarily contract the pelvic floor cannot be generally assumed, the traditional gymnastic exercises for the pelvic floor in Germany without prior confirmation of correct pelvic floor contraction, should be abandoned.

## Conflict of Interest

No conflicts of interest exist currently or in the past for either of the two authors.



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