Does a missed obstetric anal sphincter injury at time of delivery affect short-term functional outcome?

L Ramage¹, C Yen¹, S Qiu¹, C Simillis¹, C Kontovounisios^{1,2}, E Tan^{1,5}, P Tekkis^{1,2}

¹Department of Surgery and Cancer, Chelsea and Westminster Hospital, Imperial College London NHS Trust, London, UK

²Department of Colorectal Surgery, Royal Marsden NHS Foundation Trust, London, UK

³Department of Colorectal Surgery, Singapore General Hospital, Republic of Singapore

ABSTRACT

INTRODUCTION This study aimed to ascertain whether missed obstetric anal sphincter injury at delivery had worse functional and quality of life outcomes than primary repair immediately following delivery.

MATERIALS AND METHODS Two to one propensity matching was undertaken of patients presenting to a tertiary pelvic floor unit with ultrasound evidence of missed obstetric anal sphincter injury within 24 months of delivery with patients who underwent primary repair at the time of delivery by parity, grade of injury and time to assessment. Outcomes compared included Birmingham Bowel, Bladder and Urinary Symptom Questionnaire (BBUSQ), Wexner Incontinence Score, Short Form-36, Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire and anorectal physiology results.

RESULTS Thirty-two missed anal sphincter injuries were matched two to one with sixty-two patients who underwent primary repair of an anal sphincter defect. Mean time to follow-up was 9.31 ± 6.79 months. Patients with a missed anal sphincter injury had suffered more incontinence, as seen in higher the Birmingham Bowel, Bladder and Urinary Symptom Questionnaire (BBUSQ; $30.56\% \pm 14.41\%$ vs. $19.75\% \pm 15.65\%$, $P = 0.002$) and Wexner scores (6.00 ± 3.76 vs. 3.67 ± 4.06 , $P = 0.009$). They also had a worse BBUSQ urinary domain score ($28.25\% \pm 14.9\%$ vs. $17.01 \pm 13.87\%$, $P = 0.001$) and worse physical functioning as measured by the Short Form-36 questionnaire ($P = 0.045$). There were no differences in other outcomes compared, including anorectal physiology and sexual function.

DISCUSSION In the short-term, patients with a missed obstetric anal sphincter injury had significantly worse faecal incontinence and urinary function scores, however quality of life and sexual function were largely comparable between groups.

CONCLUSIONS Longer-term follow-up is needed to assess the effects of missed obstetric anal sphincter injury over time.

KEYWORDS

Obstetric anal sphincter injury – OASI – Occult injury – Functional outcomes – Faecal incontinence

Accepted 5 June 2017

CORRESPONDENCE TO

Emile Tan, E: emile.john.tan.k.w@singhealth.com.sg

Introduction

Obstetric anal sphincter injury complicates 5.9% of vaginal deliveries in England.¹ In the UK, the majority of such injuries occur in primiparous women (6.7%), with a rate of 1.7% in multiparous women.² Clinical guidelines from the Royal College of Obstetricians and Gynaecologists state that all patients who sustain an obstetric anal sphincter injury should be followed-up, where feasible in a specialist clinic with availability of endoanal ultrasound and anorectal physiology to allow full assessment of the anal sphincter complex post-delivery and to make recommendations with regards to future mode of delivery.³ Risk factors for sustaining an obstetric anal sphincter injury include macrosomia (infant birth size 4 kg), the need for instrumental delivery,

nulliparity, shoulder dystocia, prolonged second stage of labour and Asian ethnicity.^{1,4,5}

Missed anal sphincter injury is relatively common. Groom *et al.*,⁶ in a study of 121 women, found that 40% of third-degree anal sphincter injuries were missed on initial perineal assessment. However, detection rates could be improved with increased vigilance and improved training of midwives and doctors. An undetected anal sphincter injury can have implications on anal continence, with one study finding that 71.5% of patients with occult anal sphincter injury demonstrated at least moderate faecal incontinence in the early postpartum phase.⁷

The aim of our study was to identify any differences in early functional, manometric, sexual and quality of life outcomes in women who had sustained an anal sphincter injury

during normal or assisted vaginal delivery, which was not immediately apparent and therefore did not undergo primary repair, compared with those who underwent primary repair at the time of delivery in a cohort of women who presented to a specialist colorectal pelvic floor service.

Materials and Methods

A retrospective analysis of a prospectively maintained database was performed. The database comprised all-comers to a tertiary colorectal pelvic floor service maintained from 2008 to 2016. Tertiary pelvic floor services were offered to all women who had expressed concerns regarding symptoms of bowel dysfunction or those who wished to discuss delivery mode of future pregnancies. The majority of these pelvic floor clinic assessments took place at 3–12 months following delivery. Referrals were primarily received from the local perineal tear clinic run by the obstetric team, following third- or fourth-degree anal sphincter injury after delivery. During this obstetric-run perineal clinic, assessment of wound healing, bowel and urinary function was performed and advice was given regarding the importance and performance of pelvic floor exercises in the postpartum period.

During the consultation within the colorectal pelvic floor clinic, patients were given a series of self-reported questionnaires to complete. A detailed history was taken and anorectal manometry and endoanal ultrasound were performed by a colorectal surgeon with extensive experience in interpreting the results obtained. Following from this, patients were counselled as to future mode of delivery. Additionally, postnatal referrals were received for patients who had sustained a lesser degree of anal sphincter injury but were exhibiting symptoms such as faecal urgency and flatal incontinence and therefore concern regarding occult injury had been raised. These patients were assessed in a similar manner as described above.

Symptomatic patients were initially sent for biofeedback physiotherapy and were followed-up on a 6–12-monthly basis. If further treatment was indicated, in the form of sphincter repair or sacral nerve stimulation, this was offered.

Patient-reported outcome measures

Patient-reported outcome measures of bowel function were assessed through the use of the BBUSQ. This questionnaire has four domains: constipation, rectal evacuation, faecal incontinence and urinary symptoms. Each domain is scored from 0% to 100%, with a higher score signifying worse symptom severity.⁸ The normal parameters as defined in the validation criteria give cut-off values to define an abnormal score: rectal evacuation $\geq 17\%$ urinary $\geq 20\%$, faecal incontinence $\geq 17\%$ and constipation $\geq 64\%$.

Symptoms of faecal incontinence were further assessed using the Wexner Incontinence Score, which ranges from 0 to 20, with a higher score indicating worse symptom severity.⁹ Quality of life outcomes were measured using the Short Form 36 questionnaire, which has eight domains. These were scored from 0% to 100%, with a higher score indicating better quality of life.¹⁰ The Pelvic Organ Prolapse/

Urinary Incontinence Sexual Questionnaire (PISQ-12) is a 12-item questionnaire which evaluates sexual function in women with pelvic organ prolapse.¹¹ Patients were asked to complete this on a voluntary basis prior to their clinic review. The maximum score is 48, with a higher score signifying better sexual function.

Anorectal manometry

Assessment of motor and sensory function of the anal canal was performed in the left lateral position. T-DOC® Air-Charged™ anorectal manometry catheters, which have four pressure sensors measuring pressure gradients across four quadrants of the anal sphincter. Motor assessment of the anal canal was performed with measurements taken of maximum resting pressure (a measure of internal anal sphincter function), maximum squeeze pressure increment and five-second squeeze increment (a measure of external anal sphincter function). Additionally, cough pressure incremental measurements were obtained. Three readings were taken for each parameter and the mean value obtained was used in analysis.

To assess sensory function, the distal balloon was placed inside the rectum and was slowly filled to obtain measurements for the threshold volume (first sensation), urge volume (sensation of urgency) and maximum tolerated volume. The pressure sensors were connected to the Delphis IP processor by Laborie Urodynamics.

Endoanal ultrasound

Endoanal ultrasound assessment of anal sphincter morphology was undertaken by either an experienced radiologist or by a consultant colorectal surgeon with a subspecialist interest in pelvic floor disorders and imaging techniques of the anorectum. Final grade of tear was defined based on ultrasonic evidence of the degree of sphincter involvement into grade 2 (no sphincter involvement), grade G3a (< 50% external anal sphincter); G3b (50–100% external anal sphincter); G3c (external + partial internal anal sphincter) and G4 (entire external + external anal sphincter).¹²

Patients with obstetric anal sphincter injury who underwent primary repair but had a disagreement between the reported grade of tear and endoanal ultrasound grading were excluded from analysis. In addition, patients who did not undergo endoanal ultrasound for final grading of injury or had unclear initial diagnosis were excluded from analysis. Overall, there were 107 women who underwent primary repair of a sphincter defect and 34 missed anal sphincter injuries identified with at least one functional outcome reported.

Statistical analysis

Two to one propensity matching for the 34 missed obstetric anal sphincter injuries against the control group using three criteria was undertaken: parity, time from delivery to assessment and final grade of injury. Matching was performed using SPSS statistical software.

The paired T test was used to compare parametric data and the Mann Whitney U test was used to compare non-parametric data. Normality of data was tested using the

Shapiro-Wilk test. A *P* value of less than 0.05 was taken to indicate statistical significance. The Pearson chi-square test was used for analysis of proportions. All data compared were collected prior to any treatment being given.

Results

After propensity matching, only 32 of 34 missed obstetric anal sphincter injuries were matched with 62 patients who underwent primary repair of an anal sphincter defect, with 2 missed injuries only matching to 1 patient from the control group. Table 1 shows the study demographics. There were no significant differences in parity, age, instrumental delivery rates, history of prior tear and time to follow-up between the two groups. There was a significantly higher incidence of episiotomy in the missed injury group (64.3% versus 30.6%, *P* = 0.004).

Functional outcomes

Functional outcomes are shown in Table 2. Patients with a missed anal sphincter injury had a significantly worse BBUSQ (30.56 ± 14.41% vs. 19.75 ± 15.65, *P* = 0.002) and Wexner Incontinence Score (6.00 ± 3.76 vs. 3.67 ± 4.06, *P* = 0.009). Patients with a missed injury also had significantly worse BBUSQ urinary domain scores (28.25 ± 14.9% vs. 17.01 ± 13.87%, *P* = 0.001), with the repaired group having a score within the normal range as defined by the BBUSQ validation study.⁸

Approaching statistical significance was the difference in BBUSQ evacuation scores (18.23 ± 15.15 vs. 10.82 ± 9.60, *P* = 0.052), which were worse in the missed injury group,

although only slightly out with the normal range. Neither group had an abnormal constipation score.

Quality of life: Short Form 36

Patients with a missed injury scored significantly worse in the ‘physical function’ domain of the Short Form 36 questionnaire (80 ± 22.11 vs. 88.31 ± 20.14, *P* = 0.045) Otherwise, there were no significant differences between groups across seven domains of the questionnaire (Table 3).

Anorectal physiology

Table 4 gives the results of motor and sensory anorectal physiology results. Overall, there were no statistical differences found between groups. Approaching statistical significance was a difference in the maximum tolerated volume, which was less in the missed injury group (87.69 ± 27.51 ml vs. 124.19 ± 59 ml, *P* = 0.070).

Sexual function: PISQ-12

PISQ-12 scores were available for 24 patients who had undergone primary repair and 10 patients who had a missed anal sphincter injury. The mean overall score was 33.13 ± 8.14 in the repaired group, compared with 34.7 ± 6.96 in the missed injury group. The scores were not statistically different between groups (*P* = 0.597).

Discussion

This study aimed to assess for any differences in short-term functional and quality of life outcomes in patients presenting to a tertiary referral centre for the management of pelvic

Table 1 Study demographics			
	Missed OASI	Primary repair	<i>P</i> value
Patients (<i>n</i>)	32	62	–
Age at delivery (years) ^a	33.8 ± 5	32.7 ± 5	0.34
Parity (mean ± SD):			
1	24	48	0.88
2	7	13	0.88
3	1	1	0.88
Episiotomy <i>n</i> (%) ^b	18/28 (64.3)	15/49 (30.6)	0.004
Instrumental delivery <i>n</i> (%) ^b	18/29 (62.1)	35/52 (67.3)	0.64
Previous tears <i>n</i> (%) ^b	1/32 (3.1)	1/61 (1.6)	0.64
Final grade (<i>n</i>): ^b			
3A	21	42	0.73
3B	11	19	0.73
4	0	1	0.73
Mean time to assessment	10 ± 7	8.9 ± 6.7	0.47

^a Mann-Whitney U test.
^b Pearson chi-square test.
OASI, obstetric anal sphincter injury; SD, standard deviation.

Table 2 Results of functional scores

Questionnaire	Missed OASI			Primary repair			P value
	(n) ^a	(mean)	(SD)	(n) ^a	(mean)	(SD)	
BBUSQ:							
Incontinence	24	30.56	14.41	50	19.75	15.65	0.002
Evacuation	24	18.23	15.15	50	10.82	9.6	0.052
Urinary	22	28.25	14.9	44	17.01	13.87	0.001
Constipation	254	54.72	13.49	50	54.9	11.59	0.896
Wexner score	17	6	3.76	42	3.67	4.06	0.009
^a Number of responses. BBUSQ, Birmingham Bowel, Bladder and Urinary Symptom Questionnaire; OASI, obstetric anal sphincter injury; SD, standard deviation.							

Table 3 Results of the Short Form 36 questionnaire

Question	Missed OASI			Primary repair			P value ^b
	(n) ^a	(mean)	(SD)	(n) ^a	(mean)	(SD)	
Physical functioning	23	80	22.11	43	88.31	20.74	0.045
Role physical	22	81.82	22.57	41	83.99	24.88	0.428
Body pain	23	73.37	25.09	43	78.49	22.87	0.511
General health	21	72.14	19.34	41	74.21	17.4	0.828
Vitality	23	53.26	11.13	43	52.62	10.36	0.886
Social functioning	23	73.38	28.53	42	82.44	23.11	0.167
Role emotional	22	85.6	23.02	41	85.77	24.17	0.823
Mental health	23	69.78	13.77	43	69.07	11.18	0.571

^a Number of responses.
^b Mann-Whitney U test.

floor disorders who have sustained an obstetric anal sphincter injury, which has either undergone primary repair immediately following delivery or had been missed and detected on later endoanal ultrasound. Incontinence scores were significantly worse in patients who had a missed sphincter injury, as was early urinary function, which may represent a generalised reduction in pelvic floor muscle strength and the ability to control urinary flow. All missed tears involved injury to the external anal sphincter only; that is, they were grade 3a or 3b. Interestingly, the episiotomy rates were significantly higher in the missed group compared with the detected group. Verghese *et al.*,¹⁵ in their large meta-analysis of 651,114 women, found that a medio-lateral episiotomy was protective against anal sphincter injury (risk ratio 0.67, 95% confidence interval, CI, 0.49–0.92). Therefore, taking these data into consideration, our findings suggest that there is a potential for clinicians and midwives to make an assumption that the performance of an episiotomy has avoided any disruption to the anal sphincter

complex and so may not assess for it as thoroughly as in cases where there has been a natural perineal tear.

Quantification of the true frequency of missed anal sphincter injury is difficult as, unless patients present with symptoms of faecal urgency, reduced deferral time or flatal or faecal incontinence and undergo endoanal assessment, occult lesions may go undetected, only to be discovered later in life when the patient becomes more symptomatic. Oberwalder *et al.*¹⁴ performed a meta-analysis of five studies which examined rates of anal sphincter injury detected through postpartum endoanal ultrasound. They used Bayesian statistical methods to determine the overall risk of sphincter defect in primiparous and multiparous women. They found the incidence of anal sphincter injury in primiparous women was 26.9% and 8.5% in multiparous women. They also determined that, if a patient presented with symptoms of either flatal or faecal incontinence, then there was a 76.8% and 82.8% chance of anal sphincter injury in primiparous and multiparous women, respectively. Additionally,

Table 4 Anorectal physiology comparison of missed and primary repairs of obstetric anal sphincter injuries (OASI)

Measure	Missed OASI			Primary repair			P value ^b
	(n) ^a	(mean)	(SD)	(n) ^a	(mean)	(SD)	
Maximum resting pressure (mmHg) ^a	24	65.75	18.24	53	61.96	15.06	0.342
Maximum squeeze pressure (mmHg) ^a	24	99.17	29.34	52	89.23	24.48	0.127
Mean squeeze increment (mmHg) ^a	25	32.56	19.2	52	27.27	18.06	0.242
Mean 5-second squeeze increment (mmHg) ^b	15	32.27	20.22	20	27.05	25.71	0.191
Mean involuntary cough pressure (mmHg) ^b	13	51.92	28.58	20	39.65	23.82	0.158
Threshold volume (ml) ^b	14	29.27	12.84	26	33.12	19.3	0.79
Urge volume (ml) ^b	14	53.21	19.47	26	64.5	31.13	0.361
Maximum tolerated volume (ml) ^b	13	87.69	27.51	21	124.19	59	0.07

^a Unpaired T test.
^b Mann-Whitney U test.
n, Number of responses.

at least two-thirds of occult sphincter injuries were asymptomatic postpartum.

Several studies have tried to quantify the frequency of missed obstetric anal sphincter injury. Andrews *et al.*,¹⁵ in their study of 241 patients, found that the rate of anal sphincter injury increased from 11% to 24.5% when women were later re-examined. All obstetric anal sphincter injuries were apparent on endoanal ultrasound. Faltin *et al.*¹⁶ contacted women at 3 months post-delivery who had undergone repair of a presumed second-degree tear. On subsequent reassessment, they found clinically undetected tears at the time of delivery in 42 of 150 women (28%). Postal questionnaires at 3 months post-delivery were completed by participants; 15% of patients reported suffering with anal incontinence, which was predominantly flatal in nature. They concluded that clinically undetected tears were more likely to suffer symptoms of anal incontinence (odds ratio 8.8, 95% CI 2.9–26.5) than those without ultrasonic evidence of a sphincter injury. Sultan *et al.*¹⁷ performed a prospective study which examined women at 6 weeks pre-delivery, then again at 6 weeks postpartum and at 6 months if they were symptomatic. They found that 35% of 127 women had evidence of a degree of sphincter disruption. The presence of a sphincter defect on postpartum ultrasound sphincter evaluation was significantly associated with symptoms of faecal urgency and urge incontinence.

The reasons behind the under-identification of anal sphincter injuries at the time of delivery may relate to a deficit in training in the recognition and management of sphincter injuries. Fernando *et al.*¹² identified that 33% of consultants wrongly classified anal sphincter injuries as second-degree tears, with a wide variation as to the understanding of the classification system and methods of repair.

It is widely recognised that there is a significant chance of functional decline with anal sphincter injuries over longer-term follow-up. Fornell *et al.*¹⁸ followed-up 82 women at 10 years following delivery and found that function declined

with time. They concluded that an intact internal anal sphincter and a good perineal body bulk were important for maintenance of continence in the longer term. Sangalli *et al.*¹⁹ followed-up a cohort of patients at 13 years, receiving 177 responses to a postal survey. They found an anal incontinence rate of 25% with G4 and 11.5% with G3 injuries. Clearly, those with undetected anal sphincter injuries run the risk of poorer function in the long term; it is therefore vital that staff are adequately trained to detect injuries at the time of delivery to maximise detection rates and give patients the best chance of long-term sustained acceptable function.

Some studies have suggested the use of endoanal ultrasound at the time of delivery to improve detection rates of anal sphincter injury. Faltin *et al.*²⁰ conducted a randomised control trial in 752 primiparous women with clinically no evidence of anal sphincter tear. Patients were randomised to either receive standard care or to undergo endoanal ultrasound scan prior to suturing of the perineal wound, to identify any occult sphincter injury and repair as appropriate. They found the rate of anal sphincter injury detection in the treatment group to be 5.6%. At both 3 and 12 months postpartum, there was a significant difference in rates of severe faecal incontinence between groups (3.3% vs. 8.7% at 3 months and 3.2% vs. 6.7%) favouring the use of endoanal ultrasound assessment for all second-degree tears to allow for detection and subsequent appropriate management of sphincter involvement. Ozyart *et al.*⁷ screened 201 women before hospital discharge who had undergone mediolateral episiotomy and found that there was an occult sphincter injury not detectable on clinical examination in 11.5% of women.

The use of endoanal ultrasound in second-degree tears or after episiotomy as a means of identifying injuries which may otherwise have been missed is, in theory, a good means of ensuring that patients receive the best possible standard of care: primary repair of their injury. However, it is

incredibly labour intensive, with around 77% of primiparous women requiring episiotomy²¹ and requiring the presence of a clinician trained in the interpretation of endoanal ultrasonographic appearances. Further studies are needed to stratify the risk–benefit ratio and to determine which patients should be imaged prior to perineal repair or in the early postpartum period.

Limitations

The main limitation of this study is the potential for selection bias in that only patients with initial clinical symptoms of missed obstetric anal sphincter injuries were referred for full anorectal assessment. This is a consequence of the problem itself, in that there are feasibly fairly significant numbers of anal sphincter injuries that go undetected, only to present at a later stage. It could be argued that all patients with obstetric anal sphincter injuries will be expected to have at least some early evidence of bowel dysfunction, and therefore it is unlikely that many have remained unidentified. The only means by which this could truly be assessed would be through the routine screening of all women who have sustained any degree of perineal trauma with postnatal endoanal ultrasound examination.

Secondly, two to one propensity matching was used for patient selection to decrease possible confounders such as parity, time and grade. King and Nielsen argue that propensity matching brings about model dependence and bias and increases the imbalance of data, limiting accuracies of the analysis.²² The authors, however, argue that because of the nature of the data, propensity matching best enables a fair comparison between the two groups of patients. Our database consists of a small group of patients with relatively short length of follow-up is and only at a single time point.

We chose not to explore the effect of a misdiagnosis with regards to the degree of injury sustained. Instead, these patients were excluded from matching. The authors considered that it would be difficult to determine whether misclassification of a tear was due to under-recognition of the degree of injury or whether the injury was appropriately repaired but under- or over-classified due to misunderstanding of the grading system. While the questionnaires used in this study to assess the severity of symptoms and their effect on quality of life are clinically appropriate, there exist more specific questionnaires could also be used as alternative endpoints to increase the strength of analysis. More specifically, scoring systems with better psychometric properties to assess the direct effect of faecal incontinence on quality of life, such as Fecal Incontinence Quality of Life instrument, could have been used.^{23,24}

Lastly, this study has focused on the short-term functional consequence of a missed obstetric anal sphincter injury with a median follow-up duration of 9 months. During this postpartum period, there may be other variables which might affect the woman's perception of her quality of life, such as breastfeeding and maternal psychosocial factors which have not been adjusted for in this study. These variables might also indirectly affect recovery through limiting the compliance of pelvic floor exercises. More studies are needed to

quantify the longer-term functional consequences as a result of a missed obstetric anal sphincter injury.

Conclusions

From the current literature, it is evident that the risk of a missed obstetric anal sphincter injury at the time of delivery is significant. Our data reinforce that there is a potential for worse short-term outcomes with regards to faecal and urinary incontinence, as well as overall physical functioning in missed injuries. A high index of suspicion must therefore be maintained with patients who have risk factors for obstetric anal sphincter injury including a baby heavier than 4 kg, instrumental delivery and nulliparity, and a thorough and detailed examination must take place following delivery to maximise detection rates. This is especially the case where an episiotomy has been performed, as the potential for a missed injury is higher.

In cases where there is any suspicion of missed tear, then patients should have early endoanal assessment so that injury can be detected and aggressive management in terms of biofeedback physiotherapy and avoidance of future vaginal delivery can be employed early to prevent later deterioration.

References

1. Gurol-Urganci I, Cromwell DA, Edozien LC *et al*. Third- and fourth-degree perineal tears among primiparous women in England between 2000 and 2012: time trends and risk factors. *BJOG* 2013; **120**(12): 1,516–1,525.
2. Thiagamoorthy G, Johnson A, Thakar R *et al*. National survey of perineal trauma and its subsequent management in the United Kingdom. *Int Urogynecol J* 2014; **25**(12): 1,621–1,627.
3. Royal College of Obstetricians and Gynaecologists. *The Management of Third- and Fourth-Degree Perineal Tears*. Green-top Guideline No. 29. London: RCOG; 2015.
4. Twidale E, Cornell K, Litzow N *et al*. Obstetric anal sphincter injury risk factors and the role of the mediolateral episiotomy. *Aust N Z J Obstet Gynaecol* 2013; **53**(1): 17–20.
5. Tyler AD, Milgrom R, Xu W *et al*. Antimicrobial antibodies are associated with a Crohn's disease-like phenotype after ileal pouch-anal anastomosis. *Clin Gastroenterol Hepatol* 2012; **10**(5): 507–512.
6. Groom KM, Paterson-Brown S. Can we improve on the diagnosis of third degree tears? *Eur J Obstet Gynecol Reprod Biol* 2002; **101**: 19–21.
7. Ozyurt S, Aksoy H, Gedikbasi A *et al*. Screening occult anal sphincter injuries in primigravid women after vaginal delivery with transperineal use of vaginal probe: a prospective, randomized controlled trial. *Arch Gynecol Obstet* 2015; **292**: 853–859.
8. Hiller L, Radley S, Mann CH *et al*. Development and validation of a questionnaire for the assessment of bowel and lower urinary tract symptoms in women. *BJOG* 2002; **109**: 413–423.
9. Jorge JM, Wexner SD. Etiology and management of fecal incontinence. *Dis Colon Rectum* 1993; **36**: 77–97.
10. Brazier JE, Harper R, Jones NM *et al*. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *BMJ* 1992; **305**: 160–164.
11. Rogers RG, Coates KW, Kammerer-Doak D *et al*. (2003) A short form of the Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire (PISQ-12). *Int Urogynecol J Pelvic Floor Dysfunct* 2003; **14**(3): 164–168.
12. Fernando RJ, Sultan AH, Radley S *et al*. Management of obstetric anal sphincter injury: a systematic review and national practice survey. *BMC Health Serv Res* 2002; **2**: 9.
13. Verghese TS, Champaneria R, Kapoor DS *et al*. Obstetric anal sphincter injuries after episiotomy: systematic review and meta-analysis. *Int Urogynecol J* 2016; **27**(10): 1,459–1,467.

14. Oberwalder M, Connor J, Wexner SD. Meta-analysis to determine the incidence of obstetric anal sphincter damage. *Br J Surg* 2003; **90**: 1,333–1,337.
15. Andrews V, Sultan AH, Thakar R *et al*. Occult anal sphincter injuries: myth or reality? *BJOG* 2006; **113**: 195–200.
16. Faltin DL, Boulvain M, Irion O *et al*. Diagnosis of anal sphincter tears by postpartum endosonography to predict fecal incontinence. *Obstet Gynecol* 2000; **95**: 643–647.
17. Sultan AH, Kamm MA, Hudson CN *et al*. Anal-sphincter disruption during vaginal delivery. *N Engl J Med* 1993; **329**: 1,905–1,911.
18. Fornell EU, Matthiesen L, Sjødahl R *et al*. Obstetric anal sphincter injury ten years after: subjective and objective long term effects. *BJOG* 2005; **112**: 312–316.
19. Sangalli MR, Floris L, Faltin D *et al*. Anal incontinence in women with third or fourth degree perineal tears and subsequent vaginal deliveries. *Aust N Z J Obstet Gynaecol* 2000; **40**: 244–248.
20. Faltin DL, Boulvain M, Floris LA *et al*. Diagnosis of anal sphincter tears to prevent fecal incontinence: a randomized controlled trial. *Obstet Gynecol* 2005; **106**: 6–13.
21. Manzanares S, Cobo D, Moreno-Martinez MD *et al*. Risk of episiotomy and perineal lacerations recurring after first delivery. *Birth* 2013; **40**: 307–311.
22. King G, Nielsen R. Why propensity score should not be used for matching. Working Paper. 2016. <https://gking.harvard.edu/files/gking/files/psnot.pdf> (accessed 28 June 2017).
23. Rockwood TH, Church JM, Fleshman JW *et al*. Fecal Incontinence Quality of Life Scale: quality of life instrument for patients with fecal incontinence. *Dis Colon Rectum* 2000; **43**: 9–17.
24. Avery KNL, Bosch JLHR, Gotoh M *et al*. Questionnaires to assess urinary and anal incontinence: review and recommendations. *J Urol* 2007; **177**: 39–49.