ORIGINAL ARTICLE

Psoas Versus Femoral Blocks
A Registry Analysis of Risks and Benefits

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Background and Objectives: Psoas blocks are an alternative to femoral nerve blocks and have the potential advantage of blocking the entire lumbar plexus. However, the psoas muscle is located deeply, making psoas blocks more difficult than femoral blocks. In contrast, while femoral blocks are generally easy to perform, the inguinal region is prone to infection. We thus tested the hypothesis that psoas blocks are associated with more insertion-related complications than femoral blocks but have fewer catheter-related infections.

Methods: We extracted 22,434 surgical cases from the German Network for Regional Anesthesia registry (2007–2014) and grouped cases as psoas (n = 7593) and femoral (n = 14,841) blocks. Insertion-related complications (including single-shot blocks and catheter) and infectious complications (including only catheter) in each group were compared with χ^2 tests. The groups were compared with multivariable logistic models, adjusted for potential confounding factors.

Results: After adjustment for potential confounding factors, psoas blocks were associated with more complications than femoral blocks including vascular puncture 6.3% versus 1.1%, with an adjusted odds ratio (aOR) of 3.6 (95% confidence interval [CI], 2.9–4.6; $P < 0.001$), and multiple skin punctures 12.6% versus 7.7%, with an aOR of 2.6 (95% CI, 2.1–3.3; $P<0.001$). Psoas blocks were also associated with fewer catheter-related infections: 0.3% versus 0.9% (aOR of 0.4; 95% CI, 0.2-0.8; $P = 0.016$), and with improved patient satisfaction (mean ± SD 0- to 10-point scale score, 9.6 ± 1.2 vs 8.4 ± 2.9; $P < 0.001$). Results from a propensity-matched sensitivity analysis were similar.

Conclusions: Psoas blocks are associated with more insertion-related complications but fewer infectious complications.

Clinical Trial Registration: ID NCT02846610.

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Various peripheral nerve blocks can be used for major hip and knee surgery. In 1976, Chayen et al described the psoas block as a posterior approach to the lumbar plexus.[1] Since then, several works refining this regional anesthetic technique have been published.[2]

Severe and even life-threatening hemorrhagic complications have been described after psoas blocks with or without catheter insertion.[2–4]

Consequently, the American Society of Regional Anesthesia and Pain Medicine recommends applying the same guidelines for this "deep" peripheral nerve block as for neuraxial blocks in patients given anticoagulant or antiplatelet therapy.[5] Local anesthesia systemic toxicity after unintended intravascular injection has also been described.[6] Other serious adverse effects include cardiac arrest, respiratory failure, and seizures related to cephalad diffusion of the local anesthetic in the epidural or intrathecal spaces.[7,8]

Femoral nerve blocks are an alternative to psoas blocks and are considered among the easiest-to-perform peripheral blocks. Although systemic local anesthesia toxicity including cardiac arrest can occur after any block, the incidence is believed to be lower after femoral than psoas blocks.[8–10] However, femoral vein catheter placement has been shown to be associated with a higher rate of bloodstream infections compared with upper-body central venous vascular catheter placement.[11]

Available evidence thus suggests that insertion-related complications are more likely with psoas blocks, but that catheter-related infections may be less common. We therefore compared the incidences of complications during insertion and catheter-related infections associated with psoas and femoral blocks in a large registry. Specifically, we evaluated the hypotheses that insertion-related complications for single-injection blocks and catheter are more common with psoas than femoral blocks and that catheter-related infections are less common.

METHODS

This trial was registered under Ha50/11 and approved by the ethics committee of the Saarland Medical Chamber, Saarbrücken, Germany (Chairperson San.-Rat Prof Dr Hermann Schieffer) on March 22, 2011. According to the regulatory proof of protection of data privacy (Saarland commissioner, 12-MAR-2014), written consent was waived as the data were anonymous. This trial was also registered at clinicaltrials.gov on May 28, 2016 (identifier NCT02846610).

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The German Network for Regional Anesthesia, which was established in 2007 by the German Society for Anesthesiology and Intensive Care Medicine and the Professional Association of German Anesthesiologists, set up a database that collects preoperative, intraoperative, and postoperative data from treating physicians or pain nurses at 25 German centers using a standard form (Fig. 1).[12] Data were collected concurrently with patient care and included detailed information about the medical conditions of patients having regional anesthesia along with details of the procedure and postoperative course.

The registry investigated 126,236 cases in the period extending from September 2007 to May 2015. According to specific rules to delete erroneously entered data and to delete cases with missing information, data integrity was evaluated, and the relation between age, height, weight, and sex were verified. The body mass index (BMI) was defined from 13.2 to 70 kg/m^2. Anticoagulant therapy comprised warfarin and platelet inhibition, as well as high- and low-molecular-weight heparin.

All participating centers administered routine single-dose antibiotic prophylaxis based on the surgical procedure and recommended by the guidelines of the German working group of Hygiene in Hospital and Practice.[13,14] They complied with the German guidelines to prevent catheter-related infection and block-related hemorrhage in patients receiving antithrombotic or thrombolytic therapy or having coagulation disorders.[15,16]

Case Selection

We included patients who received femoral or psoas blocks with or without concomitant sciatic nerve block. Exclusion criteria were catheter use exceeding 14 days, patients with missing information about age and sex, patients with diabetes, and patients with implausible data. Implausible data included a diagnosis of diabetes and an American Society of Anesthesiologists (ASA) physical status score of 1 or the date of block insertion preceding the date of birth.

Block-related complications and patient satisfaction were prospectively defined and included the following:

1. vascular puncture: aspiration of blood by the puncture needle or catheter;
2. multiple skin punctures, defined by more than 1 skin puncture;
3. paresthesia during needle or catheter insertion: an unexpected painful, unpleasant, or electric sensation within the area innervated by the nerve(s) affected by the regional anesthesia;
4. accidental dural puncture: unintentional needle insertion through the dura mater;
5. systemic local anesthetic toxicity: symptoms of intoxication (neurologic and/or cardiovascular) after the injection of the local anesthetic;
6. premature termination (of the block procedure): procedure terminated because of unfavorable anatomic conditions, insufficient compliance of the patient, or vasovagal symptoms during the procedure; and
7. primary failure: the block did not provide intraoperative analgesia.
8. Infections at the catheter insertion site were categorized by severity: (*a*) mild infections were defined by at least 2 of 3 infection signs (redness, swelling, or local pain); (*b*) moderate infections were defined as mild plus by at least 1 of the following findings: increased C-reactive protein, leukocytosis, fever, or pus at the punctured site; and (c) severe infections were defined by the need for a surgical incision or revision.
9. Patients and provider satisfaction were measured with verbal numeric rating scales ranging from 0 (completely dissatisfied) to 10 (completely satisfied) at the last encounter.

Data Analysis

Population characteristics are reported as standardized differences (psoas − femoral). Dichotomous outcomes in patients with psoas and femoral block were compared with χ^2 tests. Continuous variables were compared with Student *t* tests (respectively, Welch *t* tests in case of unequal variances).

Logistic regression analysis was used to calculate univariate and adjusted odds ratios (aORs) with 95% confidence intervals (CIs). We adjusted for factors known to influence block-related complications including ASA physical status, diabetes, anticoagulant therapy, increased BMI, and type of block.[9,10,17,18] Additional relevant confounders were identified for each block-related complication (vascular puncture, multiple skin punctures, infection for any grade) and for satisfaction of patients and physician. Finally, we included year of surgery and hospital. Collinearity was tested by Pearson or Spearman correlation coefficients. Variables with a positive or negative correlation greater than +0.3 and less than −0.3 were assessed for interactions. Goodness of fit was assessed by Hosmer-Lemeshow tests.

A propensity score was developed for each patient based on all potential confounders and implemented as a sensitivity analysis. The patient with the closest propensity score who had a femoral block was matched to each patient with a psoas block. The maximum difference of propensity score for a matching was less than 0.05. Matched patients with psoas and femoral block were compared using McNemar test, Student *t* tests for 2 dependent samples, or conditional logistic regression. Covariable balance for propensity score matching was assessed with standardized differences. Imbalance was defined as a standardized difference of greater than 0.1 in absolute value; any imbalanced covariables

Preoperative data	Block placement and intraoperative data	Postoperative data and ward round
Male	Catheter / Single shot	Infection
Age [yrs.]	Site	Length of catheter use
Body mass index [kg/m ²]	Antibiotic prophylaxis	Patient satisfaction with RA
ASA physical status	Nerve stimulation	Physician satisfaction with RA
Diabetes mellitus	Ultrasound	
Anticoagulant therapy	Vascular puncture	
Department of surgery	Multiple skin puncture	
	Paresthesia	
	Accidental dural puncture	
	Local anesthetic systemic toxicity	
	Premature termination anatomy	
	Premature termination compliance	
	Primary failure	

FIGURE 1. Extract of the information completed after block placement and ward rounds. RA indicates regional anesthesia.

after the propensity score matching were adjusted in a further sensitivity analysis.

We used Python Essentials, an extension of SPSS, for propensity score matching. All data analyses were performed using IBM SPSS Statistics for Windows (version 22; IBM Corp, Armonk, New York). Continuous variables are expressed as means ± SDs. Categorical variables are presented as numbers of patients with percentages in parentheses. Statistical significance was accepted at a global 2-sided significance level of 0.05. Because of multiple testing, we considered Bonferroni correction to arrive at a local significance level of 0.05/9 (primary outcomes) = 0.006.

RESULTS

The final study population consisted of 22,434 cases: all 7593 qualifying psoas blocks and 14,841 femoral blocks (Fig. 2).

Patients with psoas blocks were more often female, were older, had a higher (ASA physical status score, used more anticoagulant therapy, and were more often given antibiotic prophylaxis. A greater fraction of psoas block patients had catheters inserted, and psoas blocks were more often guided by nerve stimulation (Table 1).

Patients who had psoas blocks had more vascular punctures, more often needed multiple punctures, were more likely to experience systemic toxicity of local anesthetics, and more often had premature termination of the insertion attempt. In contrast, there were fewer cases of paresthesia, primary failures, and block-related infections in patients with psoas block. Catheter duration was longer, and the satisfaction of patients and providers were higher in patients with psoas block compared with femoral block (Table 2). No cardiac arrests were reported consequent to systemic local anesthetic toxicity. No deaths were attributed to either psoas or femoral blocks.

After multivariable analysis, adjusted for potential confounding factors, psoas blocks were associated with increased risk of vascular punctures and multiple skin punctures compared with femoral blocks. In contrast, psoas blocks were associated with fewer primary failures, fewer block-related infections, and more satisfied patients and providers both before and after adjustment for confounders (Fig. 3). Goodness of fit for each adjusted model was assessed by Hosmer-Lemeshow tests and did not differ significantly.

Propensity matching successfully paired 5928 patients with psoas block (78% of 7593 patients) and with 5928 control subjects (40% of 14,841 patients). As seen in Table 1, matched patients with psoas and femoral blocks were much better balanced on covariables. However, imbalances remained for BMI (standardized difference [STD], −0.16), antibiotic prophylaxis (STD, 0.14), type of block (STD, 0.19), use of nerve stimulator (STD, 0.13), use of ultrasound (STD, −1.20), year of surgery (STD, −0.15), and hospital (STD, 0.50). To be conservative, we included each unbalanced factor in our multivariable model. In addition, satisfaction of patients and providers was also adjusted for vascular punctures, multiple punctures, primary failure, block-related infection, and duration of catheter use. The results were thus similar to those obtained from our unmatched multivariable analysis (Fig. 3).

DISCUSSION

Although major block-related complications such as systemic local anesthetic toxicity and infection are rare, they are potentially serious. Few, if any, previous studies had sufficient capacity to detect clinically important differences between psoas and femoral blocks or to accurately characterize the risks of either. Our multicenter registry analysis of 22,434 patients appears to be the world's largest systematic collection of psoas and femoral blocks. We were thus able to detect complications, even rare ones.

Psoas blocks were associated with more vascular punctures and more skin punctures than femoral blocks. But psoas blocks were also strongly associated with fewer block-related infections and greater patient satisfaction. Results were similar in our propensity-matched

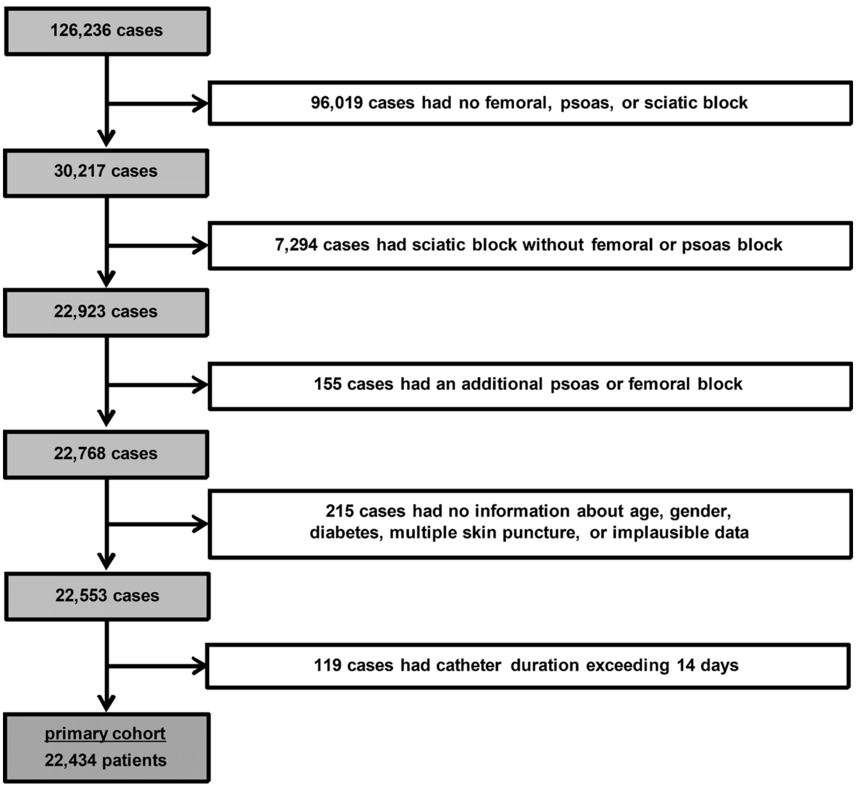

FIGURE 2. Case selection.

TABLE 1. Population Characteristics

	Before Matching			After Matching		
	Psoas Block (n = 7593)	Femoral Block (n = 14,841)	STD*	Psoas Block (n = 5928)	Femoral Block (n = 5928)	STD*
Male	3245 (42.7)	6619 (44.6)	−0.04	2590 (43.7)	2566 (43.3)	0.01
Age, y	62 ± 19	56 ± 20	0.28	60 ± 20	60 ± 18	0.00
Body mass index, kg/m^2	28.5 ± 5.9	28.2 ± 6.1	0.05	28.2 ± 5.9	29.1 ± 6.0	−0.16
ASA physical status score ≥2	6288 (83)	9595 (65)	0.42	4765 (80)	4879 (82)	−0.05
Diabetes mellitus	1018 (13.4)	1854 (12.5)	0.03	767 (12.9)	762 (12.9)	0.00
Anticoagulant therapy	2890 (38.1)	3967 (26.7)	0.25	2329 (39.3)	2304 (38.9)	0.01
Antibiotic prophylaxis	4814 (63.4)	7419 (50.0)	0.27	4115 (69.4)	3711 (62.6)	0.14
Catheter	6697 (88.2)	11,645 (78.5)	0.26	5106 (86.1)	4672 (78.8)	0.19
Nerve stimulation	6904 (90.9)	8012 (54.0)	0.91	5413 (91.3)	5168 (87.2)	0.13
Ultrasound	369 (4.9)	7578 (51.1)	−1.20	200 (3.4)	2879 (48.6)	−1.20
Sciatic nerve	4011 (52.8)	7596 (51.2)	0.03	2896 (48.9)	2861 (48.3)	0.01
Traumatology and orthopedics	6907 (91.0)	12,329 (83.1)	0.24	5837 (98.5)	5854 (98.8)	−0.02

Continuous variables are expressed as means ± SDs. Categorical variables are presented as numbers of patients with percentages in parentheses.

Other surgery includes general surgery, gynecology, internal medicine, pediatric surgery, urology, and vascular surgery.

Selected variables for pairwise matching were sex, age, BMI, ASA physical status score, diabetes, anticoagulant therapy, antibiotic prophylaxis, catheter, single-shot blocks, nerve stimulation, department of surgery, sciatic nerve catheter (as second catheter), year of surgery, and hospital center.

*The difference (psoas minus femoral) in means or proportions divided by the pooled SD.

TABLE 2. Block-Related Complications, Catheter Duration, and Satisfaction

	Before Matching			After Matching		
	Psoas Block (n = 7593)	Femoral Block (n = 14,841)	*P*	Psoas Block (n = 5928)	Femoral Block (n = 5928)	*P*
Vascular puncture	475 (6.3)	170 (1.1)	**<0.001**	400 (6.7)	107 (1.8)	**<0.001**
Multiple skin puncture	955 (12.6)	1148 (7.7)	**<0.001**	759 (12.8)	502 (8.5)	**<0.001**
Paresthesias during block insertion	31 (0.4)	122 (0.8)	**0.001**	29 (0.5)	41 (0.7)	0.32
Accidental dural puncture	1 (0.0)	0 (0.0)	0.16	0 (0.0)	0 (0.0)	—
Local anesthetic systemic toxicity	5 (0.1)	0 (0.0)	**0.002**	4 (0.1)	0 (0.0)	0.045
Premature termination (anatomy)	11 (0.2)	4 (0.0)	**0.001**	11 (0.2)	1 (0.0)	**0.004**
Premature termination (compliance)	2 (0.0)	0 (0.0)	0.048	1 (0.0)	0 (0.0)	0.317
Primary failure	57 (0.8)	337 (2.3)	**<0.001**	16 (0.3)	211 (3.6)	**<0.001**
Infection						
Any grade	24 (0.3)	134 (0.9)	**<0.001**	16 (0.3)	42 (0.7)	**<0.001**
Mild	21 (0.3)	115 (0.8)	**<0.001**	13 (0.2)	33 (0.6)	**<0.001**
Moderate	3 (0.0)	16 (0.1)	0.063	3 (0.1)	8 (0.1)	0.071
Severe	0 (0.0)	3 (0.0)	0.19	0 (0.0)	0 (0.0)	—
Missing information	1143 (15.1)	3521 (23.7)	—	1025 (17.3)	1819 (30.7)	—
Prolonged catheter use (4–14 d)	1585 (20.9)	2317 (15.6)	**<0.001**	1188 (20.0)	642 (10.8)	**<0.001**
Missing information	1494 (19.7)	4541 (30.6)	—	1327 (22.4)	2314 (39.0)	—
Patient satisfaction (0–10)	9.6 ± 1.2	8.4 ± 2.9	**<0.001**	9.7 ± 1.1	9.1 ± 1.9	**<0.001**
Missing information	3202 (42.2)	7609 (51.3)	—	2213 (37.3)	2326 (39.2)	—
Physician satisfaction (0–10)	9.0 ± 2.5	7.7 ± 3.5	**<0.001**	9.5 ± 1.4	8.8 ± 2.1	**<0.001**
Missing information	6350 (83.6)	9210 (62.1)	—	4840 (81.7)	3372 (56.9)	—

Continuous variables are expressed as means ± SDs. Categorical variables are presented as numbers of patients with percentages in parentheses. Bold data are significant.

Mild infections were defined by at least 2 out of 3 infection signs (redness, swelling, or local pain). Moderate infections were defined as mild plus at least 1 of the following findings: increased C-reactive protein, leukocytosis, fever, or pus at the punctured site. Severe infections were defined by the need for a surgical incision or revision.

Selected variables for pairwise matching were sex, age, BMI, ASA physical status score, diabetes, anticoagulant therapy, antibiotic prophylaxis, catheter, single-shot blocks, nerve stimulation, department of surgery, sciatic nerve catheter (as second catheter), year of surgery, and hospital center.

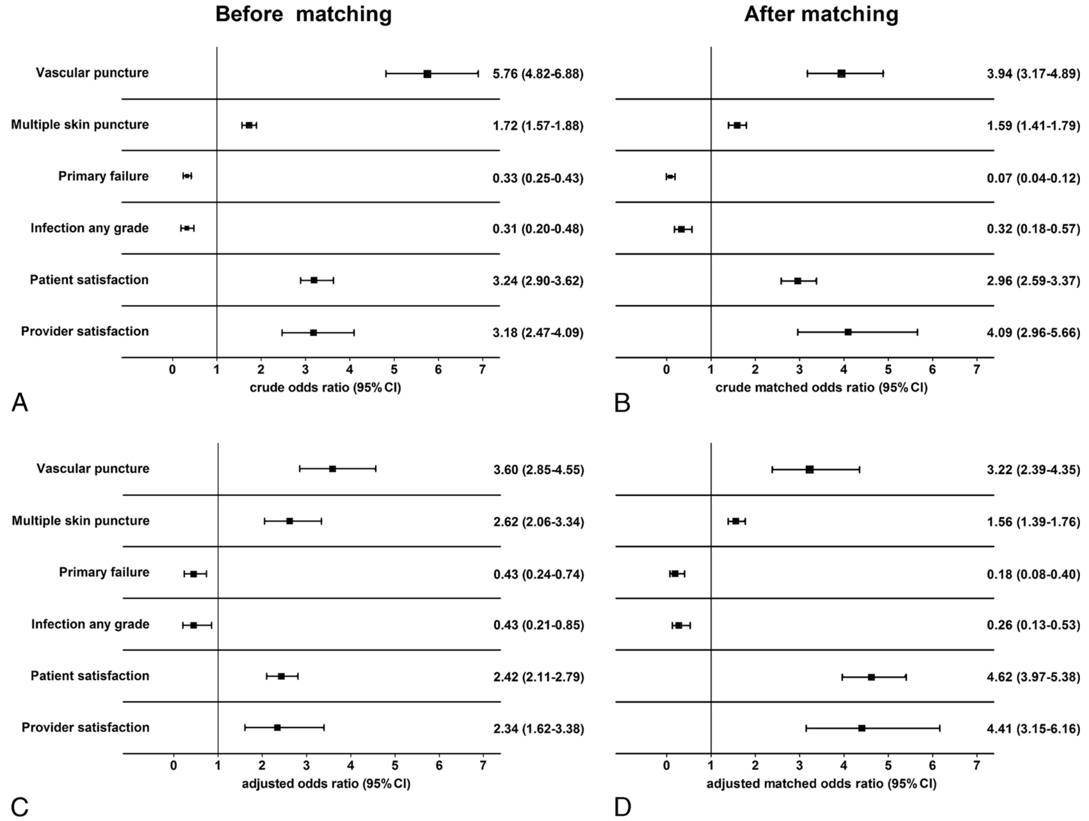

FIGURE 3. Psoas block versus femoral block: ORs of complications. Odds ratios with 95% CI complications are displayed crude (A, B), adjusted for confounders (C, D), and before (A, C) and after matching (B, D). Risk parameters in C were adjusted as follows: vascular puncture was adjusted for ASA physical status score, diabetes, anticoagulant therapy, type of block, use of nerve stimulator, surgery, multiple skin punctures, year of surgery, and hospital. Multiple skin puncture variable was adjusted for age, BMI, ASA score, diabetes, type of block, use of nerve stimulator, surgery, year of surgery, and hospital. Primary failure was adjusted for ASA score, diabetes, anticoagulant therapy, use of nerve stimulator, year of surgery, and hospital. Infection any grade was adjusted for sex, BMI, ASA score, diabetes, antibiotic prophylaxis, type of block, surgery, catheter duration, year of surgery, and hospital. Patient and provider satisfaction was adjusted for sex, age, BMI, ASA score, diabetes, antibiotic prophylaxis, type of block, use of nerve stimulator, surgery, sciatic nerve block, vascular puncture, multiple skin punctures, primary failure of block, paresthesia during block insertion, block-related infection, catheter duration, year of surgery, and hospital. Risk parameters in D were adjusted for BMI, antibiotic prophylaxis, type of block, use of nerve stimulator, use of ultrasound, year of surgery, and hospital. Patient and provider satisfaction was additionally adjusted for vascular puncture, multiple skin punctures, primary failure of block, paresthesia during block insertion, block-related infection, and catheter duration.

sensitivity analysis. One strong aspect of our study is that block-related complications were clearly defined beforehand.

Our findings are generally consistent with previously reported risks of complications during insertion of femoral or sciatic nerve blocks: vascular puncture (present data: 1.1% vs Popping et al[19]: 4.4%), multiple skin punctures (present data: 7.7% vs Popping et al[19]: 9.1%), paresthesia (present data: 0.8% vs Popping et al[19]: 0.9%), and local anesthetic systemic toxicity (present data: 0% vs Popping et al[19]: 0%).[19] However, our observed incidence of femoral catheter-related infections (0.9%) was lower than the 1.5% to 2.4% reported previously.[10,19,20] Various definitions of infection and inflammation, duration of catheter use, preventive hygiene measures, and probably many unknown factors most likely led to these differences.

Auroy et al[8] noted "80/10,000 serious complications" when psoas blocks were used. However, there were only 394 psoas blocks in their sample of voluntary reports, making their extrapolation highly unreliable. Another study reported no complications in 213 psoas blocks, which also provided an unreliable estimate.[21] In contrast, our estimate of 0.3% in 6697 continuous psoas blocks has a much larger denominator and use compulsory documentation.

Our results are consistent with previous reports showing that risk is greater during insertion of psoas than femoral blocks. For example, there are reports of fatal local anesthetic systemic toxicity and unnoticed accidental dural puncture.[8,22] Anesthesiologists should be aware of these major complications and have been advised to manage the psoas block with the same vigilance as a neuraxial procedure.[8] Moreover, anesthesiologists should be cognizant of arterial and venous anatomy within the lumbar nerve plexus and recognize that a psoas block can result in neuraxial anesthesia.[8] Therefore, this block should be performed by well-trained physicians to avoid life-threatening complications during and after the procedure.[23] In our analysis of 7593 psoas blocks, no death was reported. Therefore, we assume that the psoas block is safe as previously reported.

Femoral blocks are easier to perform than psoas blocks. Consequently, premature termination of block attempts was less common with femoral blocks. However, only 0.1% of psoas block attempts in our series terminated early—a fraction that is so low that it does not provide a basis for selecting 1 type of block over the other. Once positioned, though, primary failure was more common with femoral (2.3%) than psoas (0.8%) blocks.

Satisfaction with analgesia for both providers and patients was higher in patients with psoas than femoral blocks. The reason could be a better quality of analgesia because of the included obturator nerve.[24,25] Moreover, block-related infections were far less common with psoas than femoral blocks (0.3% vs 0.9%; $P < 0.001$). Therefore, the psoas block seems to be a good block for lower-limb surgery.

Unfortunately, we cannot determine whether the observed, mostly minor, complications were linked with prolonged hospital stay or worse long-term outcomes because the duration of hospitalization, long-term outcomes, and long-term mortality were not recorded. The observed higher satisfaction in psoas block cannot be adequately assessed based on the results of this study. Residual confounding may introduce error, which will not be eliminated by either multivariable or propensity-matched analysis as in any nonrandomized analysis.

Our results were adjusted for the year of surgery, regardless of presumed improvements in knowledge, skills, techniques, and disinfectant methods during the 8-year observation period. The care site was considered a potential confounder in our statistical model, even though there was heterogeneity in the incidence of complications among the hospitals in our analysis. Statistically significant associations that are not clinically important could be identified because of our large patient population; however, the magnitude of the associations we observed was clearly clinically meaningful. Although our analysis was retrospective, complications data in our registry were specifically collected concurrent with patient care using a priori quality to ensure validity.

In conclusion, psoas blocks are associated with more insertion-related complications, but fewer infectious complications.

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