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The Impact of Patient and Surgical Factors on the Rate of Postoperative Infection After Total Hip Arthroplasty—A New Zealand Joint Registry Study

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ABSTRACT

Background: Periprosthetic joint infection (PJI) is a devastating complication after total hip arthroplasty (THA). The potential to define and modify risk factors for infection represents an important opportunity to reduce the incidence of PJI. This study uses New Zealand Joint Registry data to identify independent risk factors associated with PJI after primary THA.

Methods: Data on 91,585 THAs performed between 2000 and 2014 were analyzed. Factors associated with revision for PJI within 12 months were identified using univariate and multivariate analyses.

Results: Revision rates for PJI were 0.15% and 0.21% at 6 and 12 months, respectively. Multivariate analysis showed significant associations with the American Society of Anesthesiologists grade (odds ratio [OR] 6.13, 95% confidence interval [CI] 1.28-29.39), severe or morbid obesity (OR 2.15, CI 1.01-4.60 and OR 3.73, CI 1.49-9.39), laminar flow ventilation (OR 1.98, CI 1.38-2.85), consultant-supervised trainee operations (OR 1.94, CI 1.22-3.08), male gender (OR 1.68, CI 1.23-2.30) and anterolateral approach (OR 1.62, CI 1.11-2.37). Procedures performed in the private sector were protective for revision for infection (OR 0.68, CI 0.48-0.96).

Conclusions: The PJI risk profile for patients undergoing THA is constituted of a complex of patient and surgical factors. Several patient factors had strong independent associations with revision rates for PJI. Although surgical factors were less important, these may be more readily modifiable in practice.

Total hip arthroplasty (THA) provides enduring benefits when evaluated by health, social, economic, and psychological indices [1–5]. Postoperative periprosthetic joint infection (PJI) is a devastating complication and can negate these benefits [6]. Although the rate of PJI is low, the number of patients affected is sizeable because of the popularity of THA [7]. Furthermore, the costs and challenges of revising a THA for infection are greater than for other causes such as aseptic loosening [8]. Therefore, the potential to define and modify risk factors for infection represents an important opportunity to reduce the incidence of this feared complication.

Historically, significant reductions in PJI rates were achieved with laminar flow ventilation, body-exhaust suits, and prophylactic antibiotics [9–12]. There has been little change in infection rates since, despite additional measures including preoperative skin preparation, adhesive draping, and antibiotic-laden cement [13]. Furthermore, contemporary laminar flow ventilation and surgical helmet systems (SHSs) are modifications of the original technology, possibly compromising their efficacy [14,15]. The 2016 New Zealand Joint Registry (NZJR) annual report demonstrated a paradoxical increased rate of PJI when the primary THA was performed in a laminar flow theater or using SHSs [16].

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Table 1
Univariate Analysis of Patient Factors for Revision for Infection After Total Hip Arthroplasty at 6 and 12 mo.

Patient Factors	6 mo					12 mo				
	Total (n)	Infection (n)	Infection (%)	*P* Value	OR (± 95% CI)	Total (n)	Infection (n)	Infection (%)	*P* Value	OR (± 95% CI)
ASA grade										
I[a]	10,944	8	0.07	**<.001**	1.00	10,931	11	0.10	**<.001**	1.00
II	38,737	60	0.15		2.12 (1.01-4.44)	38,557	84	0.22		2.17 (1.16-4.07)
III	14,941	45	0.30		4.13 (1.95-8.76)	14,656	56	0.38		3.81 (1.99-7.27)
IV	472	2	0.42		5.82 (1.23-27.47)	441	2	0.45		4.52 (1.00-20.47)
Age										
<55[a]	13,526	17	0.13	.820	1.00	13,482	22	0.16	.586	1.00
55-64	23,271	33	0.14		1.13 (0.63-2.03)	23,179	52	0.22		1.38 (0.84-2.27)
65-75	30,990	47	0.15		1.21 (0.69-2.10)	30,795	67	0.22		1.33 (0.82-2.16)
>75	24,518	40	0.16		1.30 (0.74-2.29)	24,129	47	0.19		1.19 (0.72-1.98)
Gender										
Female[a]	49,348	56	0.11	**.003**	1.00	48,966	76	0.16	**<.001**	1.00
Male	42,957	81	0.19		1.66 (1.18-2.34)	42,619	112	0.26		1.70 (1.27-2.27)
Side										
Left[a]	42,676	64	0.15	.910	1.00	42,331	81	0.19	.388	1.00
Right	49,629	73	0.15		0.98 (0.70-1.37)	49,254	107	0.22		1.14 (0.85-1.52)
Diagnosis										
Osteoarthritis[a]	78,714	112	0.14	**.040**	1.00	78,266	151	0.19	**.033**	1.00
Acute FNF	3219	3	0.09		0.66 (0.21-2.06)	3115	8	0.26		1.33 (0.65-2.71)
Avascular necrosis	2509	10	0.40		2.81 (1.47-5.37)	2483	11	0.44		2.30 (1.25-4.25)
Dysplasia	1964	1	0.05		0.36 (0.05-2.56)	1962	1	0.05		0.26 (0.04-1.89)
RA	1195	5	0.42		2.95 (1.20-7.24)	1178	6	0.51		2.65 (1.17-6.00)
Old FNF	1131	2	0.18		1.24 (0.31-5.04)	1102	3	0.27		1.41 (0.45-4.43)
Other inflammatory	701	0	0		-	696	0	0		-
Dislocation	244	1	0.41		2.89 (0.40-20.77)	243	2	0.82		4.29 (1.06-17.42)
Other	1694	3	0.18		1.25 (0.40-3.92)	1684	4	0.24		1.23 (0.46-3.33)
BMI (kg/m^2)										
<35[a]	19,258	36	0.19	**.001**	1.00	19,150	46	0.24	**.002**	1.00
35-40	2488	9	0.36		1.94 (0.93-4.03)	2475	9	0.36		1.52 (0.74-3.10)
>40	796	6	0.75		4.06 (1.70-9.65)	793	7	0.88		3.70 (1.67-8.22)
Previous surgery										
None[a]	88,593	131	0.15	.597	1.00	87,915	180	0.20	.418	1.00
Internal fixation	1725	2	0.12		0.78 (0.19-3.17)	1692	2	0.12		0.58 (0.14-2.33)
Osteotomy	487	0	0		-	487	0	0		-
Arthrodesis	66	0	0		-	66	0	0		-
Other	787	3	0.38		2.58 (0.82-8.13)	784	4	0.51		2.50 (0.93-6.75)

Bold values indicate significant *P* Values.
ASA, American Society of Anesthesiologists; BMI, body mass index; FNF, femoral neck fracture; RA, rheumatoid arthritis.
[a] Reference data points for determination of odds ratios (ORs). ORs are supplied with 95% confidence intervals (CIs).

The aim of this study was to identify independent risk factors for PJI after THA, with a particular emphasis on the use of multivariate analysis to integrate a number of otherwise potentially confounding variables.

Material and Methods

Data on 91,585 primary THAs recorded in the NZJR between 2000 and 2014 were analyzed. National ethics committee approval was obtained, and all patients consented to their data being recorded in the registry. Revision THA (defined as reoperation with removal or exchange of at least one component) specifically for PJI (as recorded in the NZJR) was the outcome of interest. Owing to a lack of consensus for a definition of early infection, revisions for PJI performed within both 6 and 12 months of the index operation were tested for associations with risk factors using univariate and multivariate analyses. Reoperations were included to the end of 2015 to capture any revision occurring within 12 months. Only data collected from the NZJR were analyzed in this study.

Statistical Analysis

Rates of revision for PJI were calculated for patient and surgical factors using Pearson's chi-square test, with a 2-tailed *P* value <.05 considered to be statistically significant. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for each category. Factors found to be associated ($P < .10$) with revision for PJI at 6 and 12 months from the univariate analyses were further analyzed to test for independent associations using stepwise multiple logistic regression analyses. The robustness of the multivariate models was confirmed by using forward and backward stepwise methods. The collection of American Society of Anesthesiologists (ASA) grade [17] and body mass index (BMI) on the NZJR commenced in 2005 and 2010, respectively. Separate multivariate analyses were performed on the 65,094 and 20,349 patients for whom ASA grade and BMI was available. SPSS, version 22, software (IBM, Armonk, New York) was used for all statistical calculations.

Results

The overall rate of revision for PJI was 0.15% at 6 months and 0.21% at 12 months.

Univariate Analysis

Patient factors associated with revision for PJI were higher ASA grade ($P < .001$), higher BMI ($P = .001$ at 6 months, $P = .002$ at 12 months), male gender ($P = .003$, <.001), and following THA performed for rheumatoid arthritis (RA) or avascular necrosis ($P = .040$, .033) (Table 1). At 12 months, any indication for THA other than osteoarthritis conferred a greater risk ($P = .005$). Revision for PJI was directly associated with increasing comorbidity, with patients