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Original Article

Surgical site infections after radical prostatectomy: A comparative study between robot-assisted laparoscopic radical prostatectomy and retropubic radical prostatectomy

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ABSTRACT

Objective: Surgical site infection (SSI) is defined as infection at or near surgical incisions within 30 days of an operative procedure and classified either incisional superficial and deep or organ/space. The aim of the study is to report and compare the incidence and management of SSIs after robot-assisted laparoscopic radical prostatectomy (RALP) and retropubic radical prostatectomy (RRP).

Material and methods: Within the last 4 years, we identified 285 patients that underwent RRP, n=187 (66%) or RALP, n=98 (34%). We reviewed the frequency, types and way of management of SSI complications.

Results: A significant difference was found between RALP and RRP (2/98, 2% vs. 27/187, 14.4%; p<0.0001) as for SSIs. The time interval between the time of surgery and diagnosis of SSIs was longer in RALP relative to RRP (median 13.5 vs. 12.9 days, p=0.761).

Conclusion: All types of SSIs could be developed after RP, however RALP patients only experienced organ or space SSIs and have a lower rate of SSIs and shorter treatment time.

Keywords: Prostate cancer; robot-assisted radical prostatectomy; surgical site infections.

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Introduction

Prostate cancer (PCa) is the most frequently diagnosed tumor in older European men. The highest incidence is in Northern and Western Europe (>200 new cases per year in 100.000 men), while the rates in Eastern and Southern Europe have shown a sustained increase.[1] It is the third most common cause of cancer-related deaths among men in Germany and the number of new cases has risen steadily in recent years, with 65.000 new cases in 2010.[2]

Surgical treatment of PCa is radical prostatectomy (RP), which has been performed for more than 100 years and is considered a gold standard for the treatment of PCa, owing to the realization that hormone therapy and chemotherapy are never curative, as not all cancer cells can be eradicated persistently by radiation or other physical forms of energy, even if the cancer is organ confined PCa.[3-5]

In 1947, Millin was the first to describe the retropubic RP approach. The morbidity due to RP was reduced substantially after several detailed anatomic studies performed in fetal and adult cadavers in the late 1970s and early 1980s which provided crucial insights into the periprostatic anatomy, especially that of the dorsal vein complex, the neurovascular bundle, and the striated urethral sphincter.[6-8]

The mortality and morbidity rates remain primary criteria for assessing the advantages and disadvantages of different surgical techniques

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and approaches and are also used as markers of surgical quality.[9] Therefore, measurement of morbidity requires an accurate definition of a surgical complication as ‘‘an undesirable, unintended, and direct result of an operation affecting the patient, which would not have occurred had the operation been achieved as well as could reasonably be hoped’’.[10,11]

Moreover, surgical site infections (SSIs) are defined as infections of or near surgical incisions within 30 days of an operative procedure. In cases where implants have been placed, this time period is extended to 1 year if the infection appears to relate to the procedure.[12] Their drawbacks are not restricted to impaired cosmetics and the physical inconvenience of the wound or prolonged time to recovery, but they may also lead to a 60% prolongation of intensive care time, a 5-fold increase in readmission rates, an increase in hospitalization time duplication of costs, a boost in the use of antibiotics, and sometimes additional surgery that may duplicate the risk of death within one month after surgery.[13-15] Four classes of surgical wounds have been described: clean, clean-contaminated, contaminated, and dirty.[16] According to the Centers for Disease Control and Prevention (CDC) SSIs are defined and classified as 3 different types (Table 1).[17]

A valid method of comparing open and robotic approaches methodology should be performed using a consistent well-defined surgical technique, grading of complications, and pathological assessment.[18] Despite the controversies regarding the choice of surgical technique and applications of the new RALP technology, and in the light of the insufficiency of other studies comparing the incidence of SSIs after robotic RALP and RRP, we have set up our study with the aim to report and compare the incidence and management of SSIs after RALP and RRP both performed at two participating centers.

Material and methods

After approval was obtained from the local ethical committees, we reviewed all RP institutional medical records and correspondence with the patient or their referring physician. A total of 285 patients were identified, and 187 (66%) patients underwent RRP, and 98 (34%) RALP at the two participating departments over the period of 4 years between 2013, and 2016. We reported the incidence of SSIs, classifying them by using CDC classifications and describing the method of their management. Additionally, demographic data of thr patients, oncological parameters, the pre-and post-operative clinical parameters and pathological findings were registered and compared between RALP, and RRP.

Surgical technique

All RPs were performed by two experienced surgeons in both institutions, either as RALP by a transperitoneal approach, or as RRP by an extraperitoneal approach. PLND was routinely performed in all patients undergoing either RRP or RALP; however, the extent of pelvic lymphadenectomy was planned, and performed at the discretion of the surgeon and was largely dependent on the patient and tumor characteristics.

Perioperative care

In general, urinalysis was performed day before the operation in all patients undergoing either RRP or RALP to ensure there is no leucocytosis or positive nitrites and to rule out urinary tract infection (UTI). Cefotaxime (2 g) was given before induction of anesthesia (in case of allergy to penicillin, an alternative was administered). Another shot of antibiotics was given 8 hours after the operation (if the operation lasted more than 6 hours, a further single shot was administered).

Statistical analysis

All data were stratified according to the surgical approach and compared by means of Fisher’s exact test and chi-squared test for nominal variables, as well as independent t-test and Mann-Whitney Test for continuous variables. Statistical analyses were performed using Statistical Package for the Social Sciences software version 21 (IBM SPSS Statistics; Armonk, NY, USA); $p<0.05$ was considered statistically significant.

Table 1. Classification of surgical site infections based on Centers for Disease Control and Prevention criteria

Superficial Incisional SSIs
Infection occurs after the operation and involves only skin or subcutaneous tissue incised.
Deep Incisional SSIs
Infection occurs after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and involves deep soft tissues (eg, fascial and muscle layers) of the incision.
Organ/Space SSIs
Infection occurs after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and involves any part of the anatomy (eg, organs or spaces), other than the incision, which was opened or manipulated during an operation.

SSI: surgical site infection

Table 2. Preoperative data

	RALP	RRP	Total	p
Cases no., %	98 (34)	187 (66)	285	
Age at operation, yr.				
Mean[a]±SE	68.9±6	67.7±6.9	68.1±6.7	0.196
Median[b] (Range)	69.5 (51-79)	68 (47-85)	69 (47-85)	0.203
**BMI, kg/m², **				
Mean[a]±SE	26.8±2.9	27.3±4	27.2±3.8	0.035
Median[b] (Range)	26.3 (22.1-34)	26.4 (19.5-42.4)	26.4 (19.5-42.4)	0.672
BMI[c], %				0.154
Normal (18.5-24.9)	26.8	33.3	32	
Overweight (25-29.9)	61	44.8	48.1	
Obese (30 or greater)	12.2	21.8	19.9	
ASA[c], %				0.517
I	1.9	5.3	4.4	
II	72.2	72.5	72.4	
III	25.9	22.2	23.1	
Preoperative PSA ng/mL, median[b]	7.4	8.7	8.1	0.082
PSA[c] ng/mL, %				0.003*
<4	4.1	9.7	7.7	
4 to <10	68.4	46.8	54.2	
10-20	19.4	23.7	22.2	
>20	8.2	19.9	15.8	
Prostatic volume, cm³				
Mean[a]±SE	45.4±23.1	41.6±20.1	42.9±21.2	0.279
Median[b] (Range)	40 (13-149)	37 (12-160)	38 (12-160)	0.236
Operative time, min				
Mean[a]±SE	331.3±57.1	269.5±47.9	290.7±58.7	<0.0001*
Catheterization time, days				
Mean[a]±SE	9.2±5.6	12.6±10.2	11.4±9	0.001*
Hospitalization time, days				
Mean[a]±SE	9.7±3.4	13.5±9.1	12.2±7.9	<0.0001*
pT stage[c], %				0.015*
T2	68.4	54.3	59.2	
T3	31.6	45.7	40.8	
N stage[c], %				0.001*
Nx	3.1	1.1	1.8	
N0	86.7	70.1	75.8	
N1	10.2	28.9	22.5	
Gleason score[c], %				0.079
<6	1	1.1	1.1	
6	23.5	21.6	22.3	

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Table 2. Preoperative data (Continued)

	RALP	RRP	Total	p
3+4	32.7	27.6	29.3	
4+3	28.6	20.5	23.3	
≥8	14.3	29.2	24	
Surgical margins, %				<0.0001*
Positive multiple	12.2	4.3	7	
Positive one	9.2	32.3	24.3	
Negative	78.6	63.4	68.7	

*Statistically significant difference (p<0.05). [a]Independent T-test. [b]Mann-Whitney U Test. [c]Chi-squared test. RALP: robot-assisted laparoscopic radical prostatectomy; RRP: retropubic radical prostatectomy; BMI: body mass index; ASA: American Society of Anesthesiologists

Table 3. Diagnosis and management of SSIs

	RALP	RRP	Total	p
SSIs, n (%)	2 (2.1)	27 (14.4)	29 (10.2)	<0.0001*
Types of diagnosed SSIs				0.001*
Incisional superficial no., %	0	10 (5.3)	10 (3.5)	
Incisional deep no., %	0	15 (8.0)	15 (5.3)	
Organ/space no., %	2 (2.1)	2 (1.1)	4 (1.4)	
Length of time from the surgery to diagnosis SSIs				
Mean±SE	13.5±5	12.9±6.4	12.9±6.2	0.761
Median (Range)	13.5 (10-17)	12 (6-30)	12 (6-30)	0.675
Durations of the treatment				
Mean±SE	9.5±5	12.3±6.9	12.1±6.7	0.509
Median (Range)	9.5 (6-13)	10 (4-31)	10 (4-31)	0.545
Treatment				0.009
Observations no., %	0	4 (2.1)	4 (1.4)	
Oral AB no., %	0	3 (1.6)	3 (1.1)	
Incision and drainage of the wound no., %	0	3 (1.6)	3 (1.1)	
VAC no., %	0	15 (8.0)	15 (5.3)	
Surgical treatment of space abscess no., %	2 (2.1)	2 (1.1)	4 (1.4)	

*Statistically significant difference (p<0.05). Fisher's extract test. Total (%) number of patients. RALP: robot-assisted laparoscopic radical prostatectomy; RRP: retropubic radical prostatectomy; SSI: surgical site infection; AB: antibiotics; VAC: Vacuum-Assisted Closure system

Results

Compared to those patients with RRP, the patients who underwent RALP had a longer operative time (mean 331.3 min. vs. 269.5 min, p<0.0001), shorter catheterization times (mean 9.2 days vs. 12.6 days, p<0.0001) and hospitalization times (mean 9.7 days vs. 13.5 days, p<0.0001) Table 2.

SSIs developed only in 29 patients, with a lower rate in patients who underwent RALP rather than RRP (2/98 (2%) vs. 27/187 (14.4%); p<0.0001). Space/organ SSIs (infected lymphocele or pelvic abscess) developed in 4 patients (two patients in each group), which were evident clinically and/or in CT/ultrasound, and confirmed by microbiological analysis of fluid obtained by aspiration or drainage i. e. drainage with a pigtail catheter under

Table 4. SSIs rates in the other studies which compared RRP and RALP

First author	Institution	No. of cases, type	Median/ mean age, y	Median/ mean BMI	Preoperative PSA ng/mL, median	Mean Prostatic vol, cm3!	Median/mean operative time, min	Mean Hospitalization time, days	Mean Catheterisation duration, d	SSIs, %
Menon et al.[21]	Vattikuti Urology Institute, Henry Ford Health System, Detroit, Michigan;	RRP 30	64	30	8.4*	48.4	138*	2.3*	13.7*	1
		RALP 30	62	30	9.94*	58.8	288*	1.5*	10.7*	1
		RALP 200	59.9	27.7	6.4	58.8	160	1.2*	7*	1
Nelson et al.[28]	Department of Urologic Surgery, Vanderbilt University Medical Center, Nashville, Tennessee	RRP 374	59.9	-	8.4	-	-	1.23	-	1.4
		RALP 629	59.3	-	6.7	-	-	1.17	-	0.3
Ficarra et al.[29]	Departments of Oncological and Surgical Sciences, Urology Clinic,	RRP 105	65*	26	6	40	-	-	-	1
		RALP 103	61*	26	6.4	37.5	-	-	-	0
Ryu et al.[30]	Department of Urology, Asan Medical Center, University of Ulsan College of Medicine, Seoul Korea	RRP 340	64.9	24.7	9.7	36.2	170.8	10.1*	7.5*	4.1*
		RALP 524	64.9	24.6	10.1	36	146.4	7.9*	6.2*	0.2*
Froehner et al.[31]	Departments of a Urology University Hospital 'Carl Gustav Carus'	RRP 2,438	64.9*	-	10.4*	-	-	7.7	-	3.2
		RALP 317	62.6*	-	6.4*	-	-	8	-	2.5
Our study	Department of Urology and Pediatric Urology, University Hospital, Kiel, Germany. Department of Urology, Sechenov Moscow State Medical University	RRP 187	67.7	26.4	8.7	41.6	269.5*	13.5*	12.6*	14.4*
		RALP 98	68.9	26.3	7.4	45.4	331.3*	9.7*	9.2*	2*

RALP: robot-assisted laparoscopic radical prostatectomy; RRP: retropubic radical prostatectomy; BMI: body mass index; SSI: surgical site infection

CT/ultrasound guidance or surgical evacuation. Superficial incisional SSIs were diagnosed in 10 patients (5.3%) who underwent RRP. Of these, 4 patients were treated by close observation only, 3 patients by oral antibiotics and 3 other patients by incision and wound drainage. Fifteen patients (8.0%) who underwent RRP developed deep incisional SSIs that required application of Vacuum Assisted Closure (VAC) and/or debridement. SSIs were diagnosed slightly later in those patients who underwent RALP (median 13.5 vs. 12.9 days for RRP after surgery; p=0.761). Patients who underwent RALP experienced a more rapid resolution of their SSIs (median 9.5 vs. 10 days, p=0.509) Table 3.

Discussion

Exogenous or endogenous bacterial contamination and proliferation with subsequent tissue reaction and an outpour of inflammatory cells, leading to tissue destruction and pus formation may occur secondary to these operative procedures. Many local factors, such as necrosis, hematoma, and dead space provide a good medium for bacterial growth which may inhibit local tissue resistance due to the presence of foreign bodies.[19]

Diabetes, cigarette smoking, systemic steroid use, obesity of >20% above the ideal body weight, as well as poor nutritional status and prolonged hospital stay are considered patient-related factors. Moreover, emergency procedures, prolonged operative procedure, use of non-absorbable sutures, foreign bodies, copious use of subcutaneous electrocautery, excessive blood loss, and hypothermia are considered operative-related factors. Both types of risk factors may increase the risk of developing SSIs during the postoperative period.[12,17,20]

All of the above risk factors may occur in patients undergoing RP. In our study, the patients who underwent RP (either RALP or RRP) were quite similar with regard to age, BMI and preoperative comorbidity, and all operations were done on an elective basis. While the operative time was longer in RALP compared to RRP, the hospital stay was longer in RRP.

Many studies show lower rates of SSI in patients undergoing RALP rather than RRP. In his

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2011 paper (Table 4). In their study investigating only superficial and deep incisional SSIs, Tollefson et al.[14] evaluated and compared the incidence of SSIs after RALP or RRP in 5908 patients, demonstrating that patients undergoing RALP had lower SSI rates (0.6% vs. 4.7%; p=0.001). Our study shows similar results, namely that the incidence of SSIs is lower after RALP relative to RRP, and that SSIs after RALP are restricted to organ/space SSIs with no incisional SSIs.

There are many local factors that may play a role in the development of SSIs during open prostatectomy including a larger incision with more tissue exposed to the air than in the robotic approach. The open approach also requires the use of retractors and electrocautery and potentially ischemic sutures, which could devitalize the skin tissue, leading to poorer wound healing.[14] On the other hand, McGee et al.[22], 2009, declared that opening the bladder neck over a longer time during RALP may increase aerobic bacterial contamination of the peritoneum. In our study, however, the patients who underwent RALP only suffered from organ/space SSIs in contrast to those who underwent RRP that had all types of SSIs which could be a result of unrecorded superficial SSIs in the RALP group.

The ultimate treatment approach for SSI is adequate pus drainage. The entire wound has to be opened by suture removal for effective drainage. In incisional SSI's, the wound is packed with moist gauze or commercial cavity dressing until granulation has appeared. Depending on the circumstances, granulating clean wounds may be approximated with secondary sutures. VAC has been clinically proven to encourage granulation of tissue and wound closure. Ultrasound/CT-guided insertion of a percutaneous drainage tube/catheter may be possible in organ space collections. Surgical drainage is often required to drain all collected pus and to remove any dead tissue or slough and to irrigate the cavity.[19] This study has some obvious limitations, such as the difficulty in defining different types of complications; and some colleagues may only document major complications and disregard minor complications.

There are a few articles describing incidence rates of SSIs after RP. Thus one of the current largest studies analysing SSIs is the US National Surgical Quality Improvement Programme (NSQIP) database which surveyed 12 454 patients who underwent RRP and RALP, and reported SSI rates of 4% for RRP and 1% for robot-assisted radical prostatectomies.[23] In a similar earlier published study, the SSI rate reported for the RRP group was 4.7% while the SSI rate in the current study it was 14.4%.[24] SSI rates in RALP and RRP were 1.12% vs. 4.77% with a statistically insignificant difference between groups (p=0.0876).[24] The reason for the higher SSI rates in our analysis can be explained as follows: 1. Two centers agreed to take a detailed digital patient history. Finalization of a patient's history was impossible without a documentation of SSI. Thus, all patients who underwent RRP or RALP had a complete report of SSI. More specifically, the reported 14.4% SSIs in RRP were related to 2 (1.1%) patients with lymphocele, and 10 (5.3%) patients with a superficial incisional infection requiring none or only minor surgical intervention (Table 3). This type of non-consequential SSI may not be taken into consideration in similar studies. However, 15 (8%) patients with a deep incisional SSI treated with VAC and/or debridement were overweight in 44.8% and obese in 21.8%, of the cases (Table 3). It is known that on one hand obesity leads to a higher rate of SSIs[23], and on the other hand obesity might predispose to higher rates of non-organ-confined disease at RP.[25,26] Nevertheless, an SSI rate of 8% is doubtlessy very high after an open surgical procedure. Both centers are tertiary referral centers without a chance of preselecting patients. The number of obese patients is growing.[23,26] The potential risk of creating more infection-associated complications is growing as well. It means that over 66% of our patients were overweight and/or obese. A growing number of obese patients was one of the arguments in both centers to equip both centers with a DaVinci robotic systems. This paper firstly describes the incredible reduction in the SSI-rates from 14.4% down to 2.1%. Unlike the high level of SSI complications in the RRP Group, a 2% reduction is comparable to the results derived from the American College of Surgeons Database NSQIP.[27] Even in a largest cohort (n=11.183) of patients undergoing minimally invasive prostate surgery, the SSI rate was 1.7% (p<0.001). This paper provides clear evidence of how implementation of robot-assisted minimally invasive surgery is capable of reducing complications of SSIs. Expectation of this improval was one of the major arguments for implementing daVinci-based surgery at our hospitals. The outcome of this analysis is an important success for both participating centers and proves our supposition. Moreover, we hope that our results might be used as ammunition for other hospitals when having to overcome the cost arguments which is often seen as an impediment to buying a robotic surgical system like the daVinci.

In conclusion, RALP showed lower rates of SSIs than RRP. All types of SSIs potentially developed after RRP, but only organ or space SSIs developed after RALP. We propose that RALP may be recommended not only as a sophisticated and advanced robot-assisted surgical technique, but also because it reduces the incidence of SSIs, which may have a significant impact on patient satisfaction and operative costs.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of the medical faculty of the Christian Albrechts University of Kiel on 9th of December 2015/D 576/15.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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