Effectiveness and Economic Outcomes in Patients Undergoing Laparoscopic Prostate Resection with a New Surgical Shear with Integrated Energy System: a retrospective study based on a tertiary hospital database in China

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Research Article

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Abstract

Background: Each year over 1.4 million men are diagnosed with prostate cancer. Surgical prostate resection offers patients with early-stage prostate cancer a high likelihood of remission and has low reoperation rates. A new surgical shear with integrated energy system (Harmonic ACE+7) is an integrated ultrasonic and electrosurgical energy system that can aid surgeons in laparoscopic prostate resections. This study aimed to demonstrate the ACE+7's value by determining its effectiveness and economic outcomes compared to conventional ultrasonic shear (CUS) in a real-world setting.

Methods: This was a multi-center clinical study of adults with prostate cancer undergoing a laparoscopic prostate resection procedure with the ACE+7 shear or CUS between August 2019 and April 2021 at Shanghai Ruijin Hospital and two affiliated centers. Demographic and diagnosis information, intraoperative and postoperative clinical outcomes, and total and categorical costs were collected. 1:1 Propensity Score Matching was performed to form the study population for each clinical group. Data were compared between the two groups using t-tests and chi-squared tests.

Results: The ACE+7 was associated with a lower number of hemostatic clips used per surgery (12.8 in the ACE+7 group vs 19.8 in the CUS group, \( P<0.001 \)), a moderate but not significant difference in average postoperative drainage duration (6.6 ± 2.2 d vs. 7.9 ± 4.1 d, \( P=0.082 \)), a reduction on total drainage volume (275.5 ± 374.3 ml vs. 492.9 ± 1495.0 ml, \( P=0.321 \)) and a lower average rate of postoperative hemostatic drug usage (16% vs. 52%, \( P<0.001 \)). There was no significant difference in total costs between the ACE+7 and CUS groups.

Conclusion: This study provides real-world data demonstrating that the ACE+7 shear with integrated energy system improves clinical outcomes compared to CUS and can offer cost savings for hospitals and health systems. Using the ACE+7's during LPRs allows physicians to help their patients achieve better outcomes and not spend additional money.

Background

Each year over 1.4 million men are diagnosed with prostate cancer [1]. Prostate cancer is the second most common cancer in men and has a higher burden in men over 65. Therefore, its incidence is expected to rise as life expectancy increases [2]. Although improved therapies and diagnostic tools have decreased prostate-cancer related mortality, access to innovative, lifesaving prostate cancer care is not available worldwide [2, 3]. In turn, prostate cancer's incidence and mortality rates are rising in some countries such as China [4]. As the burden of prostate cancer grows in the coming years, it is essential to ensure people have access to clinically effective and cost-effective treatments regardless of where they live. Through effective care, people worldwide can live long and productive lives.

Treatments for prostate cancer include surgery, radiation therapy, high-intensity focused ultrasound, cryotherapy, chemotherapy, and immunotherapy [2]. Physicians choose a treatment to use based on the patient's disease progress [2]. For example, in China, surgical prostate resections are recommended for
the management of resectable prostate cancer [5]. Surgical prostate resection offers patients with early-stage prostate cancer a high likelihood of remission and has low reoperation rates. Most Chinese surgeons perform this surgery laparoscopically as laparoscopic prostate resections (LPRs) are less invasive than open prostatectomies, decrease operation time, decrease blood loss, have a lower risk of causing postoperative urinary leakages, and have a lower risk of causing sexual dysfunction [6]. However, parts of the procedure, including the resection of collateral ligaments, are very technically demanding for surgeons [7]. In response to these difficulties, researchers are constantly developing new surgical techniques and tools to make LPRs safer.

One example of these tools is a new surgical shear with integrated energy system (Harmonic ACE + 7). It is an integrated ultrasonic and electrosurgical energy system that leverages adaptive tissue technology with predictive analytics to modulate energy delivery during the sealing cycle [6]. With greater burst pressures than those from older bipolar technologies, the Harmonic ACE + 7 shear with advanced hemostasis mode can seal vessels up to 7 mm in diameters [7]. Several clinical trials demonstrate the ACE + 7’s hemostasis efficacy, ability to seal large vessels, and its lower thermal energy output [6–9]. Furthermore, the innovative device can improve operative efficiency by eliminating the need for instrument exchanges during surgery, making it best suited for surgeries that require dissection, mobilization, and large vessel sealing [10]. Thus, it could be a useful tool for LPRs.

Although current evidence establishes the ACE + 7’s clinical benefits, few studies have used real-world data to assess the economic value of the ACE + 7. For more surgeons to use the ACE + 7, it is essential to offset the premium price by showing the ACE + 7 is a high-value, cost-effective surgical tool. This study aimed to demonstrate the ACE + 7’s value by determining its effectiveness and economic outcomes compared to conventional ultrasonic shears (CUS) in LPRs in a real-world setting.

**Methods**

**Study Population and Data Source**

This is a multi-center observational study of adults (≥ 18 years old) with prostate cancer undergoing an LPR procedure with the ACE + 7 shear or CUS between August 2019 and April 2021 at Shanghai Ruijin Hospital, including the headquarters, the North Center and Luwan Center in China. Patients were excluded from the study if they had a robotic-assisted surgery or an intra-fascial prostate resection.

The demographic, diagnosis, and surgical information, intraoperative and postoperative clinical outcomes, and hospitalization costs were collected retrospectively through an Electronic Hospital Information System (HIS). Data extraction was performed by trained physicians and validated by a research assistant to ensure the data’s accuracy. The study was reviewed and approved by Ethical Committee in September 2021.

Surgeon preference dictated which type of ultrasonic shear was used during surgery. 1:1 Propensity Score Matching (PSM) was performed to form the study population for each clinical group (ACE + 7 or CUS).
PSM is a standard, widely applied technique that simulates an experimental study to estimate a causal effect in an observational data set [11]. It attempts to control confounding biases by making the groups receiving treatment and no treatment comparable to the control variables. Propensity scoring was performed using age, study site, BMI, comorbidities, abnormal rate of coagulation, Gleason score, lymph node dissection, and pelvic adhesiolysis.

**Clinical Effectiveness**

Researchers assessed several endpoints to evaluate the clinical effectiveness of the ACE + 7 shear with integrated energy system compared to the CUS. These included intraoperative hemostatic clip usage, intraoperative blood loss, transfusion rate, operation time, postoperative rate of using hemostatic drugs, postoperative length of drainage, postoperative drainage volume, length of stay (LOS), postoperative LOS, re-operation rate during index hospitalization, and postoperative readmission within 30 days.

**Hospitalization Costs**

To determine the cost-effectiveness of the ACE + 7 compared to CUS, direct medical costs during index hospitalization on each patient was collected through an HIS. Direct hospitalization costs included total cost and the cost breakdown comprised of device cost, treatment cost, pharmaceutical cost, nursing cost, board and room cost, lab test cost, examination cost, transfusion cost, oxygen therapy cost, traditional Chinese medicine (TCM) cost, diagnosis cost, and other costs.

**Statistical Analysis**

Descriptive analysis of the baseline characteristics was performed before and after PSM. Mean and standard deviation were tabulated for continuous variables. Frequency and percentage were tabulated for categorical variables. Statistical differences of continuous variables between the ACE + 7 and CUS groups were analyzed by a t-test. Categorical outcome variables were compared using a Chi-square test when the expected frequency is greater than 5 for all cells or a Fisher exact test when the expected frequency is less than 5 in at least one of the cells. Hospitalization costs were compared between the two groups using a t-test.

All statistical analyses were performed using R software version 3.5.3, with $P$ values $< 0.05$ considered as statistically significant.

**Results**

A total of 222 cases met the inclusion and exclusion criteria. After excluding patients with missing data, 193 patients were included for descriptive analysis at baseline, with 70 in the ACE + 7 group and 123 in the CUS group (Fig. 1).

Baseline characteristics were compared in the initial 193 patients. It was found that the distribution of study site was statistically different between the two groups. The percent of preoperative abnormal
coagulation function and the percent of lymph node dissection during surgery were statistically higher in ACE + 7 group compared to CUS group (Table 1).

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>ACE + 7 group (N = 70)</th>
<th>CUS group (N = 123)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD</td>
<td>68.6 ± 6.6</td>
<td>68.9 ± 6.5</td>
<td>0.736</td>
</tr>
<tr>
<td>Study site, N(%)</td>
<td></td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>Ruijin Hospital and North Center</td>
<td>35 (50.0%)</td>
<td>88 (71.5%)</td>
<td></td>
</tr>
<tr>
<td>Ruijin Luwan center</td>
<td>35 (50.0%)</td>
<td>35 (28.5%)</td>
<td></td>
</tr>
<tr>
<td>BMI(kg/m²), mean ± SD</td>
<td>24.5 ± 2.4</td>
<td>23.9 ± 2.7</td>
<td>0.156</td>
</tr>
<tr>
<td>Comorbidity of hypertension, N(%)</td>
<td>34 (48.6%)</td>
<td>61 (49.6%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Comorbidity of diabetes, N(%)</td>
<td>13 (18.6%)</td>
<td>18 (14.6%)</td>
<td>0.608</td>
</tr>
<tr>
<td>Pre-op abnormal coagulation function, N(%)</td>
<td>36 (51.4%)</td>
<td>42 (34.1%)</td>
<td>0.028</td>
</tr>
<tr>
<td>Gleason score, mean ± SD</td>
<td>7.5 ± 1.0</td>
<td>7.3 ± 0.9</td>
<td>0.115</td>
</tr>
<tr>
<td>Lymph node dissection during surgery, N(%)</td>
<td>57 (81.4%)</td>
<td>63 (51.2%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pelvic adhesiolysis during surgery, N(%)</td>
<td>35 (50.0%)</td>
<td>58 (47.2%)</td>
<td>0.818</td>
</tr>
</tbody>
</table>

After 1:1 PSM, there were 50 patients in each treatment group with no statistical difference in baseline characteristics between the groups (Table 2). The average age for patients in the ACE + 7 group was 68.2 ± 6.2 years, and 68.4 ± 7.1 years for the CUS group. Rates of underlying conditions were similar between groups. In the ACE + 7 group, 26 (52%) patients had hypertension, and 9 (40%) were diabetic. In comparison, 25 (50%) of the CUS group had hypertension, and 21 (42%) were diabetic. Patients in each group had similar disease progression with 7.6 vs. 7.7 Gleason scores in the ACE + 7 and CUS groups, respectively.
Table 2  
Baseline characteristics comparisons between ACE + 7 group and CUS group after 1:1 Propensity Score Matching

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>ACE + 7 group (N = 50)</th>
<th>CUS group (N = 50)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD</td>
<td>68.2 ± 6.2</td>
<td>68.4 ± 7.1</td>
<td>0.858</td>
</tr>
<tr>
<td>Study site, N(%)</td>
<td></td>
<td></td>
<td>0.682</td>
</tr>
<tr>
<td>Ruijin Hospital and North Center</td>
<td>32 (64.0%)</td>
<td>29 (58.0%)</td>
<td></td>
</tr>
<tr>
<td>Ruijin Luwan center</td>
<td>18 (36.0%)</td>
<td>21 (42.0%)</td>
<td></td>
</tr>
<tr>
<td>BMI(kg/m$^2$), mean ± SD</td>
<td>24.3 ± 2.6</td>
<td>23.6 ± 3.2</td>
<td>0.224</td>
</tr>
<tr>
<td>Comorbidity of hypertension, N(%)</td>
<td>26 (52.0%)</td>
<td>25 (50.0%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Comorbidity of diabetes, N(%)</td>
<td>9 (18.0%)</td>
<td>7 (14.0%)</td>
<td>0.785</td>
</tr>
<tr>
<td>Pre-op abnormal coagulation function, N(%)</td>
<td>20 (40.0%)</td>
<td>21 (42.0%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Gleason score, mean ± SD</td>
<td>7.6 ± 1.0</td>
<td>7.7 ± 1.0</td>
<td>0.477</td>
</tr>
<tr>
<td>Lymph node dissection during surgery, N(%)</td>
<td>39 (78.0%)</td>
<td>37 (74.0%)</td>
<td>0.815</td>
</tr>
<tr>
<td>Pelvic adhesiolyis during surgery, N(%)</td>
<td>32 (64.0%)</td>
<td>25 (50.0%)</td>
<td>0.226</td>
</tr>
</tbody>
</table>

Clinical Effectiveness

The number of hemostatic clips used per surgery was significantly different between the ACE + 7 and the CUS groups. Surgeons, on average, used 12.8 hemostatic clips for patients in the ACE + 7 group compared to 19.8 clips for patients in the CUS group ($P<0.001$). There was a moderate but not significant difference in average postoperative drainage duration: 6.6 ± 2.2 d in the ACE + 7 group vs. 7.9 ± 4.1 d in the CUS group ($P=0.082$). Additionally, there was nearly a 50% reduction in average drainage volume in the ACE + 7 group compared with the CUS group: total drainage volume: 275.5 ± 374.3 ml in the ACE + 7 group vs. 492.9 ± 1495.0 ml in the CUS group, ($P=0.321$). The ACE + 7 group had a significantly lower average postoperative hemostatic drug usage rate: 16% vs. 52% ($P<0.001$). No significant differences were found in the amount of blood loss, the transfusion rate, the operation time, or the LOS (Table 3).
Table 3
Clinical Outcomes Comparisons between ACE + 7 group and CUS after PSM

<table>
<thead>
<tr>
<th>Endpoints</th>
<th>ACE+7 group (N = 50)</th>
<th>CUS group (N = 50)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraoperative hemostatic clip usage, mean ± SD</td>
<td>12.8 ± 5.8</td>
<td>19.8 ± 6.6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Intraoperative blood loss (mL), mean ± SD</td>
<td>191.1 ± 152.8</td>
<td>204.2 ± 181.6</td>
<td>0.782</td>
</tr>
<tr>
<td>Transfusion rate, N(%)</td>
<td>1 (2.0%)</td>
<td>3 (6.0%)</td>
<td>0.610</td>
</tr>
<tr>
<td>Operation time (min), mean ± SD</td>
<td>162.6 ± 44.8</td>
<td>158.0 ± 37.4</td>
<td>0.586</td>
</tr>
<tr>
<td>Post-op rate of hemostatic drug usage, N(%)</td>
<td>8 (16.0%)</td>
<td>26 (52.0%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Post-op length of drainage (days), mean ± SD</td>
<td>6.6 ± 2.2</td>
<td>7.9 ± 4.1</td>
<td>0.082</td>
</tr>
<tr>
<td>Post-op drainage volume within 24 hours (mL), mean ± SD</td>
<td>72.0 ± 59.1</td>
<td>133.4 ± 282.0</td>
<td>0.135</td>
</tr>
<tr>
<td>Post-op drainage volume within 48 hours (mL), mean ± SD</td>
<td>143.4 ± 135.5</td>
<td>239.6 ± 495.9</td>
<td>0.189</td>
</tr>
<tr>
<td>Post-op total drainage volume (mL), mean ± SD</td>
<td>275.5 ± 374.3</td>
<td>492.9 ± 1495.0</td>
<td>0.321</td>
</tr>
<tr>
<td>Length of stay (days), mean ± SD</td>
<td>10.7 ± 3.4</td>
<td>11.3 ± 4.8</td>
<td>0.413</td>
</tr>
<tr>
<td>Postoperative length of stay (days), mean ± SD</td>
<td>7.9 ± 3.0</td>
<td>8.6 ± 4.2</td>
<td>0.337</td>
</tr>
<tr>
<td>Re-operation during index hospitalization, N(%)</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Post-op readmission within 30 days, N(%)</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
</tbody>
</table>

Hospitalization Costs

Although the price of the ACE + 7 shear is higher than that of the CUS, there was no significant difference in total cost between the ACE + 7 group and the CUS group: RMB 42,675 vs. RMB 41,426 (P = 0.349) (Table 4). This was explained by cost savings in several line items, including treatment costs, pharmaceutical costs, lab test costs, exam costs, board and room costs, nursing costs, transfusion costs, and oxygen therapy costs (Table 4). The total cost excluding intervention cost was RMB 38357.8 in the ACE + 7 group compared to RMB 39983.1 in the CUS group. This difference was not statistically significant (P = 0.223)
Table 4
Direct hospitalization cost comparison between ACE + 7 group and CUS group after PSM.

<table>
<thead>
<tr>
<th>Costs (RMB), mean ± SD</th>
<th>ACE + 7 group (N = 50)</th>
<th>CUS group (N = 50)</th>
<th>Difference (ACE + 7 – CUS)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost</td>
<td>42675.0 ± 5134.5</td>
<td>41426.3 ± 7623.7</td>
<td>1248.8</td>
<td>0.349</td>
</tr>
<tr>
<td>Device cost</td>
<td>23308.4 ± 5702.0</td>
<td>19467.5 ± 5946.7</td>
<td>3840.9</td>
<td>0.002</td>
</tr>
<tr>
<td>Treatment cost</td>
<td>3287.0 ± 3902.9</td>
<td>4412.4 ± 4097.2</td>
<td>-1125.4</td>
<td>0.176</td>
</tr>
<tr>
<td>Pharmaceutical cost</td>
<td>6800.3 ± 4169.0</td>
<td>7436.4 ± 4481.4</td>
<td>-636.0</td>
<td>0.478</td>
</tr>
<tr>
<td>Nursing cost</td>
<td>555.6 ± 275.8</td>
<td>649.9 ± 352.1</td>
<td>-94.3</td>
<td>0.149</td>
</tr>
<tr>
<td>Board and room cost</td>
<td>723.0 ± 636.0</td>
<td>858.7 ± 694.4</td>
<td>-135.7</td>
<td>0.325</td>
</tr>
<tr>
<td>Lab test cost</td>
<td>2636.8 ± 805.9</td>
<td>3132.3 ± 1280.2</td>
<td>-495.5</td>
<td>0.025</td>
</tr>
<tr>
<td>Examination cost</td>
<td>3591.3 ± 763.4</td>
<td>3792.1 ± 1178.1</td>
<td>-200.7</td>
<td>0.324</td>
</tr>
<tr>
<td>Transfusion cost</td>
<td>20.0 ± 141.4</td>
<td>49.2 ± 192.0</td>
<td>-29.2</td>
<td>0.400</td>
</tr>
<tr>
<td>Oxygen therapy cost</td>
<td>44.3 ± 8.4</td>
<td>62.9 ± 50.8</td>
<td>-18.7</td>
<td>0.012</td>
</tr>
<tr>
<td>TCM cost</td>
<td>996.5 ± 1034.8</td>
<td>765.4 ± 999.0</td>
<td>231.1</td>
<td>0.275</td>
</tr>
<tr>
<td>Diagnosis cost</td>
<td>376.0 ± 88.7</td>
<td>384.4 ± 106.0</td>
<td>-8.4</td>
<td>0.677</td>
</tr>
<tr>
<td>Other cost</td>
<td>335.8 ± 355.5</td>
<td>415.1 ± 426.8</td>
<td>-79.3</td>
<td>0.328</td>
</tr>
<tr>
<td>Total cost excluding intervention cost*</td>
<td>38357.8 ± 5127.1</td>
<td>39983.1 ± 7618.3</td>
<td>-1625.2</td>
<td>0.223</td>
</tr>
</tbody>
</table>

*Intervention cost for ACE + 7 group is the service fee of integrated ultrasonic and electrosurgical energy system (800 RMB) and the cost of Harmonic ACE + 7 shear (3500 RMB) which has a separate Billing-Code. Intervention cost for CUS group is service fee of ultrasonic shear system (1400 RMB) which contains cost of ultrasonic shear and relevant service.

Discussion

While other studies show the device's clinical effectiveness, this is one of the first studies to use real-world evidence to demonstrate that the ACE + 7 shear could improve intraoperative and postoperative outcomes without increasing the total hospitalization cost. This study's results are comparable to previous studies and shows that the ACE + 7 shear with integrated energy system provides better hemostasis effectiveness than conventional ultrasonic shears. Previous studies have focused explicitly
on the technical processes and modes of improvement associated with the ACE + 7, such as decreased thermal energy and increased burst energy, but have not investigated clinical outcomes related to the new ACE + 7 technology compared to CUS. This study provides evidence that there are clinical benefits associated with using the ACE + 7 in LPR procedures.

In particular, the new surgical shear was associated with decreased use of hemostatic clips and hemostatic drugs. A recent systematic review found that excessive bleeding was one of the most common LPR complications, affecting 12% of patients [12]. This is considerably higher than the 3% of patients who experience excessive bleeding in surgeries overall [13]. Excessive bleeding can cause hemodilution, hypothermia, consumption of clotting factors, and acidosis [14]. Greater bleeding control could lower surgical complications.

Similarly, in older populations, hemostasis medications are associated with a high risk of gastrointestinal bleeding [15]. Therefore, decreasing hemostatic drug usage is particularly important as older men are more likely to develop prostate cancer. Adopting medical innovations to reduce complications in the populations most affected by prostate cancer is essential to provide high-quality care and achieve better outcomes.

Additionally, the ACE + 7 shear was associated with lower postoperative drainage duration and nearly a 50% reduction in drainage volume. Longer postoperative draining durations can increase the risk of infections [16]. These infections usually clear on their own but can cause urinary tract infections or more widespread infections throughout the body. In turn, using the ACE + 7 shear decreases the average draining duration for LPR patients, reducing the risk of irritating and potentially dangerous postoperative complications, and even antibiotic drug usage.

The ACE + 7 did not reduce total hospital costs for LPR patients but lowered several categorical costs. Most notably, patients in the ACE + 7 group experienced cost savings through needing fewer hemostatic clips. While hemostatic clips are not extremely expensive, it is essential to cut costs wherever possible during surgery to compensate for the tool’s higher price. The premium price of the ACE + 7 shear is offset by cost reductions in treatment cost, pharmaceutical cost, nursing cost, and room and board cost. These cost savings are relevant results of the better clinical outcomes associated with the ACE + 7 shears. For example, if patients in the ACE + 7 group needed fewer hemostatic drugs, they would have lower pharmaceutical costs.

Medical innovations such as the ACE + 7 shear with integrated energy system are essential to giving patients Value-Based Care (VBC) or care that offers people the best outcomes for the lowest costs. When evaluating the cost of a new technology, it is essential to take the total relevant costs into consideration, rather than narrowly focusing on the device price. For example, if a device improves a surgical process, perioperative hospitalization costs could be affected by the introduction of the new technology and should be analyzed comprehensively. In the context of VBC, the ACE + 7 technology results in better outcomes but does not increase overall costs. Although the tool itself costs the health system more money, there are areas for further cost savings that offset the device cost.
VBC is essential if China wants to reach Universal Health Coverage. In 2009, China launched an extensive
health reform plan to provide all citizens equal access to quality health and financial risk protection [17].
In response to current gaps in this plan, the WHO released recommendations to help China achieve the
goal, such as improving quality of care through patient-centered care and VBC to overcome these
shortfalls in the hopes of patients having better health, higher-quality care, and care at affordable costs
[18]. Overall, increasing the ACE + 7 shear uptake for LRPs can lead to high-quality, cost-effective care for
patients with prostate cancer.

There are several limitations in this study. Firstly, in the initial study population, patients had more
complex conditions in the ACE + 7 group than the CUS group. For example, the percentage of abnormal
cogulation function and conducting lymph node dissection during surgery are both much higher in ACE + 7 group. Although we conducted PSM to control the difference, the inconsistence could not be entirely
eliminated since some confounders could not be recorded in our study, such as the tumor size, TNM
stage, prostate tissue condition, etc. There was also a loss of sample size due to the inconsistence of
baseline characteristics. Secondly, we did not capture indirect costs, such as the patient care cost after
discharge. Finally, Ruijin Hospital is one of the top Tier Ⅲ hospital in China according to Hospital Rankings
in China (Fudan 2020 version). The surgeons’ surgical skill in Ruijin Hospital is relatively advanced
compared to those in Tier Ⅱ hospitals. As a result, the study results might not be the same in Tier Ⅱ hospitals. However, we assume the new technology with a stable clinical effectiveness could help to
standardize the surgical procedures and reduce reliance on surgical skills, and so that could provide
better performance for junior surgeon.

Conclusions

This real-world study demonstrated that the ACE + 7 shear with integrated energy system improved
clinical outcomes compared to the conventional ultrasonic shear for patients receiving LPRs. While the
device cost more than a conventional ultrasonic shear, the ACE + 7 can offer other cost savings for
hospitals and health systems.

Abbreviations

ACE + 7
Harmonic ACE + 7 Shear
CUS
Conventional ultrasonic shears
HIS
Electronic Hospital Information System
LPR
Laparoscopic prostate resections
LOS
Length of stay
Declarations

Ethics Approval and consent to participate: All methods were carried out in accordance with relevant guidelines and regulations. The study and protocol were reviewed and approved by Ruijin Hospital Ethics Committee in Shanghai JiaoTong University School of Medicine in September 2021 (Ethics committee reference number: 2020-304). Waiver of informed consent elements was approved by Ruijin Hospital Ethics Committee in Shanghai JiaoTong University School of Medicine as the research is a retrospective, observational study based on data from existing Electronical Hospital Information System and no human intervention was involved, and the research involves no more than minimal risk to subjects and will not adversely affect the rights and welfare of the subjects.

Consent for publication: Not applicable

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Availability of data and materials: The data that support the findings of this study are available from Information Technology Department of Ruijin Hospital but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Information Technology Department of Ruijin Hospital.

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References

**Figures**

**Figure 1**

Patient Population Selection