

# Project Surgical RADAR: Mastery registry of Objective Performance Indicators during a realistic nerve-sparing robotic radical prostatectomy simulation.

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## Background:

- Erectile dysfunction after robot-assisted radical prostatectomy (NS-RARP) is highly variable, ranging from 8% to 49% even among experienced surgeons
- No consensus available on tasks/approaches that produce best potency
- Objective Performance Indicators (OPIs) derived from da Vinci console data recorders have been shown to differentiate surgical skill in correlation with Global Rating Systems (GRS) like GEARS and DART

## Aim

- Using clustering-based methodologies, evaluate differences in surgical console kinematic and event data between board-certified surgeons performing NS-RARP and their effect on force output within a standardized, validated radical prostatectomy simulation.

## Methods

- 30 urologists with average RARP volume of 734 performed NS-RARP (Figure 1) on a validated hydrogel-based simulation model containing embedded force sensors within the Neurovascular Bundle (NVB) (Figure 1).
- OPI data was collected using the da Vinci console integrated data recorder (IDR)
- Hierarchical clustering was utilized for feature selection/elimination of highly associated variables
- Force was converted into a high/low force categorical value based on metric averages for surgeons with >250 prostatectomy cases as primary surgeon (literature-defined learning curve for nerve sparing in RARP)
- A Gaussian Mixture Clustering model (n=3 clusters) was utilized to group the data into three distinct groups
- Tukey's HSD test was used to assess differences within an ANOVA model of RARP case volume and force categorical assignments.
- Bonferroni-corrected Mann-Whitney U test was used to assess statistical differences between assigned groups for OPI variables used as clustering parameters

## Results:

### Clustering by experience level (Figure 2)

- Surgeons were segregated into three groupings with statistically significant differences in surgical case volume
- Super Users (5/5) and High Volume (4/5) surgeons showed significant differences in force metrics compared to Low Volume surgeons
- Super Users and High Volume surgeons did not show significant differences in forces applied
- "Smoothness Metrics" – showed significant differences between Super Users and High Volume surgeons for 11/13 variable categories
- Super Users (7/9) and High Volume (6/9) surgeons showed significant differences in efficiency (economy of motion) vs Low Volume surgeons

### Correlations with Force (Figure 3)

- Significant negative correlations were found between robotic volume and applied forces
- Stronger negative correlations were found between RARP volume and applied forces
- Smoothness metrics that retained significance were positively correlated with respect to Average Force, Average Peak Height (Magnitude) of high-force events, and Variability (standard deviation) within the force signal, and negatively correlated with Total Force Peaks and Total Force applied.
- Total workspace volume correlated positively with force metrics.
- Left hand tool (USM1, bipolar instrument) speed was found to have the strongest positive correlations with applied forces.

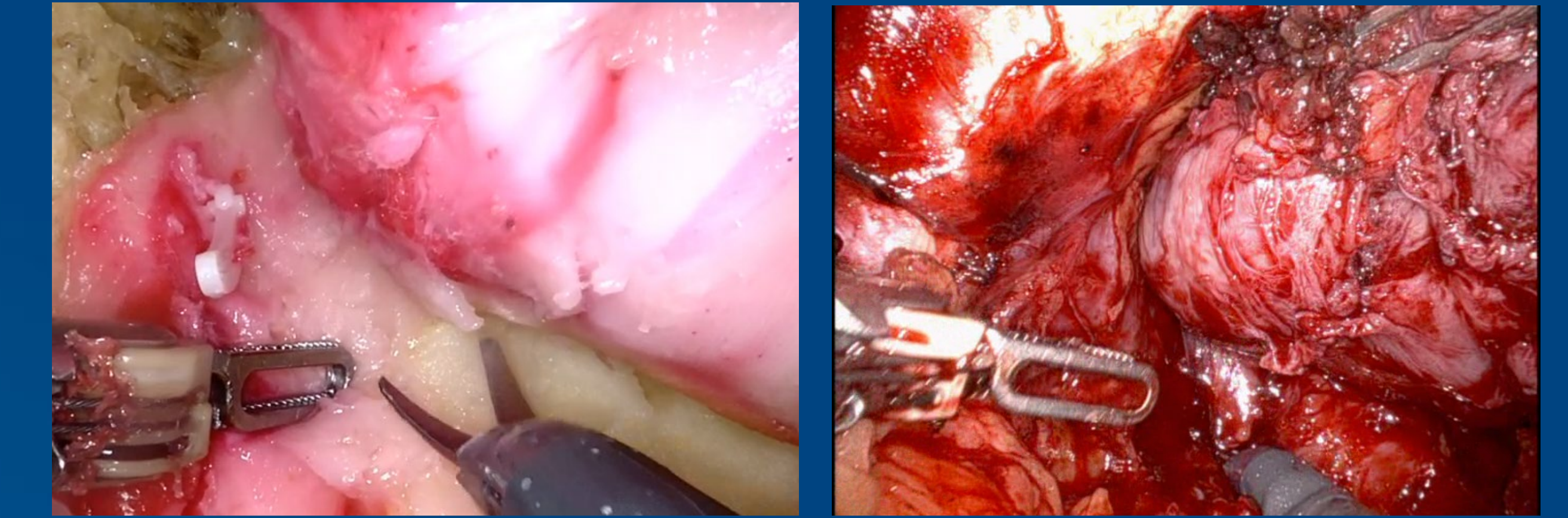


Figure 1: Simulation (Left) vs Live Case (Right)

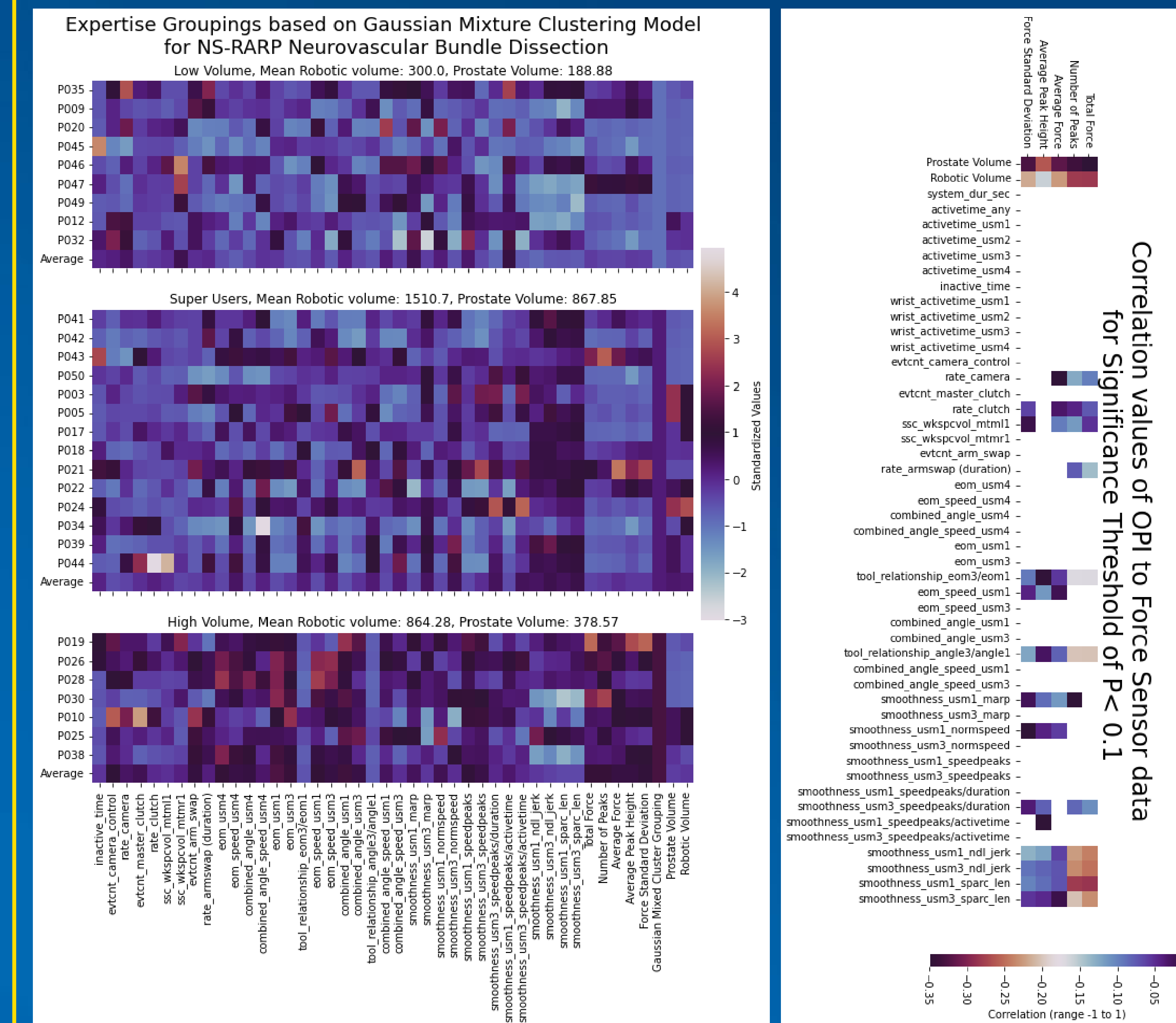


Figure 2: Gaussian Mixture Clustering Results

Figure 3: Force-OPI correlations

## Conclusions:

Experienced urologists showed higher incidence of efficiency and operative fluidity versus their less experienced counterparts, which was similarly reflected in force data. Structured feedback may identify tendencies employed by super users that can be used by less experienced urologists to improve surgical efficiency.