



Orthopedics and  
Sports Medicine

Poster 75

# Machine Learning Prediction of “Optimal Observed Outcome” for Anterior Shoulder Instability Surgery

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Investigation performed at the Mayo Clinic Department of Orthopedic Surgery, Rochester, Minnesota



# I (and/or my co-authors) have something to disclose.

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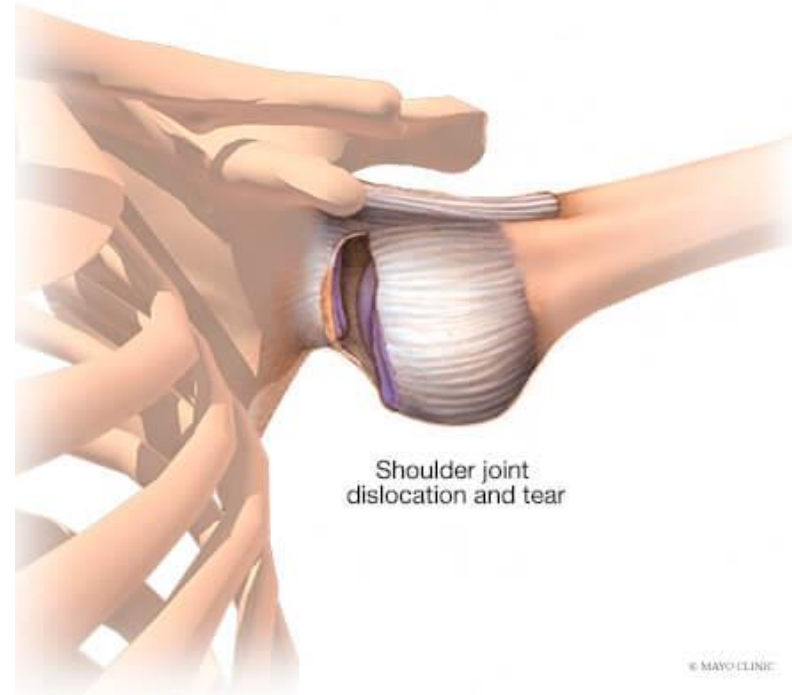
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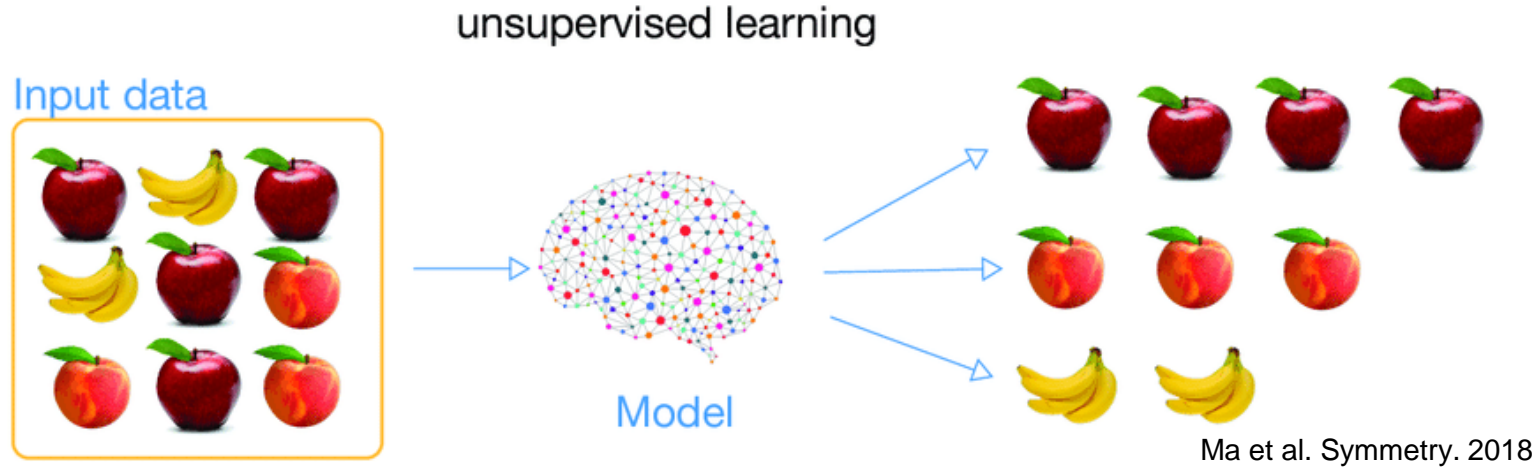
# ANTERIOR SHOULDER INSTABILITY (ASI)

- Common causes of shoulder dysfunction in athletes
- Surgery recommended for:
  - hx of multiple instability events
  - substantial bone loss
- Goal to improve pain, stability, range of motion, and return to previous sport or activity without progression of future arthritis
- Are these outcomes mutually exclusive?



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# THE ROLE OF ARTIFICIAL INTELLIGENCE



- Unsupervised learning can identify hidden patterns
  - Takes all features and group data points based on similarity to each other
  - Optimal outcomes (apples)
  - Suboptimal outcomes (oranges)

## STUDY QUESTION

***How do we best define the  
“optimal observed outcome”  
after anterior shoulder  
instability surgery?***

# PURPOSE

- Aim 1: **Define** the “optimal observed outcome” after operative treatment for ASI
- Aim 2: **Determine** percentage of patients who achieved optimal outcome and timeline for achievement
  - **Determine** percentage of patients who achieved a “perfect outcome” defined as top performer in all outcome measures
- Aim 3: **Identify** factors correlated with achieving this “optimal observed outcome”

# METHODS: DATA CURATION

- Retrospective cohort study from the Rochester Epidemiology Project
- Patients were included if
  - 1 or more ASI events
  - <40 years of age at the time of initial instability
  - treated surgically
  - minimum of 2-years follow-up
- Patients with evidence of multidirectional or posterior instability only were excluded

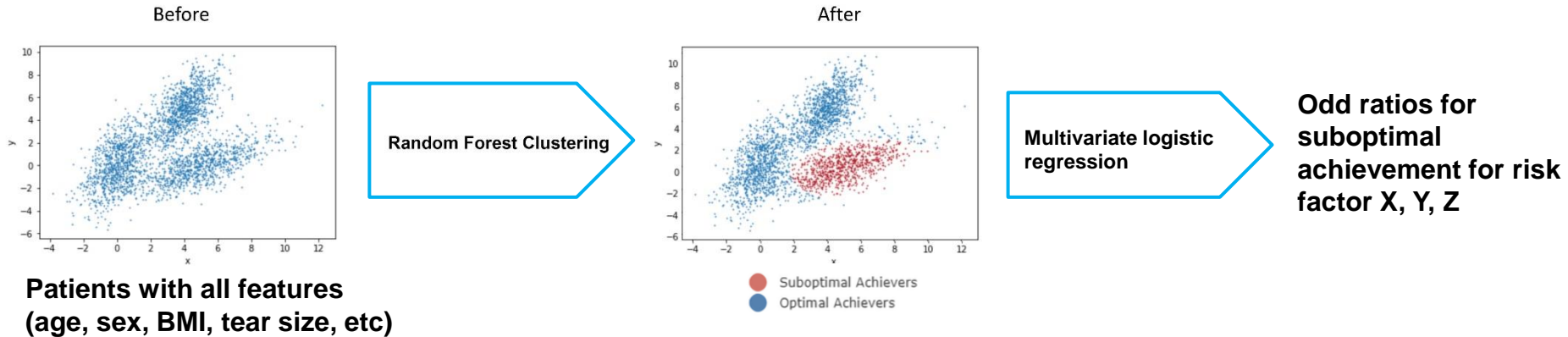
# METHODS: OUTCOMES

- **Primary outcome:** subgroups in composite achievement of the following outcomes
  - Restoration of ROM to within 5 degrees of normal
  - No recurrent instability
  - No revision surgery
  - No pain at final follow-up
  - Full return to sports
  - No progression to OA
  - No complications
  - Achievement of all => **Perfect outcome**



# METHODS: WORKFLOW

- Risk factors for a patient being in the suboptimal subgroup using multivariate logistic regression





# RESULTS: BASELINE DEMOGRAPHICS



- 228 patients
  - 146 (64%) optimal outcome
    - 82 perfect outcome (41%)
  - 54 (36%) suboptimal outcome
- Median follow-up 11.1 years
- No differences in gender and sports participation



# RESULTS: BASELINE DEMOGRAPHICS

Baseline characteristics of cohorts after clustering			
	Optimal Outcome	Suboptimal Outcome	
Number of Patients	(N =146) 	(N=54) 	
Age at instability diagnosis	21.37 (6.44)	25.30 (7.84)	<b>&lt;0.001</b>
Months from initial instability to presentation	11.58±15.21	55.86±54.37	<b>&lt;0.001</b>
Months from initial instability to surgery	24.80 (23.13%)	63.54 (52.70%)	<b>&lt;0.001</b>
Age at initial surgery	22.22 (6.45%)	25.62 (7.64%)	<b>0.002</b>
Habitual Voluntary Dislocation	9 (6.2%)	10 (18.5%)	<b>0.018</b>

# RESULTS: CSO ACHIEVEMENT BY SUBGROUP

Comparison of CSOs Stratified by Subgroup Membership			
	Optimal Outcome (N =146) 	Suboptimal Outcome (N=54) 	
Number of Patients			
Recurrent Pain	33 (22.6%)	28 (51.9%)	<b>&lt;0.001</b>
Recurrent Instability	18 (12.3%)	22 (40.7%)	<b>&lt;0.001</b>
Post-Operative Pain			<b>0.001</b>
<i>None</i>	127 (87.0%)	35 (64.8%)	
<i>Mild</i>	17 (11.6%)	12 (22.2%)	
<i>Moderate</i>	2 (1.4%)	6 (11.1%)	
<i>Severe</i>	0 (0.0%)	1 (1.9%)	
Underwent Revision Surgery	14 (9.6%)	13 (24.1%)	<b>0.015</b>
Symptomatic Osteoarthritis	7 (4.8%)	10 (18.5%)	<b>0.005</b>

# RESULTS: PREDICTORS OF OPTIMAL OUTCOME

Predictors of optimal observed outcome following operative treatment of anterior shoulder instability			
	Odds Ratio (OR)	95% CI	P value
Months from initial instability to surgical consult	0.95	0.92-0.98	<b>0.006</b>
Number of subluxations prior to surgery	1.30	1.02-1.65	<b>0.030</b>
Habitual/voluntary instability	0.17	0.04-0.77	<b>0.020</b>

# CONCLUSION

- Total of 64% of patient achieved the “optimal observed outcome” defined as: minimal postoperative pain, no recurrent instability or OA, low revision surgery rates, and increased ROM.
  - Only 41% achieved a “perfect outcome.”
- Positive predictors were shorter time to presentation and predilection towards pre-operative subluxations over dislocations.

# LIMITATIONS

- Single institution, retrospective data
- Inconsistency in operative techniques and post-operative regimens.
  - Injury characteristics and nuances (such as bone loss) often determine best surgical technique.
- Lacking in patient reported outcomes

