BS Structured Summary

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INTRODUCTION / BACKGROUND

Meniscus tears are among the most common knee injuries treated by both generalists and musculoskeletal specialists, yet treatment is strikingly variable and the patient-specific factors that drive those decisions remain unclear. Tears are often lumped together as a single entity, even though patterns behave very differently: root and radial tears disrupt hoop-stress function almost completely, whereas horizontal degenerative tears may barely alter knee kinematics.

The evidence base pulls in two directions. In middle-aged patients with degenerative tears and arthritis, partial meniscectomy generally yields outcomes no better than nonoperative care; conversely, specific patterns — bucket-handle and root tears — do benefit from surgery, with superior results after repair. Layered on top is the diagnostic noise of MRI: meniscus tears are highly prevalent even in asymptomatic middle-aged and elderly knees, and they coexist with a range of degenerative findings that make a radiology report hard to act on. Demographics and social determinants may further sway decisions in a condition already flagged for low-value-care variability.

Electronic health records now make population-scale analysis feasible, and natural language processing (NLP) can extract structured features from free-text radiology reports. This study used NLP across a large UCSF cohort to test whether specific MRI-report features — tear pattern, whole-knee findings — together with demographics predict the treatment patients actually receive, hypothesising that tear pattern, joint findings and social factors would all be significant predictors of operative and nonoperative pathways.

OBJECTIVE

To investigate whether big-data analytics and natural language processing (NLP) of knee-MRI reports can identify factors — meniscus tear morphology, other knee findings, and patient demographics — that predict the treatment decisions made for patients with meniscus tears, in a large real-world cohort.

METHODS

Retrospective, cross-sectional analysis of the UCSF Information Commons, a de-identified EHR data warehouse (~5 million patients, 2011–2022). Patients were included by ICD-9/10 codes for meniscus tear and/or CPT codes for lower-extremity MRI, meniscectomy, meniscus repair or transplant; MRI reports were filtered (SQL) to those documenting a meniscus tear. Patients imaged after meniscus surgery or with an associated ligament injury were excluded.

Free-text MRI reports were processed with cTAKES (Mayo Clinic, HIPAA-compliant), using a custom meniscus vocabulary built from chart review of how radiologists described tear patterns and other findings across 1,000 random reports, with post-processing in SQL/Access. Classification accuracy was validated against chart review of 100 randomly selected reports, with sensitivities and specificities calculated for key entities.

Recorded treatments were physical-therapy (PT) referral, NSAID prescription, opioid prescription, intra-articular injection, and surgery (meniscectomy or repair). Demographics included age, sex, race, ethnicity and insurance payor. Multivariate logistic regression modelled each treatment as a function of demographics, tear characteristics and other MRI findings; surgery was assessed both short-term (≤90 days of MRI) and at any time. Significance was set at $P < .05$.

MAIN RESULTS

The cohort comprised 4,013 patients (mean age 46.1 ± 14.0 years; BMI 26.9; 52.6% male; 59.0% White; 53.1% commercial insurance). Combined medial-and-lateral tears were most common (47.4%), then isolated medial (37.3%) and lateral (15.3%); the commonest descriptors were complex (42.3%), horizontal (31.8%) and radial (29.7%), and the commonest associated finding was edema (74.9%).

By frequency of treatment: PT was most common (62.4%), then NSAIDs (33.8%), opioids (25.6%), any surgery (19.6%) and intra-articular injection (15.6%). Surgery split into meniscectomy (12.5%) and repair (7%); among those who had surgery, 90.2% had first been prescribed PT, and 44.2% were operated within 30 days and a further 35.6% between 30 and 90 days of the MRI.

Tear pattern was the dominant surgical driver. A bucket-handle tear was the single strongest independent predictor of surgery within 90 days (OR 4.04) and of meniscus repair specifically (OR 4.60); root tear strongly predicted repair (OR 2.31). Other positive surgical predictors included parameniscal cyst, cystic changes, flap and body tears, fissuring and radial tears. The strongest negative predictors of surgery were arthrosis (OR 0.18), other/self-pay insurance and Medicare, full-thickness cartilage loss, and combined medial-and-lateral involvement — i.e., the degenerative, older, lower-coverage phenotype was steered toward nonoperative care.

Two findings stand out for practice. First, demographics independently shaped care: female sex predicted PT and injections; Medicaid/HMO predicted PT and NSAIDs; Medicare and arthrosis predicted nonoperative pathways. Second, opioids were prescribed to 25.6% — higher than expected for this condition — with positive predictors (arthrosis, Medicare/Medicaid, higher BMI, degenerative findings) that are largely the mirror image of the surgical predictors, suggesting opioids are filling a treatment gap in older degenerative knees.

AUTHORS' CONCLUSION

Specific meniscus tear types and other MRI knee findings, together with demographic variables, are significantly associated with the treatment patients receive. Bucket-handle and root tears were most likely to be treated surgically, while patients on Medicare and those with arthrosis were more likely to receive nonoperative care. NLP of big data — including radiology findings — may help provide clinical decision support for interpreting knee MRIs, though decisions must remain patient-specific. Opioid prescribing in meniscal tears occurred at a higher-than-expected rate. Level of Evidence: III.

BS DISCUSSION

This is not our paper, but it is squarely our world — the knee, the meniscus, and the messy gap between what an MRI report says and what the patient actually gets. What makes it worth a BS Papers slot is the method: instead of another opinion on meniscus management, it uses NLP across 4,013 real MRIs to show what truly predicts treatment. For a teaching platform, that is a model of how big-data tools can audit our own practice patterns rather than just our outcomes.

The cleanest clinical signal is one we already teach but now have population-level numbers for: tear pattern decides the knife. Bucket-handle (OR 4.04 for early surgery; 4.60 for repair) and root tears (2.31 for repair) rise to the top, while arthrosis (OR 0.18) and full-thickness cartilage loss pull strongly the other way. That is the Katz/ESCAPE message encoded in routine-care data — mechanical tears get fixed, degenerative knees get managed — and it is exactly the bucket-handle-and-root triage logic worth drilling at our Labs and Summit.

The finding that should genuinely change a BS attendee's Monday is the opioids: 25.6% of meniscus-tear patients prescribed a narcotic, with predictors (arthrosis, Medicare/Medicaid, higher BMI) that are the photographic negative of the surgical predictors. Opioids are being poured into exactly the degenerative, older, lower-access knees that are least likely to be offered surgery and most likely to sit in the early-OA treatment gap. The actionable BS message is blunt: in this phenotype, reach for NSAIDs, injections, structured PT and weight/activity strategies before a narcotic — the literature says they work about as well, without the harm.

The equity thread deserves honest airtime rather than a footnote. Insurance and demographic variables independently predicted treatment — Medicaid/HMO toward PT

and NSAIDs, Medicare and ‘other/self-pay’ away from surgery, female sex toward injections and PT. The authors are careful that current patterns are not necessarily best practice; for BS, the reading is that some of this variation is appropriate triage by tear biology, but some is access and coverage shaping care, and we should be able to tell the two apart in our own data.

I would temper enthusiasm with the design limits the authors flag, because they matter for how far we push this at the Summit. It is cross-sectional treatment-received data with no patient-reported outcomes — it describes what happened, not what worked; ICD-10 coding collapses bucket-handle, root and flap tears into ‘complex/other’, blunting exactly the distinctions that drove surgery; there is no symptom, exam, mechanism or compliance data; and it is a single metropolitan health system. The right BS takeaway is therefore two-sided: a strong, teachable triage signal (pattern drives surgery) and a genuine red flag (opioid overuse), wrapped in the honest caveat that NLP of reports is decision support, not the decision.

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