Impact of microbreaks on visual and physical strain during simulated robotic surgical tasks on HUGO™ RAS

SAGES 2026 March 25-28 Tampa Convention Center | Tampa, Florida

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Background

- Robotic surgery improves surgical precision through:
  - ♦ 3D visualization ♦ Tremor filtration ♦ Improved ergonomics
- However, surgeons continue to report visual and physical strain, particularly during prolonged procedures.
- Open-console robotic platforms such as HUGO™ RAS require polarized-glasses 3D visualization, introducing additional optical demands.
- Literature shows microbreaks reduce fatigue during laparoscopic surgery, but effect in robotic surgery remains unexplored.
- Evidence gap: No studies have evaluated structured microbreaks during robotic surgical tasks.

Aims and Objectives

- Evaluate the effect of microbreaks on visual, musculoskeletal, mental strain and task performance during simulated robotic surgical tasks.
- Assessment of visual fatigue using objective and subjective parameters during simulated robotic surgical tasks.
- Assessment of musculoskeletal and mental strain using subjective parameters during simulated robotic surgical tasks.

Inclusion and Exclusion criteria

Inclusion Criteria: Best corrected visual acuity (BCVA) 6/6

Exclusion Criteria

- Ocular diseases causing visual impairment(corneal disease, cataract, maculopathy, oculomotor disorders)
- Contact lens use
- History of ocular surgery or trauma
- Current topical ocular medication
- Failed stereoacuity test
- Known cardiac illness

Methodology

- **Study Design:** Prospective, randomized, controlled interventional study
- **Study Duration:** 18 months (April 2024 – October 2025)
- **Location:** SET Facility, AIIMS New Delhi
- **Participants:** 36 surgical residents
- **Randomization:** Block randomization (6:6)

Methodology

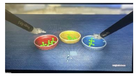
Study Design Flowchart

Participants
36 Surgical Residents

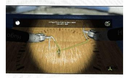
Pre-test Evaluation
Block Randomization (6:6)

Control Group
Continuous Tasks

Microbreak Group
5-min Break After 45 min



Simulator
HUGO™ RAS with 3D Polarized Glasses



Tasks
Adaptation Tasks ×2
Robotic Simulation Tasks ×4
Mean Duration: 77.1 min

Post-test Evaluation

Assessment

Visual Strain

Objective:

- Schirmer's test
- Tear Break-Up Time
- Near Point of Accommodation (NPA)
- Near Point of Convergence (NPC)
- Stereoacuity (TNO test)

Subjective:

- 15-item Visual fatigue questionnaire

Physical Strain

- Body Part Discomfort Scale (BPDS)
- SURG-TLX physical domain

Mental Strain

Objective:

- HRV analysis (5-min ECG)

Subjective:

- SURG-TLX mental domain

Performance

- Error scores
- Execution times


Schirmers test for dry eye


TBUT for dry eye using Slit lamp


TNO Stereotest


RAF ruler test

Demographic Profile

Parameter	Group A (n=18)	Group B (n=18)	Total (n=36)
Mean Age ± SD (years)	26.44 ± 1.2	26.56 ± 0.98	26.5 ± 1.08 (p=0.76)
Gender: Male	13 (72.22%)	15 (83.33%)	28 (77.78%) (p=0.69)
Dexterity (Left handed)	3 (16.66%)	2(11.11%)	5(13.88%)
Comorbidities	0	0	0
Heart Rate Variability (milliseconds)	61.2 ± 3.96	62.4 ± 5.29	61.81 ± 4.65 (p=0.89)
Occasional Alcohol intake	12	13	25
Smoking	4	5	9
Junior Residents	14	14	28
Senior Residents	1	1	2

Results

- No significant differences between groups (p > 0.05) were observed in:
  - Subjective visual strain – Similar worsening of symptoms
  - Subjective physical strain – Comparable strain across body regions
  - Objective eye parameters – Mild comparable post-task decline
  - New onset visual and physical symptoms - Only 2 visual symptoms differed significantly
  - Workload ratings – Higher mental and physical demand in control group, but not significant (p = 0.284; p = 0.079)

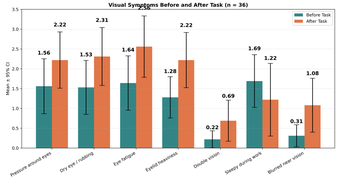
Microbreak benefit

Group A vs Group B (New-onset)

- Dry eye (p = 0.022)
- Eye irritation (p = 0.022)

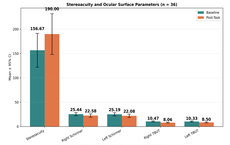
All Participants were analyzed as a Cohort:

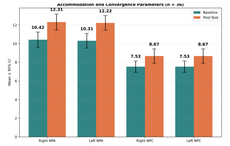
1. Subjective eye symptoms showed significant post-task deterioration across both groups for following parameters:
   - Pressure around eyes ↑ (p = 0.033)
   - Dryness ↑ (p = 0.017)
   - Eye fatigue ↑ (p = 0.023)
   - Eyelid heaviness ↑ (p = 0.009)
   - Double vision↑ (p = 0.02)
   - Sleepiness at work ↑ (p = 0.021)
   - Blurred near vision ↑ (p = 0.004)



2. Objective visual parameters showed significant post-task deterioration across both groups:
   - NPA (p = <0.001)
   - NPC (p = <0.001)
   - Stereoacuity (p = 0.039)
   - Schirmer's (p = 0.012, 0.003)
   - TBUT (<0.001)

(All the values being within physiological limits)





3. Subjective physical symptoms also significant post-task deterioration across both groups in following regions:

Neck Shoulders Wrists Back

Discussion

- Microbreaks alone are insufficient to address surgeon fatigue.
- They should be combined with
  - optimized console setup
  - posture monitoring
  - improved visualization for a comprehensive ergonomic approach
- This work provides early, platform-specific insights on fatigue and microbreaks in HUGO RAS.
- Larger and longer studies are needed to determine whether structured microbreaks should be incorporated into robotic training and clinical practice.

Conclusion

- Simulated robotic surgery on the HUGO™ RAS platform causes:
  - Significant visual strain, both dryness and accommodation fatigue
  - Significant musculoskeletal strain- especially- neck, wrist, fingers and back
- Microbreaks provide modest relief only for subjective eye fatigue, but
- Do NOT improve objective ocular parameters
- Do NOT reduce musculoskeletal strain
- Do NOT improve HRV or performance