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## Digital Therapeutic App–Guided Self-Rehabilitation Versus Conventional Exercise Therapy in Patients With Frozen Shoulder or After Rotator Cuff Repair:A KMFDS-Approved,Pilot Randomized Controlled Trial

**Jong-Ho Kim<sup>1</sup>, Eun-Ji Yoon<sup>1</sup>, So-Youn Chang<sup>2</sup>, Youn Kyu Lee<sup>4</sup>, Hyun Tae Shin<sup>3</sup>, Chul Ho Lee<sup>3</sup>, Su Jeong Lee<sup>3</sup>, Hong Kwon Lee<sup>3</sup>, Tae Hyung Kim<sup>5</sup>**

Orthopedic Surgery, The Catholic University of Korea Yeouido St. Mary's Hospital , Korea, Republic of<sup>1</sup>  
Rehabilitation Medicine, The Catholic University of Korea Yeouido St. Mary's Hospital , Korea, Republic of<sup>2</sup>  
Development Team, OrthoCare., Co., Ltd , Korea, Republic of<sup>3</sup>  
School of Computer Science and Engineering, Chung-Ang University , Korea, Republic of<sup>4</sup>  
3Department of Computer Engineering, Hongik University , Korea, Republic of<sup>5</sup>

### Introduction and Background

This study evaluated the safety and preliminary efficacy of the ANAPA digital therapeutic system for home-based rehabilitation in patients after arthroscopic rotator cuff repair (ARCR) or with frozen shoulder.

### Material and Method

Two single-center, assessor-blinded, randomized pilot studies were conducted. Patients undergoing ARCR (24-week program) or diagnosed with frozen shoulder (12-week program) were randomized to either digital rehabilitation (DR) using the ANAPA application or conventional rehabilitation (CR) using YouTube-guided exercise. Both groups followed identical exercise protocols. Outcome measures included shoulder range of motion (ROM), muscle strength (ARCR cohort), and clinical scores: visual analog scale (VAS), Constant Shoulder Score (CSS), Shoulder Pain and Disability Index (SPADI), and EuroQol-5D-5L (EQ-5D-5L). ARCR patients underwent ultrasonography at 24 weeks to assess tendon integrity. Mixed-effects models were used to analyze within-group changes, between-group differences, and time-by-group interactions.

### Results

In the ARCR cohort (DR n=8; CR n=9), both groups demonstrated significant improvements in ROM and clinical outcomes (all  $p<0.05$ ). The DR group showed greater gains in forward flexion (FF), abduction, abduction external rotation (abdER), and internal rotation (IR) at 18 and 24 weeks (all  $p<0.05$ ), and significantly higher IR strength at 18 weeks ( $p<0.05$ ). Significant time-by-group interactions were observed for abduction, side external rotation (sER), and IR (all  $p<0.05$ ), indicating superior longitudinal improvement in the DR group.

In the frozen shoulder cohort (DR n=7; CR n=7), both groups improved significantly in ROM and clinical scores (all  $p<0.05$ ). The DR group showed earlier ROM gains, including FF and sER at 2 weeks, FF, sER, abdER, and IR at 4 weeks, and improvement in all ROM parameters by 12 weeks (all  $p<0.05$ ). DR group showed significant better outcome of sER at 12 weeks compared to CR group ( $p<0.05$ ). EQ-5D-5L at 12 weeks favored DR ( $p=0.0135$ ), with a significant time-by-group interaction ( $p=0.018$ ).

### Conclusions

Across both cohorts, ANAPA yielded comparable or superior improvements in ROM, pain, functional scores, and quality of life, supporting its feasibility and potential as an AI-based digital therapeutic adjunct for shoulder rehabilitation.

