Application Effect of Facial Recognition Technology in Assisted Reproduction

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Abstract: Objective To explore the application effect of facial recognition technology in identity verification during oocyte retrieval in assisted reproduction. Methods: The data for this study were derived from a prospective controlled trial (which has been submitted for publication separately) that evaluated the "application of a facial recognition identity binding and medical record management system in improving assisted reproductive patient management." This paper extracted the intraoperative identity verification data of all patients (n=5955) who underwent oocyte retrieval between January and December 2025 from the cohort of that parent study for specialized analysis. On the day of oocyte retrieval, both fingerprint recognition and facial recognition were simultaneously used for identity verification. The verification time and recognition success rate of fingerprint recognition and facial recognition were compared. Results The fingerprint verification time was (19.41±15.31) seconds, while the facial verification time was (5.82±2.65) seconds, with a statistically significant difference ($P < 0.01$). The fingerprint recognition rate was 96.3% (5,732), and the facial recognition rate was 100%. Pearson correlation analysis showed that age was positively correlated with fingerprint verification time, meaning that as age increased, fingerprint verification time became longer ($P < 0.05$). However, there was no correlation between age and facial verification time ($P > 0.05$). Educational level was negatively correlated with fingerprint verification time, indicating that higher educational level was associated with shorter fingerprint verification time ($P < 0.05$). No correlation was found between educational level and facial verification time ($P > 0.05$).Conclusion Facial recognition is easy to operate and can effectively improve the efficiency of identity verification in assisted reproduction, reducing the workload of nurses. It is worthy of further promotion.

[Hui Wei, Yan Fu, Mengjie Li, Xiaocheng Yao, Jing Liang, Sien Mo, Nan Li, Yanmei Li, Gaosheng Su. *Biomedicine and Nursing* 2026;12(1):23-28]. ISSN 2379-8211 (print); ISSN 2379-8203 (online). http://www.nbmedicine.org. 04. doi:10.7537/marsbnj120126.04

Keywords: Facial recognition; Fingerprint recognition; Identity verification; Assisted reproduction; Oocyte retrieval; Effect

Declaration: The data for this study is derived from a previous paper titled Application of a Face Recognition Identity Binding System and Medical Record Management System in Improving the Management of Assisted Reproductive Patients, conducted by the same research team. Based on the data from that main study, this paper presents a specialized analysis and report focusing on the "oocyte retrieval" scenario, with an emphasis on examining the impact of demographic factors on verification time.

Assisted reproductive technology has become a crucial method for treating infertility, but it faces many challenges in patient identity management and embryo identification. Traditional identity verification methods are difficult to meet the specific needs of assisted reproduction centers. With the rapid development of artificial intelligence, facial recognition technology has been widely applied in many fields. Facial recognition technology achieves personal identity verification through facial information comparison and has the characteristic of not requiring direct contact with devices. Our center began using the facial recognition system in July 2024, adding a second biometric method (facial recognition) on the basis of original manual verification (checking the authenticity of documents, consistency with photos, etc.) and biometric verification (fingerprint recognition). Studies have shown that effective identity verification can ensure the identity safety of patients undergoing assisted reproductive technology, promote doctor-patient harmony, and maintain social stability. Currently, there is limited domestic research on the application of facial recognition for identity verification in assisted reproduction. This study aims to provide clinical evidence for identity verification in assisted reproduction by exploring the application effect of facial recognition technology.

1. Materials and Methods

1.1 Research Subjects

This study constitutes a secondary analysis of data from the research titled Application of a Face Recognition Identity Binding System and Medical Record Management System in Improving the Management of Assisted Reproductive Patients. From the cohort of that study, we extracted the intraoperative identity verification data of patients (n=5,955) who underwent oocyte retrieval from January to December 2025 for specialized analysis. The data include patient

demographics, verification time, recognition success rate, and other relevant metrics.

All patients met the indications for assisted reproduction as outlined in the 10th edition of "Obstetrics and Gynecology." On the day of oocyte retrieval, identity verification for all cycles was performed by two nurses using manual verification and two biometric methods (fingerprint recognition + facial recognition).

1.2 Methods

1.2.1 Facial Recognition Method:

Identity verification was performed by comparing the patient's face with pre-stored identity information in the Assisted Reproductive Technology (ART) management system's facial recognition device, ensuring consistency between the operator and the patient. The system integrated liveness detection (infrared binocular + micro-expression analysis) and a multi-angle adaptive alignment module. Patients completed facial image entry on the ART system's facial recognition device during the ART filing day (collecting 3 frames each of frontal and left/right 45° side face images in a single session), which were automatically stored in the image database. On the day of oocyte retrieval, a single recognition taking ≤3 seconds was judged as successful, with the system providing a voice prompt "Verification successful." Timeout or similarity ≤60% automatically triggered a re-verification prompt "Verification failed." After a single collection failure, a maximum of 3 retries were allowed. The recognition threshold was set at a matching score ≥60 (out of 100).

1.2.2 Fingerprint Recognition Method:

The ART system was combined with an optical fingerprint scanner. Patients were required to press the sensor with moderate force for 3 seconds. After a single collection failure, a maximum of 3 retries were allowed. The recognition threshold was set at a matching score ≥60 (out of 100). A score below this threshold or 3 consecutive failures was judged as fingerprint recognition failure, initiating the manual verification process.

1.2.3 Identity Verification Method on Oocyte Retrieval Day:

All operations were performed by reproductive specialist nurses trained and certified by national or provincial ART training bases, strictly following the ART identity verification procedures. Two nurses performed identity verification on 5955 oocyte retrieval patients using manual verification (ID card, marriage certificate originals, copies, portrait) and two biometric methods (fingerprint recognition + facial recognition). Fingerprint and facial recognition results (success/failure) and reasons for failure to recognize were recorded. The time consumed for each verification (in seconds) was recorded, with the timer starting when the nurse clicked the "Start Verification" button and ending when the system automatically captured the verification completion signal (voice prompt "Verification successful" or manual verification confirmation). If suspected false documents or inconsistent information were discovered during the audit, operations had to be stopped immediately and reported to superiors for handling.

1.2.4 Observation Indicators

The main observation indicators of this study included: ① Patient general information, including: age, duration of infertility, education level, ethnicity, occupation, etc. ② Verification time consumption (seconds, mean ± standard deviation); ③ Recognition success rate (%) (including success after re-verification) and recognition failure rate (%) and their reasons.

1.2.5 Statistical Analysis

All data were exported from the ART identity verification system in Excel format and double-checked. SPSS 25.0 software was used for statistical analysis. Measurement data were expressed as mean ± standard deviation (X±SD), with intergroup comparisons using t-tests; multi-sample comparisons used F-tests (analysis of variance); enumeration data were expressed as rates (%), with intergroup comparisons using chi-square tests. $P<0.05$ was considered statistically significant.

2. Results

2.1 Basic Patient Information

The age of the 5955 oocyte retrieval cycle patients ranged from 20 to 52 years, with an average age of (36.38±5.56) years. The duration of infertility ranged from 0 to 25 years, with an average of (4.17±3.62) years. Education level distribution: primary school and below 445 cases (7.5%), junior high school 2120 cases (35.6%), high school/vocational school 841 cases (14.1%), college 960 cases (16.1%), bachelor's degree 1414 cases (23.7%), master's degree 159 cases (2.7%), doctoral degree 6 cases (0.1%); Ethnicity distribution: Han 2855 (47.9%), Zhuang 2804 (47.1%), other minorities 296 (5.0%); Occupation distribution: farmer 532 (8.9%), self-employed 450 (7.6%), unemployed 1864 (31.3%), employee 3109 (52.2%). See Table 1.

2.2 Comparison of Verification Time and Recognition Success Rate between Fingerprint and Facial Recognition

Comparing the verification time of fingerprint and facial recognition, the fingerprint verification time was (19.41±15.31) seconds, and the facial verification time was (5.82±2.65) seconds, with a statistically significant difference ($P<0.01$), see Table 2. The fingerprint recognition success rate was 96.3% (5,732), with 223 oocyte retrieval cycle patients failing recognition due to fingerprint wear. All 5,955 oocyte retrieval cycles passed facial recognition, with a facial recognition rate of 100%.

Table 1: Basic Patient Information

Item	Category	Cycles	Percentage（%）
Education Level	Primary School	445	7.5
	Junior High School	2120	35.6
	High School	841	14.1
	Associate Degree	960	16.1
	University	1414	23.7
	Master's Degree	159	2.7
	Doctorate	16	0.3
Ethnicity	Han	2855	47.9
	Zhuang	2804	47.1
	Other	296	5.0
Occupation	Farmer	532	8.9
	Self-employed	450	7.6
	Unemployed	1864	31.3
	Staff	3109	52.2

Table 2: Comparison of Verification Time between Fingerprint and Facial Recognition

Item	Cycles	Time（S）	Success Rate%
Fingerprint	5955	19.41±15.31	96.3（5732/5955）
Face	5955	5.82±2.65	100（5955/5955）
T Value		97.79	169.79
P Value		＜0.005	＜0.005

2.3 Comparison of Facial and Fingerprint Recognition among Different Occupational Groups

Among the 532 farmer patients, the average age was (38.98±5.14) years, average duration of infertility was 5.31±4.53 years, fingerprint recognition time was (21.21±14.49) seconds, facial recognition time was 5.78±2.66 seconds, facial recognition success rate was 100%, and fingerprint recognition was only 95.6%. Among the 2314 self-employed/unemployed patients, the average age was 36.00±5.77 years, average duration of infertility was 4.39±3.75 years, fingerprint recognition time was 18.48±12.21 seconds, facial recognition time was 5.78±2.66 seconds, facial recognition success rate was 100%, and fingerprint recognition was only 95.4%. Among the 3109 employee patients, the average age was 36.22±5.35 years, average duration of infertility was 3.81±3.28 years, fingerprint recognition time was 19.79±17.35 seconds, facial recognition time was 5.88±2.67 seconds, facial recognition was 100%, and fingerprint recognition was 97.11%. Due to occupational characteristics causing more fingerprint wear, farmer patients had a significantly lower recognition rate compared to self-employed/unemployed and employee groups (P<0.05), while facial recognition was not affected by such factors (P>0.05). See Table 3.

Table 3: Comparison of Facial and Fingerprint Recognition among Different Occupational Groups

Item	Cycles	Age	Time	Fingerprint（S）	Face（S）
Farmer	532	38.98±5.14	5.31±4.53	21.21±14.49	5.78±2.66
Staff	3109	36.22±5.35	3.81±3.28	19.79±17.35	5.88±2.67
Self-employed	2314	36.00±5.77	4.39±3.75	18.48±12.21	5.75±2.61
P Value		＞0.005	＞0.005	＞0.005	＞0.005

Table 4: Comparison of Facial and Fingerprint Recognition among Different Education Level Groups

Item	Cycles	Age	Time	Fingerprint（S）	Face（S）
Associate Degree and below	4366	36.44±5.73	4.45±3.83	21.05±15.62	5.79±2.65
University and above	1589	36.24±5.07	3.41±2.83	14.89±13.44	5.91±2.65
P Value		＞0.005	＞0.005	＜0.005	＞0.005

2.4 Comparison of Facial and Fingerprint Recognition among Different Education Level Groups

For the 4366 cycles with college education and below, the average age was 36.44±5.73 years, average duration of infertility was 4.45±3.83 years, fingerprint recognition time was 21.05±15.62 seconds, facial recognition time was 5.79±2.65 seconds, and recognition success rates were 95.9% and 100% respectively. For the 1589 individuals with bachelor's degree and above, the average age was 36.24±5.07 years, average duration of infertility was 3.41±2.83 years, fingerprint recognition time was 14.89±13.44 seconds, facial recognition time was 5.91±2.65 seconds, and recognition success rates were 96.9% and 100% respectively. See Table 4.

2.5 Correlation between Facial/Fingerprint Recognition and Different Age Groups

Pearson correlation analysis showed: a significant correlation between facial recognition and fingerprint recognition time ($r=-0.043$, $P<0.01$), indicating that facial recognition technology performs more stably and reliably across different populations. Age was positively correlated with fingerprint verification time ($r=0.037$, $P<0.05$). However, there was no significant correlation between facial recognition time and age ($P>0.05$), indicating that facial recognition technology is not affected by age.

3. Discussion

Based on the verification data obtained from the previously developed regional face recognition identity binding and medical record management system by our team, this study conducted a focused analysis on the key procedure of oocyte retrieval within assisted reproductive cycles. The prior main study (Application of a Face Recognition Identity Binding System and Medical Record Management System in Improving the Management of Assisted Reproductive Patients) demonstrated at a macro level that this integrated system enables precise, whole-process, and cross-institutional management of patients, significantly improving verification success rates and efficiency. From the perspective of a specific scenario (oocyte retrieval), this study corroborates the core findings of the main research, confirming that face recognition holds advantages in both efficiency and accuracy, thereby providing further empirical supplementation to the main study. Specifically, this analysis revealed that increased age and lower education levels significantly prolong fingerprint verification time, whereas face recognition remains entirely unaffected by these demographic factors. The research highlights that the advantages of face recognition technology not only enhance average efficiency but also eliminate verification disparities caused by individual patient differences (such as age and education level). Thus, at the operational level, it offers a more universal and equitable technical assurance for "whole-process management," a detail not fully elaborated in the macro-level system evaluation of the main study. Consequently, this study can be regarded as an important deepening and empirical extension of the intrinsic mechanisms of the technological advantages and their application value at critical junctures, building upon the established overall system effectiveness demonstrated in the main research.

3.1 Facial recognition can effectively improve the efficiency of identity verification.

In this study, among 5955 oocyte retrieval cycles, the facial verification time was (5.82±2.65) seconds, significantly better than the fingerprint verification time ($P<0.01$), and the facial recognition rate was 100%, higher than the fingerprint recognition success rate (96.3%). 223 oocyte retrieval cycles failed fingerprint recognition due to fingerprint wear, while no failures related to biometric degradation were observed with facial recognition. Therefore, the stability advantage of facial recognition technology in the identity verification link stems from its immunity to biometric degradation—it does not rely on the integrity of epidermal ridges nor is it affected by temporary skin conditions. This characteristic makes it more clinically adaptable under the trends of aging and grassroots expansion in assisted reproduction, providing reliable technical support for constructing a standardized, low-anxiety, high-fault-tolerant pre-operative preparation process for oocyte retrieval.

3.2 Fingerprint recognition rates differ among people with different education levels, while facial recognition shows no difference.

Fingerprint recognition technology has the highest application rate in biometric identification, but issues such as severe finger abrasion, difficulty in fingerprint recognition, and the use of fake fingerprint films exist. This study found significant differences in fingerprint recognition time among people with different education levels ($P<0.05$), with higher-educated individuals having faster fingerprint recognition, while facial recognition showed no significant difference across education levels ($P>0.05$), indicating that facial recognition technology is more universal and convenient. Regardless of educational background or level, facial recognition demonstrated significant advantages of high efficiency and stability in identity verification for oocyte retrieval patients, with short verification time and high success rate. Especially in cases of fingerprint wear or poor hand conditions, facial recognition technology can still reliably complete identity verification stably, and the entire process is automatic without manual intervention, reducing the complexity and error rate of manual management. It provides a more convenient and efficient solution for

identity management in assisted reproduction. Facial recognition offers more equitable and reliable technological support for identity verification in assisted reproduction. It not only improves work efficiency but also reduces patient waiting time, enhances the medical experience, provides strong support for the construction of smart healthcare, and is a more ideal choice for biometric technology.

3.3 Farmers have lower fingerprint recognition rates compared to other occupational groups, while facial recognition performs consistently across occupations.

This study shows that farmer patients, due to occupational characteristics causing more fingerprint wear, had significantly lower recognition rates compared to other occupational groups ($P<0.05$), while facial recognition was not affected by such factors ($P>0.05$). Facial recognition is not influenced by occupational characteristics, demonstrating significant advantages in medical identity verification, especially among populations with poor fingerprint conditions. It provides a more inclusive and equitable identity verification solution for assisted medicine. Therefore, facial recognition can significantly improve the efficiency of patient identity verification, reduce medical errors, ensure patient safety, and simultaneously enhance medical service quality and patient satisfaction.

3.4 Fingerprint recognition time increases with age, while facial recognition stability is unaffected by age.

Pearson correlation analysis in this study showed: a significant correlation between facial recognition and fingerprint recognition time ($P<0.01$), indicating facial recognition technology's stability. Age was positively correlated with fingerprint verification time ($P<0.05$). However, there was no significant correlation between facial recognition time and age ($P>0.05$). This indicates that fingerprint recognition time tends to increase with age among patients of different age groups, while facial recognition performs stably across different age groups, providing reliable guarantee for the universalization of assisted reproductive technology. This technological breakthrough not only improves the accuracy of medical services but also reflects technological humanistic care. With its efficiency, accurate identification technology, universality, and stability, facial recognition technology has become the ideal choice for identity verification in assisted reproduction, providing a fair and efficient medical experience for different populations, highlighting the inclusive value of technology in the medical field. The promotion and application of this technology will further improve the quality of medical services, allowing more patients to enjoy the convenience and safety brought by technological progress, and assisting the medical system in developing towards greater intelligence and humanization.

In summary, facial recognition, as an innovative technology, will continue to optimize medical service processes, providing patients with more convenient, safe, and efficient medical experiences, and promoting the medical industry towards more intelligent and inclusive development. Through rigorous data collection and scientific statistical analysis, this study provides reliable evidence for clinical practice in assisted reproduction, while laying the foundation for future research directions, promoting continuous advancement in assisted reproductive technology, and benefiting more infertile patients.

Funding:

This work was supported by the Guangxi Healthcare Appropriate Technology Development and Promotion Project (S2024127, S2023056); Guangxi Traditional Chinese Medicine Appropriate Technology Development and Promotion Project (GZSY2026072), Self-funded Research Project of the Health Commission of Guangxi Zhuang Autonomous Region (Z-A20220367, Z-A20220364, Z-A20230437, Z-A20250356, Z-A20230427, Z-A20220371), Youjiang Medical University for Nationalities Research Project (yy2025ky002).

Acknowledgements:

This study is part of a series of research. The foundational work has been fully presented in the paper titled Application of a Face Recognition Identity Binding System and Medical Record Management System in Improving the Management of Assisted Reproductive Patients. We extend our gratitude to all colleagues who participated in the discussions and provided valuable insights for this study. We also sincerely acknowledge the financial support from the above-mentioned funding projects, which made the completion of this manuscript possible.

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