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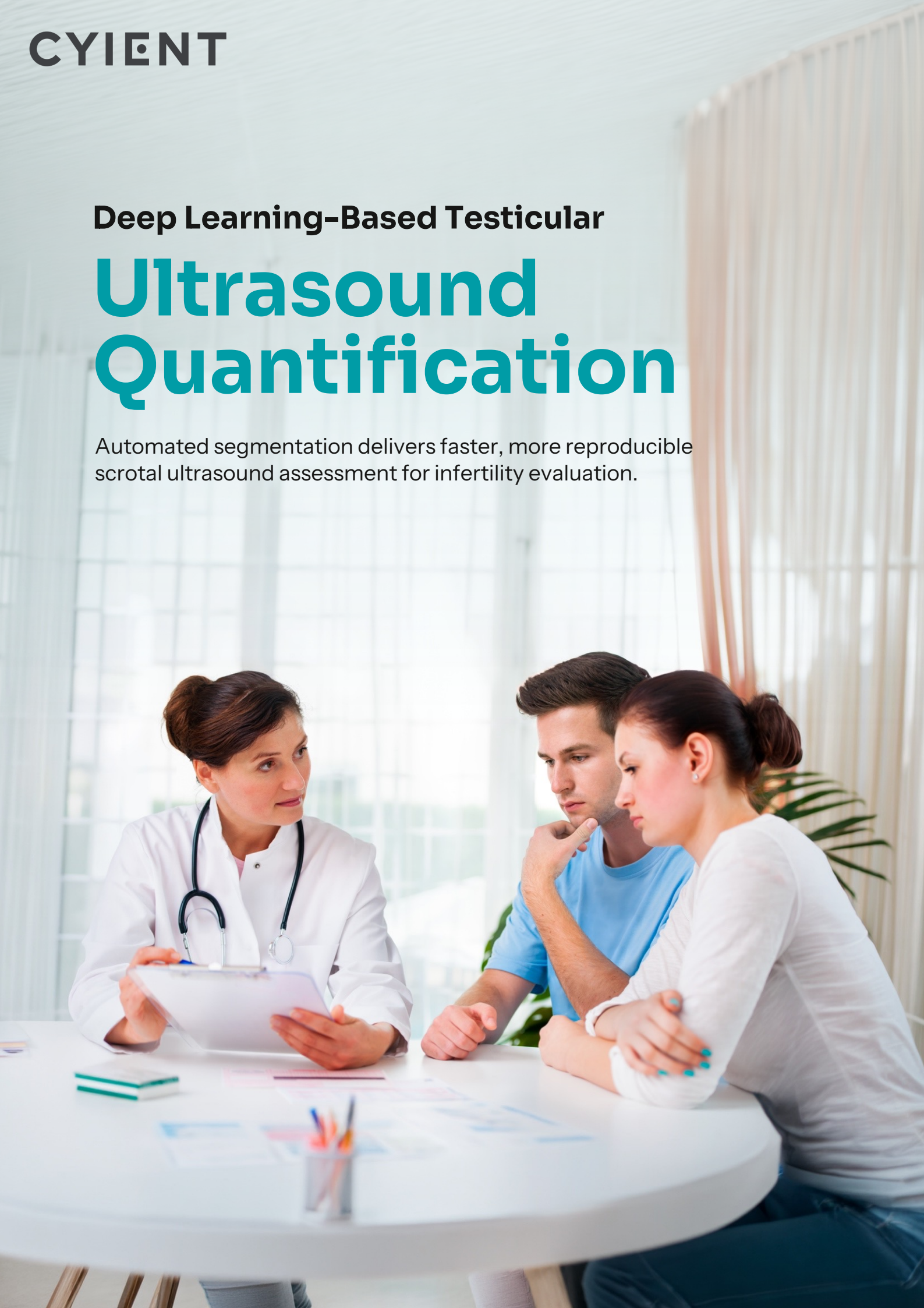
Deep Learning-Based Testicular

Ultrasound Quantification

Automated segmentation delivers faster, more reproducible scrotal ultrasound assessment for infertility evaluation.



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Abstract

Manual testicular measurement using electronic calipers is standard in scrotal ultrasound, but it can be time-consuming and operator-dependent, with variation arising from image plane selection, caliper placement, and image quality. This whitepaper presents a deep learning-based approach to automated 2D testicular quantification that segments the testicular boundary and derives objective morphometric parameters, including area, major axis, minor axis, equivalent diameter, and perimeter. By standardizing measurement across cases, the technology helps reduce inter-operator variability, speed up reporting, and improve reproducibility for clinical follow-up and research – as a decision-support tool that complements, rather than replaces, clinical interpretation.

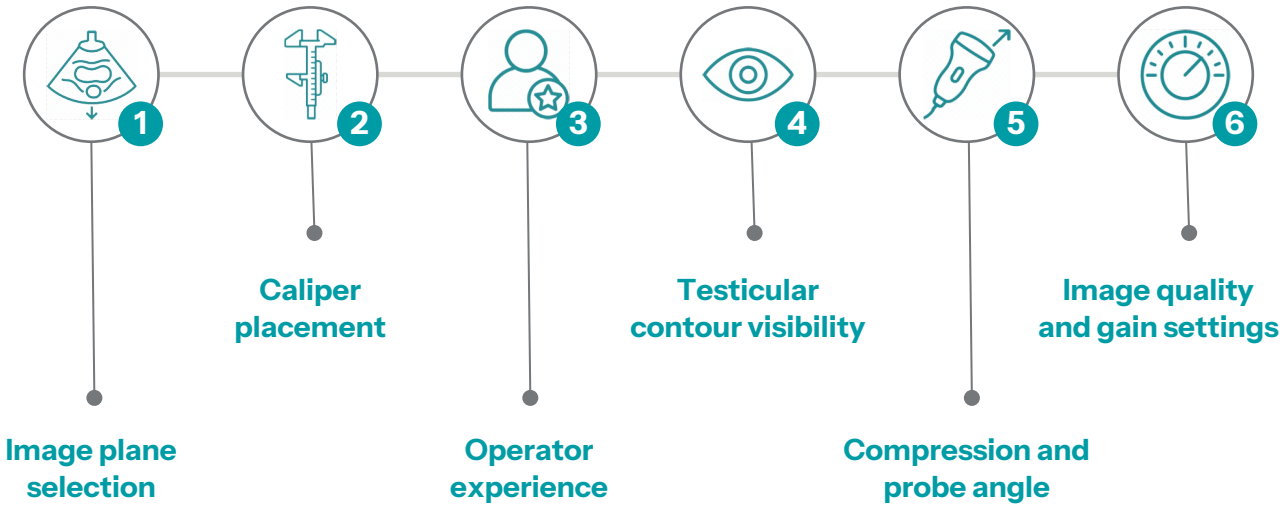
Role of Ultrasound in Male Infertility Assessment

Scrotal ultrasound is routinely used to assess testicular size, morphology, echotexture, and related clinical findings in male infertility evaluation. In standard practice, testicular measurements are performed manually by placing electronic calipers along the longest visible testicular axis and the orthogonal short axis. While widely accepted, this approach can be time-consuming and operator-dependent, particularly when multiple planes, bilateral testes, serial follow-up scans, or research datasets are involved.

Manual testicular measurement can be time-consuming and operator-dependent.

Limitations of Manual Testicular Measurement

Manual caliper measurement can vary depending on:



Even small differences in caliper placement may produce measurable variation, particularly in borderline cases or longitudinal follow-up, and repeated manual measurement increases reporting time in high-throughput clinics and research studies.

Deep Learning-Based Testicular Segmentation

Deep learning-based automated 2D testicular quantification uses a trained segmentation model to automatically identify the testicular boundary on 2D grayscale ultrasound images. A measurement engine then computes quantitative morphometric parameters from the generated mask. The workflow follows four steps:

Automated segmentation reduces measurement to a single image review step.

A 2D ultrasound image is loaded into the application

The deep learning model automatically segments the testicular parenchyma

The segmented mask is used to compute area, major axis, minor axis, equivalent diameter, perimeter, and shape descriptors

The operator visually confirms the segmentation and exports measurements for reporting, audit, or research use

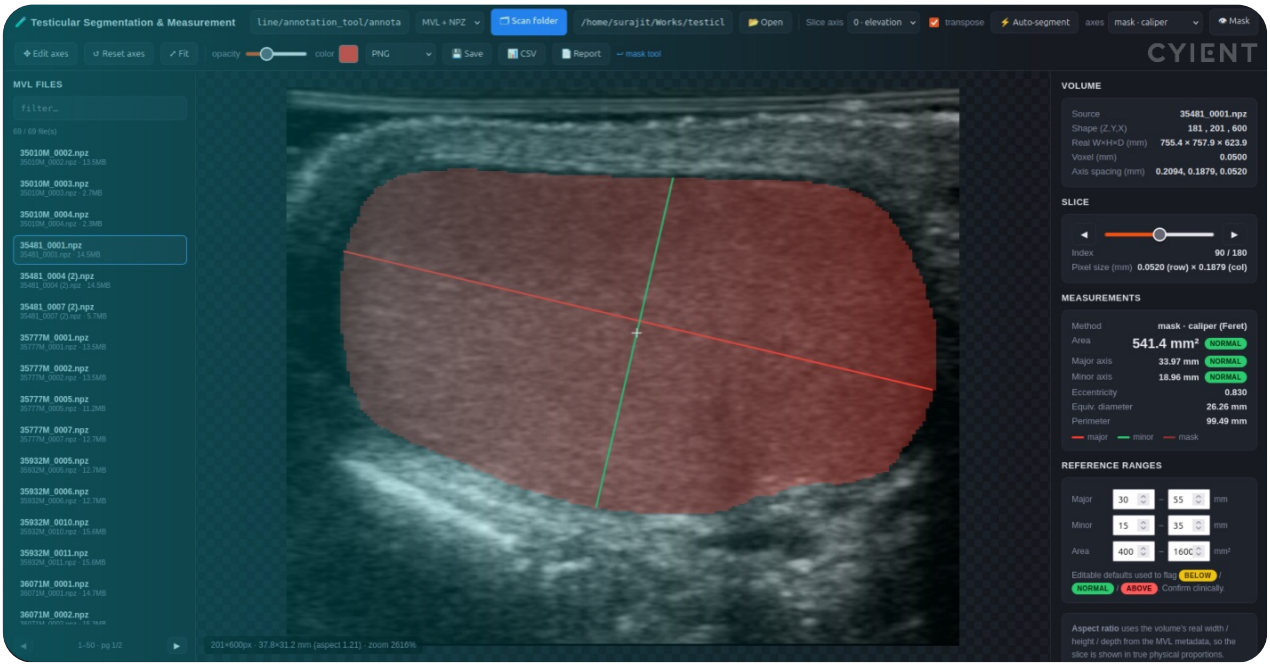


Figure 1. Deep learning–based testicular segmentation and measurement interface.

Automated 2D Quantification Parameters

The measurement engine calculates area (mm^2 or cm^2), the longest Feret or fitted-axis diameter (major axis), the orthogonal short-axis measurement (minor axis), boundary length (), and shape descriptors such as eccentricity/aspect ratio, using image pixel spacing to report values in physical units. These automated measurements provide a consistent quantitative representation of the testis on the selected 2D plane and, when integrated into standard imaging workflow, can reduce the need for repeated manual caliper placement across bilateral, serial, and multi-image studies.

Operational Benefits in Ultrasound Measurement

Faster Measurement

Automated segmentation reduces the measurement process to a single image review step, enabling faster measurement during routine scanning, retrospective review, and research annotation – especially useful for bilateral testes or longitudinal follow-up studies.

Reduced Inter-Operator Variability

Applying the same algorithmic criteria across cases helps reduce variability related to operator experience, subjective boundary selection, and repeated manual measurement.

Improved Reproducibility for Research & Follow-Up

Consistent, objective measurements support imaging biomarker extraction across large datasets and more reliable comparison between follow-up time points, provided acquisition planes and technical conditions are standardized.

Transparent Visual Review

The segmentation mask and measurement axes are displayed directly on the ultrasound image, allowing the operator to inspect and confirm results before export, supporting quality control and transparency.

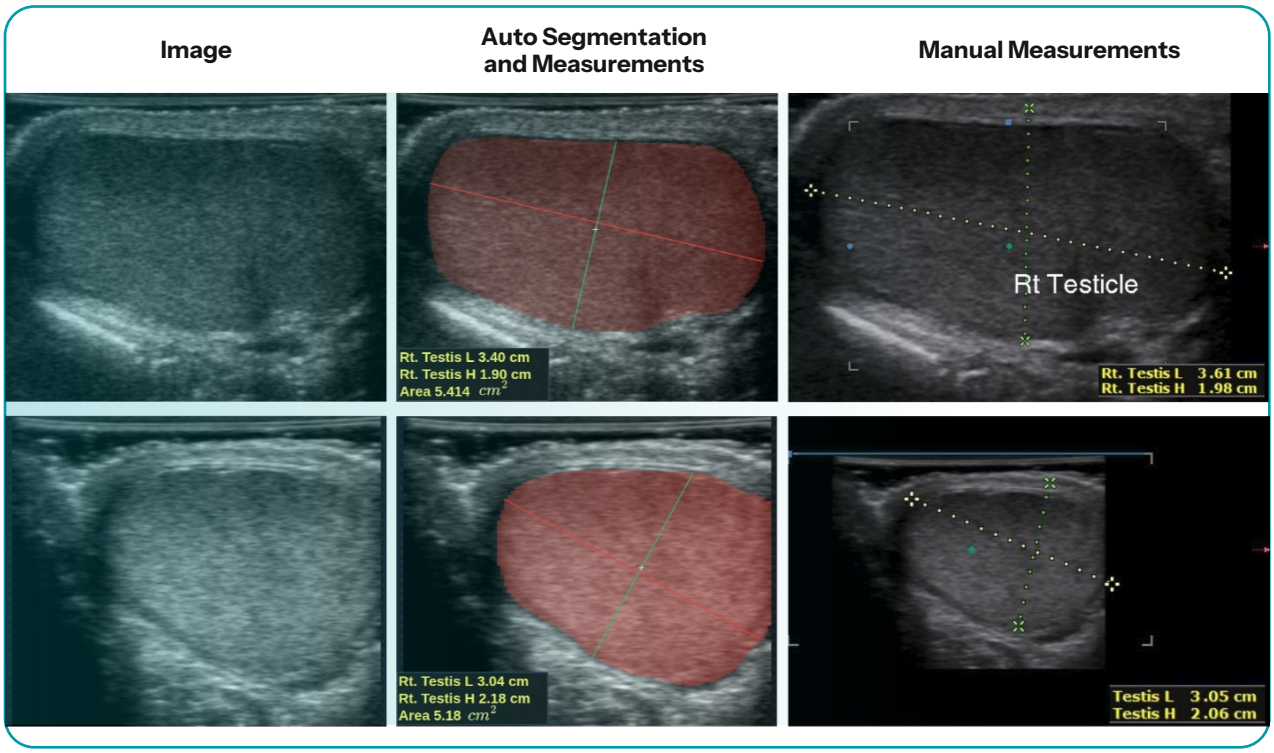


Figure 2. Comparison of manual and automated testicular measurements.

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Q: Why is manual testicular measurement inconsistent?
Depends on caliper placement and operator experience

Q: What does the AI system do?
Automatically segments the testis and measures it

Q: What parameters does it measure?
Area, major axis, minor axis, perimeter, eccentricity

Q: How does it improve workflow?
Cuts measurement time and reporting variability

Q: Can clinicians still review the results?
Yes – operators confirm or correct segmentation

Q: Does it replace clinical judgment?
No – physician interpretation remains essential

Conclusion

Deep learning-based 2D ultrasound testicular quantification enables rapid, standardized, and reproducible measurement of testicular morphology. By automatically segmenting the testis and extracting area, major axis, minor axis, and related parameters, the technology can reduce manual measurement time and minimize operator-dependent variability. It supports efficient scrotal ultrasound workflow, improves consistency in measurement reporting, and provides objective imaging biomarkers for clinical review, research, and longitudinal assessment – always as a decision-support and workflow-assistance tool, with final interpretation remaining under qualified clinical supervision.

Automated measurement supports – but does not replace – clinical interpretation.

About the Authors

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