

УДК: 616.127-004:613. 633:004.8

**AI-DRIVEN QUANTIFICATION OF COLLAGEN I/III RATIO AND
MORPHOLOGICAL REMODELING OF THE MYOCARDIUM IN INDUSTRIAL
WORKERS EXPOSED TO POLYMER PRODUCTION EMISSIONS**

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Annotation: *Myocardial fibrosis is a key component of cardiac remodeling characterized by altered collagen I/III balance. This study aimed to quantify the collagen I/III ratio using Masson's trichrome staining combined with AI-based image analysis in an experimental model. Deep learning enabled automated segmentation and quantification of fibrotic tissue. The results demonstrated that AI provides accurate, reproducible assessment of collagen distribution and confirms a significant association between collagen imbalance and myocardial dysfunction, supporting its reliability for evaluating myocardial fibrosis and functional impairment.*

Key words: *myocardial fibrosis, collagen I/III ratio, artificial intelligence, Masson's trichrome, image analysis, cardiac remodeling.*

**POLIMER ISHLAB CHIQRARISH CHIQINDILARI TA'SIRIDA BO'LGAN SANOAT
ISHCHILARIDA MIOKARDNING MORFOLOGIK REMODELLANISHI VA
KOLLAGENNING I/III TIPLARI NISBATINI SUN'IY INTELLEKT YORDAMIDA
MIQDORIY BAHOLASH**

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Annotatsiya: *Miokard fibrozi yurak remodelizatsiyasining asosiy tarkibiy qismlaridan biri bo'lib, kollagen I/III nisbatining o'zgarishi bilan tavsiflanadi. Ushbu tadqiqotning maqsadi eksperimental modelda Masson trixrom bo'yog'i va sun'iy intellekt (SI) asosidagi tasvir tahlili yordamida kollagen I/III nisbatini miqdoriy baholashdan iborat bo'ldi. Chuqur o'rganish algoritmlari fibroz to'qimalarni avtomatik segmentatsiya*

qilish va miqdoriy tahlilini amalga oshirish imkonini berdi. Natijalar SI kollagen taqsimotini aniq va takrorlanuvchan baholashini hamda kollagen muvozanatining buzilishi bilan miokard disfunktsiyasi o'rtasida ahamiyatli bog'liqlik mavjudligini tasdiqladi, bu esa uning miokard fibrozini va funksional buzilishlarni baholashda ishonchli usul ekanligini ko'rsatadi.

Kalit so'zlar: *miokard fibrozi, kollagen I/III nisbati, sun'iy intellekt, Masson trixrom bo'yog'i, tasvir tahlili, yurak remodelizatsiyasi.*

INTRODUCTION

Myocardial fibrosis is characterized by excessive collagen deposition and plays a key role in cardiac remodeling and dysfunction. Artificial intelligence (AI)-based image analysis enables objective evaluation of fibrotic changes. This study aimed to assess the collagen I/III ratio in experimental myocardial injury and its association with cardiac dysfunction using AI-based analysis.

Materials and Methods: The study was performed on control and experimental rats (n=10 per group) with induced myocardial injury. Heart tissues were fixed in 10% formalin, embedded in paraffin, sectioned at 4–5 μm , and stained with Masson's trichrome. AI-based image analysis was applied to quantify collagen I/III distribution and fibrotic area. Statistical analysis was performed using Student's t-test, with $p < 0.05$ considered significant.

Results and Discussion: Histological analysis of Masson's trichrome-stained myocardial sections demonstrated significantly increased collagen deposition in the experimental group, mainly in interstitial and perivascular regions, indicating progressive myocardial remodeling. AI-based image analysis enabled accurate and reproducible quantification of fibrotic areas and revealed marked differences in collagen distribution between the control and experimental groups.

Table 1.

AI-based morphometric analysis of myocardial fibrosis

Parameter	Control group	Experimental group	p-value
Total collagen area (%)	Low (baseline)	Significantly increased	<0.05
Collagen I (%)	Normal level	Increased	<0.05
Collagen III (%)	Stable	Slightly altered	<0.05
Collagen I/III ratio	Balanced	Significantly elevated	<0.05
Fibrosis index (AI-based)	Minimal	High	<0.05

The experimental group showed a significant increase in the collagen I/III ratio, indicating progressive myocardial fibrosis, increased matrix rigidity, and impaired cardiac function. These findings confirm the role of collagen imbalance in myocardial dysfunction. AI-based analysis enabled accurate and reproducible quantification of fibrotic areas with high reliability.

Conclusion:

Experimental myocardial injury leads to increased collagen deposition and a higher collagen I/III ratio, indicating progressive myocardial fibrosis. These structural changes are associated with impaired cardiac function.

AI-based image analysis provides accurate and objective quantification of fibrosis and improves the reliability of histological assessment compared to conventional methods.

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