CLAIMS

~~What is claimed is:~~

1. A computational simulation platform for interventional procedures planning, comprising a computer-implemented method that includes:

generating a three-dimensional (3D) reconstruction of a vessel lumen and a surface of the vessel lumen based on invasive or non-invasive imaging;

generating a mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen;

assigning material properties to the 3D reconstructed surface of the vessel lumen;

importing design and material properties of stents and balloons;

generating a mesh of a stent and balloon;

positioning the meshed stent and balloon within the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen, wherein the meshed stent and balloon in their crimped state are computationally positioned and bent in the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen;

performing balloon pre-dilation, stenting and balloon post-dilation computational simulations with the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen; and

assessing stent and vessel morphometric and biomechanical measures based on the computational simulations.

2. The computational simulation platform of claim 1, wherein the invasive or non-invasive imaging comprises at least one of: coronary angiography, intravascular ultrasound, optical coherence tomography or computed tomography angiography.

3. The computational simulation platform of claim 1, wherein the design and material properties of the stents and balloons are imported based on invasive or non-invasive imaging.

4. The computational simulation platform of claim 1, wherein the design and material properties of the stents and balloons are imported from one or more databases including manufacturer-provided data.

~~5. The computational simulation platform of claim 1, wherein the meshed stent and balloon in their crimped state are computationally positioned and bent in the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen.~~

~~6~~5. The computational simulation platform of claim 1, wherein the balloon pre-dilation, stenting and balloon post-dilation computations are computationally simulated using finite element analysis.

6~~7~~. The computational simulation platform of claim 1, wherein the material properties are assigned to the 3D reconstructed surface of the vessel lumen based on invasive or non-invasive imaging.

7~~8~~. The computational simulation platform of claim 6~~7~~, wherein the assigning of the material properties to the 3D reconstructed surface of the vessel lumen based on invasive or non-invasive imaging includes:

determining wall or plaque thickness, lumen area, plaque eccentricity and plaque constituents based on invasive or non-invasive imaging.

8~~9~~. The computational simulation platform of claim 7~~8~~, wherein the assigning of the material properties to the 3D reconstructed plaque based on invasive or non-invasive imaging further includes:

dividing the vessel lumen into sequential zones of plaque material; and

assigning a quarter number ranging from purely calcium plaque material to purely lipid plaque material.

9~~10~~. The computational simulation platform of claim 8~~9~~, wherein the computer-implemented method further includes:

assigning plaque plasticity based on the material properties assigned to the 3D reconstructed plaque.

1011. A system for simulation and planning of interventional procedures, comprising:

one or more medical imaging devices;

one or more computer systems communicatively coupled to the one or more medical imaging devices, the one or more computer systems being configured to:

generate a three-dimensional (3D) reconstruction of a vessel lumen and a surface of the vessel lumen based on invasive or non-invasive imaging data received from the one or more medical imaging devices;

generate a mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen;

assign material properties to the 3D reconstructed surface of the vessel lumen;

import design and material properties of stents and balloons;

generate a mesh of a stent and balloon;

position the meshed stent and balloon within the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen, wherein the meshed stent and balloon in their crimped state are computationally positioned and bent in the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen;

perform balloon pre-dilation, stenting and balloon post-dilation computational simulations with the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen; and

assess stent and vessel morphometric and biomechanical measures based on the computational simulations.

1112. The system of claim 1011, wherein the invasive or non-invasive imaging data comprise at least one of: coronary angiography data, intravascular ultrasound data, optical coherence tomography data or computed tomography angiography data.

12~~13~~. The system of claim 10~~11~~, wherein the design and material properties of the stents and balloons are imported based on invasive or non-invasive imaging data received from the one or more medical imaging devices.

13~~14~~. The system of claim 10~~11~~, wherein the design and material properties of the stents and balloons are imported from one or more databases including manufacturer-provided data.

~~15. The system of claim 11, wherein the meshed stent and balloon in their crimped state are computationally positioned and bent in the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen.~~

~~16~~14. The system of claim ~~11~~10, wherein the balloon pre-dilation, stenting and balloon post-dilation computations are computationally simulated using finite element analysis.

15~~17~~. The system of claim 10~~11~~, wherein the material properties are assigned to the 3D reconstructed surface of the vessel lumen based on invasive or non-invasive imaging data received from the one or more medical imaging devices.

16~~18~~. The system of claim 15~~17~~, wherein the assigning of the material properties to the 3D reconstructed surface of the vessel lumen based on invasive or non-invasive imaging data includes:

determining wall or plaque thickness, lumen area, plaque eccentricity and plaque constituents based on invasive or non-invasive imaging data;

dividing the vessel lumen into sequential zones of plaque material; and

assigning a quarter number ranging from purely calcium plaque material to purely lipid plaque material.

17~~19~~. The system of claim 16~~18~~, wherein the one or more computer systems are further configured to:

assign plaque plasticity based on the material properties assigned to the 3D reconstructed plaque.

1820. A computational simulation platform for interventional procedures planning, comprising a computer-implemented method that includes:

generating a three-dimensional (3D) reconstruction of a vessel lumen and a surface of the vessel lumen based on invasive or non-invasive imaging;

assigning material properties to the 3D reconstructed surface of the vessel lumen;

importing design and material properties of stents and balloons;

generating a mesh of a stent and balloon;

positioning the meshed stent and balloon within the 3D reconstructed vessel lumen and surface of the vessel lumen, wherein the meshed stent and balloon in their crimped state are computationally positioned and bent in the mesh of the 3D reconstructed vessel lumen and surface of the vessel lumen;

performing balloon pre-dilation, stenting and balloon post-dilation computational simulations with the 3D reconstructed vessel lumen and surface of the vessel lumen; and

assessing stent and vessel morphometric and biomechanical measures based on the computational simulations.