[0004] Handheld Doppler probes, which are typically permanently positioned on the distal tip of a pen-like device instead of being placed or left within the body, are helpful in blood flow monitoring, but they suffer from several drawbacks. One drawback with handheld probes is their inability to be reliably positioned about a vessel.

[0005] It is of great importance after microvascular surgery to monitor the region of the surgery in order to make sure that the blood flow is maintained at the desired level and that no problems, such as thromboses have occurred. Should thrombosis occur, the transferred tissue would die. Other indirect means of monitoring the functioning of blood flow through blood vessels, which have been subjected to microvascular surgery, are also often inadequate. For example, surface temperature measurements, transcutaneous PO_2 monitoring, photo plethysmography and laser Doppler flow meters have been employed. However, these approaches generally require an accessible exposed portion of the flap. Additionally, buried free tissue transfers and intraoral flaps cannot be monitored effectively by these methods.

SUMMARY

[0006] The present disclosure provides improved vascular monitoring systems, devices and methods to improve the accessibility, detection and/or reliability of detecting blood flow to confirm vessel patency at an anastomotic site.

[0006a] In an aspect, the present disclosure refers to a remote monitoring system~~Doppler blood flow monitoring device~~ comprising: a signal generation module configured to send a signal to a probe positioned in a probe receptacle on a vascular coupler positioned about a patient's vessel, wherein the visual indication includes a plurality of bars and each respective bar of the plurality of bars represents a blood velocity threshold; a signal reception module configured to receive a return signal from the probe; a signal filtration module configured to filter the return signal; a signal conversion module configured to convert the filtered signal into an audible indication and a visual indication corresponding to a characteristic of blood flow in the patient's vessel; at least one speaker configured to emit the first audible indication; and a user interface configured to display the visual indication.

[0006b] In another aspect, the present disclosure refers to a Doppler blood flow

monitoring system comprising: a vascular coupler positioned about a patient's vessel; a transducer attached to the vascular coupler; and a monitor configured to: generate a signal to send to the transducer, wherein the transducer is configured to emit an ultrasonic signal based on the signal generated by the monitor, and wherein the ultrasonic signal is transmitted through the patient's vessel, receive a return signal from the transducer, and convert the return signal into a first indication and a second indication corresponding to a characteristic of blow flow in the patient's vessel, wherein the second indication is a visible indication including a plurality of bars, wherein each respective bar of the plurality of bars represents a blood velocity threshold.

[0006c] In another aspect, the present disclosure refers to a remote monitoring system comprising: a monitor configured to: generate a signal to send to a transducer positioned within a vascular coupler, wherein the vascular coupler is positioned about a patient's vessel, the transducer is configured to emit an ultrasonic signal based on the signal generated by the monitor, and the ultrasonic signal is transmitted through the patient's vessel, receive a return signal from the transducer, and convert the return signal into a first indication and a second indication corresponding to a characteristic of blow flow in the patient's vessel, wherein the second indication is a visible indication including a plurality of bars, wherein each respective bar of the plurality of bars represents a blood velocity threshold; and a remote database configured to: receive one or more files associated with the first indication, and store the one or more files associated with the first indication, wherein the one or more files are remotely accessible via a user device.

[0007] In one example, a Doppler blood flow monitoring device includes a signal generation module, a signal reception module, a signal filtration module, a signal conversion module, at least one speaker, and a user interface. The signal generation module is configured to send a signal to a probe positioned in a probe receptacle on a vascular coupler positioned about a patient's vessel. The signal reception module is configured to receive a return signal from the probe. The signal filtration module is configured to filter the return signal. The signal conversion module is configured to convert the filtered signal into an audible indication and a visual indication corresponding to a characteristic of blood flow in the patient's vessel. The at least one speaker is configured to emit the first audible indication. Additionally, the user interface is configured to display the visual indication.

CLAIMS

The invention is claimed as follows:

1. A remote monitoring system ~~Doppler blood flow monitoring device~~ comprising:

a signal generation module configured to send a signal to a probe positioned in a probe receptacle on a vascular coupler positioned about a patient's vessel;

a signal reception module configured to receive a return signal from the probe;

a signal filtration module configured to filter the return signal;

a signal conversion module configured to convert the filtered signal into an audible indication and a visual indication corresponding to a characteristic of blood flow in the patient's vessel, wherein the visual indication includes a plurality of bars and each respective bar of the plurality of bars represents a blood velocity threshold;

at least one speaker configured to emit the ~~first~~ audible indication; and

a user interface configured to display the visual indication.

2. The system ~~device~~ of claim 1, wherein the signal sent by the signal generation module is a pulsed ultrasonic signal.

3. The system ~~device~~ of claim 1, wherein the signal sent by the signal generation module is a pulse wave Doppler signal.

4. The system ~~device~~ of any of claims 1 to 3, wherein filtering the return signal includes at least one of applying a low band-pass filter to the return signal, applying a high band-pass filter to the return signal, and applying a fast Fourier transform to the return signal.

5. The system ~~device~~ of any of claims 1 to 4, wherein filtering the return signal includes applying a frequency adjustment to the return signal, wherein the frequency adjustment is applied to the return signal prior to wave shaping the return signal.

6. The system ~~device~~ of claim 5, wherein the frequency adjustment is a frequency boost between 150 Hz and 300 Hz.

7. The system ~~device~~ of claim 6, wherein the frequency boost is between 230 Hz and 240 Hz.

8. A Doppler blood flow monitoring system comprising:

a vascular coupler positioned about a patient's vessel;

a transducer attached to the vascular coupler; and

a monitor configured to:

generate a signal to send to the transducer, wherein the transducer is configured to emit an ultrasonic signal based on the signal generated by the monitor, and wherein the ultrasonic signal is transmitted through the patient's vessel,

receive a return signal from the transducer, and

convert the return signal into a first indication and a second indication corresponding to a characteristic of blow flow in the patient's vessel, wherein the second indication is a visible indication including a plurality of bars, wherein each respective bar of the plurality of bars represents a blood velocity threshold.

9. The monitoring system of claim 8, wherein the first indication is an audible indication.

~~10. The monitoring system of claims 8 or 9, wherein the second indication is a visible indication.~~

~~11.~~10. The Doppler blood flow monitoring system of any of claim 8 to ~~10~~9, wherein the vascular coupler is a first vascular coupler and the transducer is a first transducer, and wherein the first vascular coupler and the first transducer are associated with a first channel of the monitor, and which further comprises:

a second vascular coupler positioned about a different vessel of the patient;

a second transducer, wherein the second vascular coupler and the second transducer are associated with a second channel of the monitor, wherein

the first vascular coupler and the first transducer are connected to a first input connector port of the monitor via a first external lead,

the first input connector port is associated with the first channel,

the second vascular coupler and the second transducer are connected to a second input connector port of the monitor via a second external lead,

the second input connector port is associated with the second channel; and

the monitor is further configured to:

generate another signal to send to the second transducer,

receive a different return signal from the second transducer, and

convert the different return signal into a primary indication and a secondary indication corresponding to a characteristic of blow flow in the different vessel of the patient.

~~12.~~11. The monitoring system of claim ~~11~~10, wherein the primary indication is an audible indication.

~~13.~~12. The monitoring system of claims ~~11~~ 10 or ~~12~~11, wherein the secondary indication is a visible indication.

~~14.~~13. The monitoring system of any of claims 8 to ~~13~~12, wherein the signal emitted from the transducer is a pulsed ultrasonic signal.

~~15.~~14. The monitoring system of any of claims 8 to ~~14~~13, wherein the signal generated by the monitor is a pulsed ultrasonic signal.

~~16.~~15. The monitoring system of any of claims 8 to ~~13~~12, wherein the signal emitted from the transducer is a pulse wave Doppler signal.

~~17.~~16. The monitoring system of any of claims 8 to ~~13~~ 12 and ~~16~~15, wherein the signal generated by the monitor is a pulse wave Doppler signal.

~~18.~~17. The monitoring system of any of claims 8 to ~~17~~16, wherein the transducer is removably retained within the vascular coupler.

~~19.~~18. The monitoring system of claim ~~18~~17, wherein the transducer is removably retained within the vascular couple by at least one of a friction fit, a mechanical coupler, and adhesive.

~~20.~~19. The monitoring system of any of claims 8 to ~~19~~18, wherein the vascular coupler is adapted to permit the transducer to be later removed from a receptacle of the vascular coupler.

~~21.~~20. The monitoring system of any of claims 8 to ~~20~~19, wherein the monitor is further configured to filter the return signal prior to converting the return signal into at least one of the first indication and the second indication.

~~22.~~21. The monitoring system of claim ~~21~~20, wherein filtering the return signal includes at least one of applying a low band-pass filter to the return signal, applying a high band-pass filter to the return signal, and applying a fast Fourier transform to the return signal.

~~23.~~22. The monitoring system of claims ~~21~~ 20 or ~~22~~21, wherein filtering the return signal includes applying a frequency adjustment to the signal, wherein the frequency adjustment is applied to the return signal prior to wave shaping the return signal.

~~24.~~23. The monitoring system of claim ~~23~~22, wherein the frequency adjustment is a frequency boost between 150 Hz and 300 Hz.

~~25.~~24. The monitoring system of claim ~~24~~23, wherein the frequency boost is between 230 Hz and 240 Hz.

~~26.~~25. The monitoring system of any of claims 8 to ~~25~~24, wherein the transducer comprises a piezoelectric crystal.

~~27.~~26. A remote monitoring system comprising:

a monitor configured to:

generate a signal to send to a transducer positioned within a vascular coupler, wherein

the vascular coupler is positioned about a patient's vessel,

the transducer is configured to emit an ultrasonic signal based on the signal generated by the monitor, and

the ultrasonic signal is transmitted through the patient's vessel,

receive a return signal from the transducer, and

convert the return signal into a first indication and a second indication corresponding to a characteristic of blow flow in the patient's vessel, wherein the second indication is a visible indication including a plurality of bars, wherein each respective bar of the plurality of bars represents a blood velocity threshold; and

a remote database configured to:

receive one or more files associated with the first indication, and

store the one or more files associated with the first indication, wherein the one or more files are remotely accessible via a user device.

~~28.~~27. The remote monitoring system of claim ~~27~~26, wherein the monitor is further configured to filter the return signal prior to converting the return signal into at least one of the first indication and the second indication.

~~29.~~28. The remote monitoring system of claim ~~28~~27, wherein filtering the return signal includes at least one of applying a low band-pass filter to the return signal, applying a high band-pass filter to the return signal, and applying a fast Fourier transform to the return signal.

~~30.~~29. The remote monitoring system of claims ~~27~~ 26 or ~~28~~27, wherein filtering the return signal includes applying a frequency adjustment to the signal, wherein the frequency adjustment is applied to the return signal prior to wave shaping the return signal.

~~31.~~30. The remote monitoring system of claim ~~30~~29, wherein the frequency adjustment is a frequency boost between 150 Hz and 300 Hz.

~~32.~~31. The remote monitoring system of claim ~~31~~30, wherein the frequency boost is between 230 Hz and 240 Hz.

~~33.~~32. The remote monitoring system of any of claims ~~27~~ 26 to ~~32~~31, wherein the remote database is configured to:

receive one or more files associated with the second indication, and

store the one or more files associated with the second indication, wherein the one or more files associated with the second indication are remotely accessible via a user device.