

M e d i c a l R e v i e w

**Preliminary Experience of Ultra-High Frequency
Imaging with the Aplio i-series**

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Introduction

The advancing technological improvements of high frequency linear transducers offers significant clinical benefits for ultrasound operators where the anatomical structures and hemodynamics of minute vessels can be delineated with unprecedented clarity and definition. These advances in high frequency transducers are of particular benefit where very high resolution is paramount. For example, in musculoskeletal (MSK) and peripheral nerve imaging, small parts (salivary and thyroid glands), as well as soft tissue “lumps and bumps” dermatologically. The detailed information of the surrounding vasculature can also be of significant diagnostic benefit.

Incorporating the innovative iBeam

forming technology, front-end Intelligent Dynamic Micro-Slice technology (iDMS) and latest transducer components, two new high frequency linear transducers have been developed for the Aplio™ i-series. These technologies produce sharper, finer and a more uniform ultrasound beam. The grey scale images have enhanced resolution and penetration while the Doppler sensitivity is improved especially with Superb Micro-vascular Imaging (SMI) enabling depiction of neovascularity not possible with conventional Colour/Power Doppler.

The ultra-wideband high frequency linear transducer covers the frequency range normally provided by two previous conventional linear transducers (1005BT & 1204BT) and provides optimum resolution and penetration in one transducer. This 2-in-1

transducer enables more effective transducer management.

The outstanding new development however, has to be the ultra-high frequency probe which utilises frequencies of up to 24MHz, previously unimaginable in clinical imaging. This new probe provides exquisite spatial resolution on both greyscale and Doppler imaging but with surprisingly sufficient penetration for it to be utilized in routine clinical scans. This elevated frequency range expands the horizon of clinical ultrasound allowing depiction of anatomy and diagnoses in structures not previously possible.

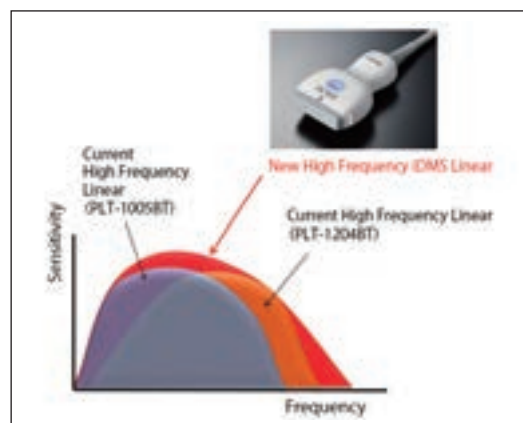


Figure 1. Ultra-wideband high frequency linear transducer

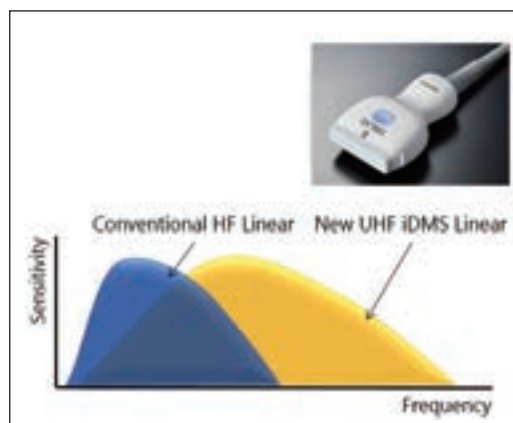


Figure 2. Ultra-high frequency linear transducer

CASE STUDIES

MSK

Case 1: Supraspinatus Tear

A former cricket player complained of ongoing shoulder pain. Using the i18LX5, a partial width, partial thickness, humeral surface supraspinatus tear was identified. However, with the i24LX5, the tissue structures and tear were delineated with greater detail and definition. The high resolution of the ultra-high frequency transducer allows greater diagnostic confidence obviating the need for further imaging and thus enabling appropriate treatment without delay.

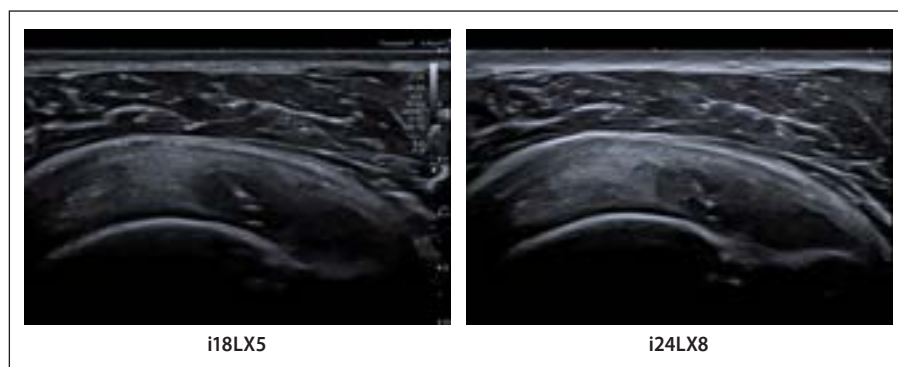


Figure 3.

Case 2: Supraspinatus Tendinosis and Subacromial Subdeltoid Bursitis

The i18LX5 shows detailed structures with good penetration for an operator to perform this routine examination rapidly with good diagnostic confidence. The i24LX8, shows significantly increased detail of tissues in the near field and with sufficient penetration through the whole supraspinatus tendon for it to be diagnostic clinically. These paired images demonstrate the capabilities of both the i18LX5 and particularly the adequate penetration of the ultra-high frequency transducer i24LX8 which allows it to be utilized in general MSK imaging.



Figure 4.

Case 3: Rheumatoid Arthritis

This female patient with known rheumatoid arthritis complained of mild tenderness in the left metacarpophalangeal joint (MCPJ) of her index finger and was referred for an ultrasound scan of the joints in her hand to assess if there was any active synovitis. The detailed B mode of the i24LX8 probe shows a relatively normal joint with no synovial hypertrophy, effusion or erosions. However, vascular flow can be detected within the joint using SMI but not with Power Doppler (PD). Her other, non-symptomatic joints did not demonstrate any vascular flow with SMI or PD. Doppler Ultrasound is currently the gold standard for denoting active synovitis in small joints and together with state-of-art SMI technology may prove even more effective at early detection of active inflammation in patients with arthritides, thus enabling appropriate treatment without delay and further damage to these joints.

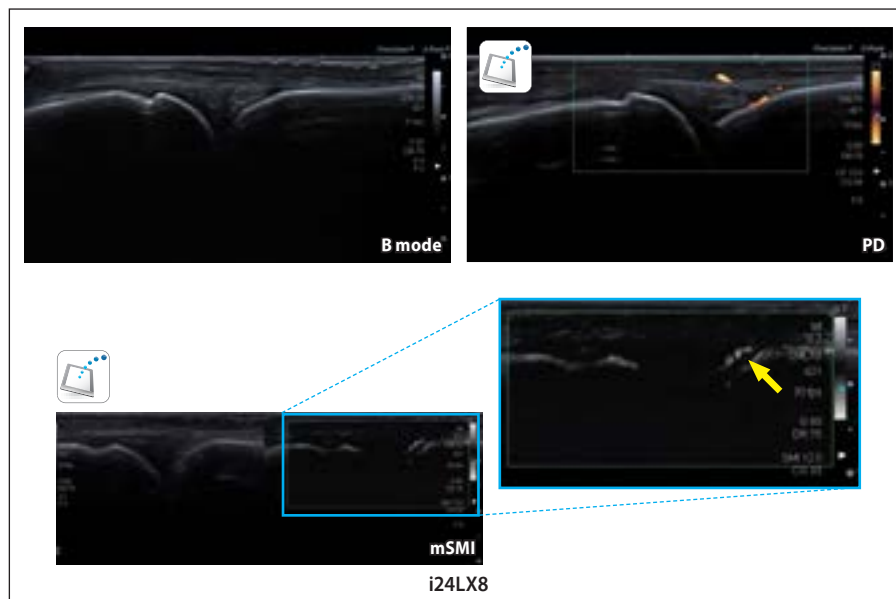


Figure 5.

Case 4: Mid-Substance Achilles Tendinopathy

Both i-series linear transducers show good detail of the thickened Achilles tendon and also depiction of the neovascularity confirming the diagnosis. However, utilizing the ultra-high frequency transducer, the subtle fusiform thickening and tendon structure is better delineated with higher detail although there is slight reduction in the Doppler signal.

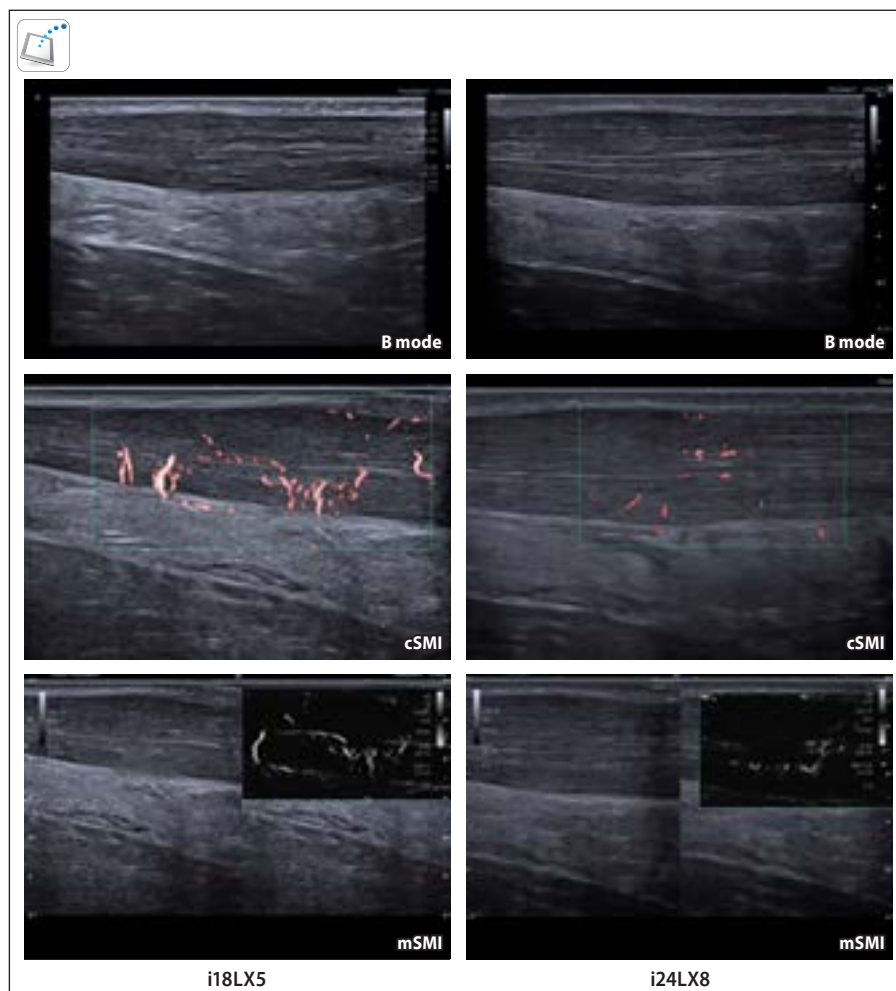


Figure 6.

Peripheral Nerves

Case 1: Median Nerve

This case demonstrates a thickened right median nerve compared with the left median nerve at the level of the flexor retinaculum compatible with a diagnosis of right carpal tunnel syndrome. Using the i24LX8, the ultra-high frequency allows depiction of the neurofibrillar structures in great detail and appreciation of the subtle focal thickening. The measurements highlight the difference between the two median nerves adding to the diagnostic confidence.

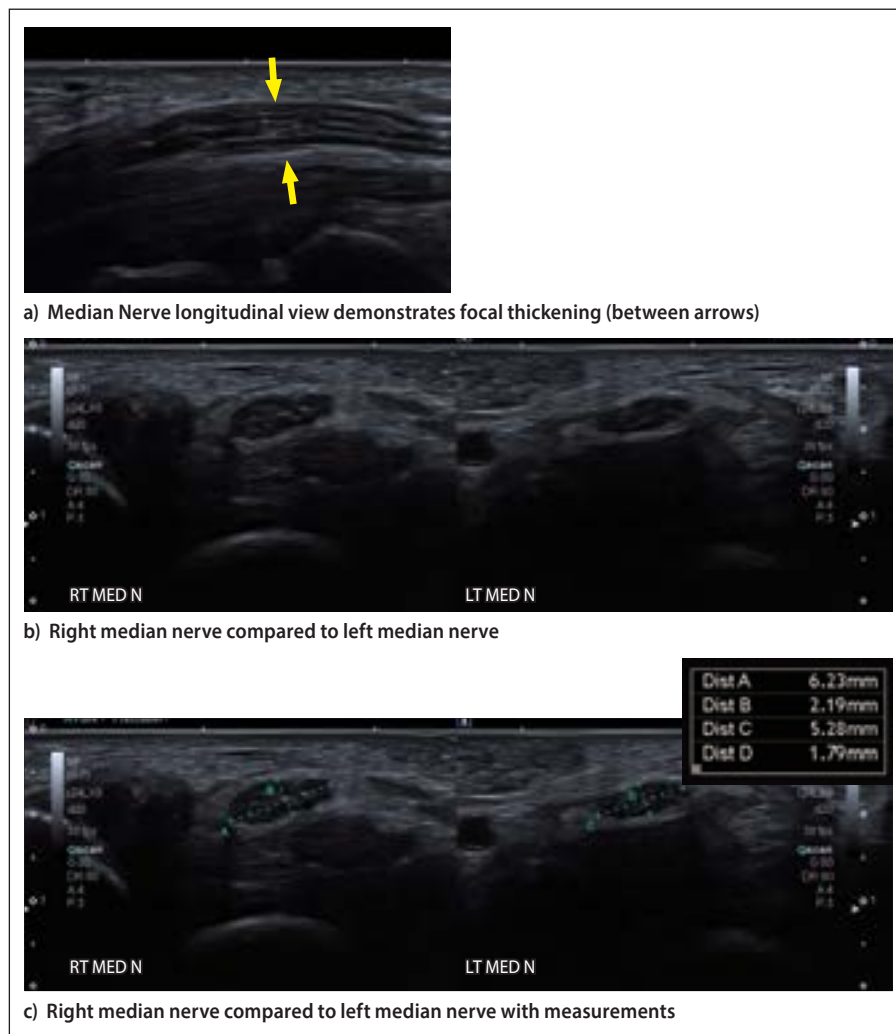


Figure 7.

Thyroid

Case 1: Thyroid Nodules

These paired images are of a patient with hypothyroidism and multiple semicystic/solid nodules. Both i-series transducers outline the internal structures of the thyroid nodules well. However, with the i24LX8, the contour and border of the smaller nodule are sharper and there is no loss of penetration even working at this very high frequency. This greater clinical detail may aid diagnosis and better classification of thyroid nodules.



Figure 8.

Dermatology

Case 1: Small Sebaceous Cyst

Case 1a

This small palpable 3mm subcutaneous lesion can be easily detected using the i18LX5 probe. However, the subtle track leading to the skin can only be clearly delineated when scanning with the i24LX8 confirming a sebaceous cyst. These paired images again show off the ultra-high frequency probe which enables accurate diagnostic capability thus avoiding any doubt and avoiding any confirmatory intervention or follow up interval scans. Note the subtle echogenicity around this tiny cyst suggesting oedema and inflammation.

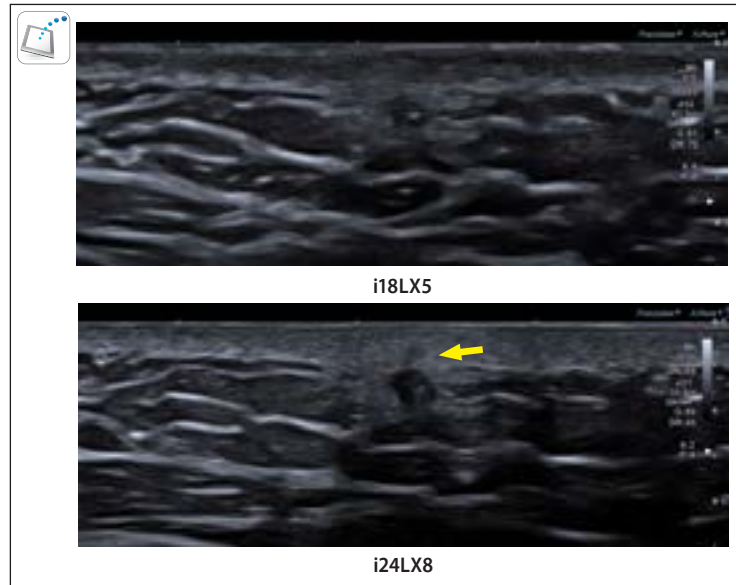


Figure 9.

Case 1b

This is a male patient with a sebaceous cyst where again the dermal track is shown on the i24LX8 only allowing an accurate and confident diagnosis thus obviating any further tests.



Figure 10.

Case 2: Infected Malignant Skin Ulcer

The unprecedented image quality of Doppler imaging on i24LX8 in the near field is demonstrated in this infected malignant skin ulcer. cSMI and mSMI denotes the extensive rich hypervascular network of capillaries with high resolution not appreciated with lower frequency.

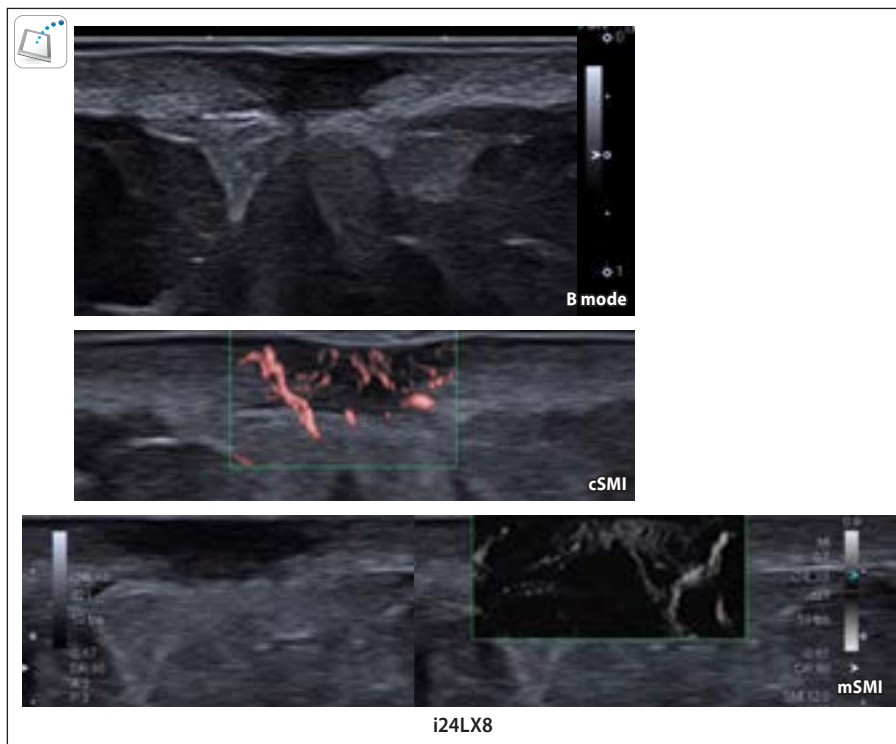


Figure 11.

Conclusion

The Aplio i-series is equipped with two extraordinary transducers, the ultra-wideband frequency linear transducer i18LX5 (a "2 in 1" probe) and the ultra-high frequency 24MHz linear transducer i24LX8. The Doppler sensitivity and grey scale resolution of both probes are extraordinary and significantly improved on previous technologies. The combination of these probes allows greater diagnostic confidence as anatomical structures and vascularity are delineated in very high detail. The high resolution images obtained in the near field without loss of penetration of the 24MHz transducer are unprecedented. This has opened up a new horizon of clinical applications which are currently under evaluation.



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