Digital Imaging and Communications in Medicine (DICOM)

Supplement 227: Ultrasound Elastography Structured Report

DICOM Standards Committee

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Table of Contents

Scope and Field

This supplement to the DICOM Standard introduces an SR section template for Ultrasound Elastography results and a General Ultrasound Report within which it can be used.

Ultrasound elastography is used on tissues including liver, breast, prostate, and tendon. In shear wave elastography (SWE), the ultrasound system measures shear wave speed (SWS) and derives a value for elasticity (in kPa) from that. Some systems also assess viscosity (which can be correlated to inflammation) by generating a value such as shear wave dispersion slope. In strain elastography (SE), elasticity/stiffness is assessed qualitatively by comparing the compression of tissue in a target region to that of tissue in a nearby reference region.

References:

https://doi.org/10.1148/radiol.2020192437 Update to the Society of Radiologists in Ultrasound Liver Elastography Consensus Statement – Jun 2020 – Full Text

https://pubs.rsna.org/doi/full/10.1148/rg.2017160116 SWE Basic Physics and Musculoskeletal Applications

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5720889/

2015 EASL-ALEH Clinical Practice Guidelines: Non-invasive tests for evaluation of liver disease severity and prognosis https://www.journal-of-hepatology.eu/article/S0168-8278(15)00259-7/fulltext

Guidelines from WFUMB (World Federation for Ultrasound in Medicine and Biology) and EFSUMB (European Federation of Societies for Ultrasound in Medicine and Biology)

- *EFSUMB Guidelines and Recs on the Clinical Use of **Liver** Ultrasound Elastography, Update 2017 (Long Version), Dietrich CF et al., Ultraschall Med. https://www.thieme-connect.com/products/ejournals/pdf/10.1055/s-0043-103952.pdf*
- *WFUMB guidelines and recs for clinical use of ultrasound elastography: Part 3: **liver**, Ferraioli G et al., Ultrasound Med Biol. 2015 May;41(5):1161-79;*
- *EFSUMB guidelines and recs for the clinical practice of Elastography in Non-Hepatic Application: Update 2018, Săftoiu A, et al., Ultraschall Med. 2019 Aug;40(4):425-453.; Section 5 **Breast***
- *WFUMB guidelines and recs for clinical use of ultrasound elastography: Part 2: **breast**, Barr RG et al., Ultrasound Med Biol. 2015 May;41(5):1148-60;*
- *EFSUMB guidelines and recs for the clinical practice of Elastography in Non-Hepatic Application: Update 2018, Săftoiu A, et al., Ultraschall Med. 2019 Aug;40(4):425-453.; Section 7 **Thyroid***
- *WFUMB Guidelines and Recs on the Clinical Use of Ultrasound Elastography: Part 4. **Thyroid**, Cosgrove D et al., Ultrasound Med Biol. 2016 Aug 25;*
- *EFSUMB guidelines and recs for the clinical practice of Elastography in Non-Hepatic Application: Update 2018, Săftoiu A, et al., Ultraschall Med. 2019 Aug;40(4):425-453.; Section 6 **Prostate***
- *WFUMB Guidelines and Recs on the Clinical Use of Ultrasound Elastography: Part 5. **Prostate**, Barr RG et. Al, Ultrasound Med Biol. 2016 Aug 23*

The following are currently less consolidated in the daily clinical practice or, like the vascular applications, are still areas of active research

- *EFSUMB guidelines and recs for the clinical practice of Elastography in Non-Hepatic Application: Update 2018, Săftoiu A, et al., Ultraschall Med. 2019 Aug;40(4):425-453.; Section 8 **Pancreas**, Section 9 **GastroIntestinal Tract**, Section 10 **Spleen**, Section 11 **Kidney**, Section 12 **Lymph nodes**, Section 13 **MusculoSkeletal**, Section 14 **Testis**, Section 14 **Vascular***

OPEN ISSUES

Q. Are there additional "confounding details" that should be captured in Patient Characteristics?

For example, some guidelines have noted elevated liver function results, non-fasting (postprandial hyperemia), intense physical exercise, and vascular congestion could elevate liver stiffness readings. Other confounding factors might include, but are not limited to, acute hepatitis, liver inflammation, transaminitis flares with alanine aminotransferase value more than five times the upper limit of normal, obstructive cholestasis, hepatic congestion, and infiltrative liver diseases such as amyloidosis, lymphoma, or extramedullary hematopoiesis. In all these conditions, however, stiffness values within the normal range exclude significant liver fibrosis.

Patient Orientation can already be included to track deviation from supine or slight (<30°) left decubitus which can result in measurement variability. Details like suspended tidal respiration and transducer make/model could also be captured elsewhere.

Q. Should Ultrasound Strain Elastography (SE) be addressed in this supplement?

The supplement text has been driven mostly by Ultrasound Shear Wave Speed Elastography (SWE).

Q. Is adequate information captured for assessing repeated measurements over time (months, years)?

The equipment module captures the make/model of the ultrasound system as a whole.
Should recording of transducer make/model be highlighted, or made mandatory?
Are there calibration values that would be useful/important?

CLOSED ISSUES

Q. Make a SOP Class or just a TID?
A: TID

It's the precedent for Ultrasound SRs. Make a General Ultrasound Report TID that includes an Elastography section.

Changes to NEMA Standards Publication PS3.16

Digital Imaging and Communications in Medicine (DICOM)

Part 16: Content Mapping Resource

Add a General Ultrasound Report root template as shown

TID newTID1 General Ultrasound Report

This is the Template for the root of the content tree for a general ultrasound procedure report.

Type: Extensible
Order: Significant
Root: Yes

Table TID newTID1. General Ultrasound Report

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	BCID newCID0 "General Ultrasound Report Document Titles"	1	M		
2	>	HAS CONCEPT MOD	INCLUDE	DTID 1204 “Language of Content Item and Descendants”	1	U		
3	>	HAS OBS CONTEXT	INCLUDE	DTID 1001 “Observation Context”	1	M		
4	>	CONTAINS	INCLUDE	DTID newTID2 "Ultrasound Patient Characteristics"	1	U		
5	>	CONTAINS	CONTAINER	DT (55111-9, LN, "Current Procedure Descriptions")	1	U		
6	>>	CONTAINS	CODE	DT (125203, DCM, "Acquisition Protocol")	1-n	M		BCID 12001 “Ultrasound Protocol Types”
7	>>	CONTAINS	CODE	DT (113743, DCM, "Patient Orientation")	1	U		DCID 19 “Patient Orientation”
8	>>>	HAS CONCEPT MOD	CODE	EV (113744, DCM, "Patient Orientation Modifier")	1	U		DCID 20 “Patient Orientation Modifier”
9	>	CONTAINS	CONTAINER	EV (18785-6, LN, "Indications for Procedure")	1	U		
10	>	CONTAINS	CONTAINER	EV (111028, DCM, "Image Library")	1	U		
11	>>	CONTAINS	IMAGE		1-n	M		
12	>	CONTAINS	CONTAINER	DT (59776-5, LN, "Findings")	1-n	U		
13	>>	CONTAINS	INCLUDE	DTID 300 “Measurement”	1-n	U		
14	>>	CONTAINS	TEXT	EV (121071, DCM, "Finding")	1-n	U		

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
15	>	CONTAINS	INCLUDE	DTID 5X01 “Ultrasound Elastography Section”	1-n	U		

Content Item Descriptions

Row 10	The Image Library provides potentially relevant characteristics of images associated with the measurements. There is no requirement to include all, or any, of the images referenced in the ROIs and measurements elsewhere in this template. The template may also include images that are associated with, but not directly referenced in, the ROIs and measurements. The Image Library is not replicating the content of the SOP Instance Reference Sequence.
Row 11	No purpose of reference is specified.

Add TID for Ultrasound Patient Characteristics as shown

TID newTID2 Ultrasound Patient Characteristics

100 **Type: Extensible**
Order: Significant
Root: No

Table TID newTID2. Ultrasound Patient Characteristics

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		CONTAINER	NUM	EV (121118, DCM, "Patient Characteristics")	1	M		
2	>	CONTAINS	NUM	EV (113550, DCM, "Fasting Duration")	1	U		UNITS= EV (h, UCUM, "hours")
3	>	CONTAINS	TEXT	EV (113552, DCM, "Recent Physical Activity")	1	U		
4	>	CONTAINS	NUM	EV (271649006, SCT, "Systolic Blood Pressure")	1	U		UNITS= EV (mm[Hg], UCUM, "mmHg")
5	>	CONTAINS	NUM	EV (271650006, SCT, "Diastolic Blood Pressure")	1	U		UNITS= EV (mm[Hg], UCUM, "mmHg")
6	>	CONTAINS	CODE	EV (newcode04, DCM, "Relevant Patient Conditions")	1-n	U		
7	>	CONTAINS	TEXT	EV (121106, DCM, "Comment")	1	U		

105 **Content Item Descriptions**

Row 6	Currently present patient conditions that may affect, or are otherwise relevant to, the capture or interpretation of the findings in this report.
Row 7	General comments which may also include relevant patient conditions that would otherwise be recorded in Row 6 if appropriate codes were available.

Add Elastography Section TID 5X01 as shown

TID 5X01 Ultrasound Elastography Section

This section template incorporates a set of measurements for assessing tissue elasticity characteristics.

110 **Type: Extensible**
Order: Significant
Root: No

Table TID 5X01. Ultrasound Elastography Section

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	DT (59776-5, LN, "Findings")	1	M		
2	>	HAS CONCEPT MOD	CODE	EV (121058, DCM, "Procedure Reported"	1	M		DT (448764002, SCT, "Ultrasound elastography (procedure)"
3	>	HAS CONCEPT MOD	CODE	EV (363698007, SCT, "Finding Site"	1	M		BCID NewCID1 "Elastography Sites"
4	>>	HAS CONCEPT MOD	CODE	EV (272741003, SCT, "Laterality")	1	U		DCID 244 “Laterality”
5	>	HAS ACQ CONTEXT	CODE	EV (399264008, SCT, "Image Mode")	1	U		BCID 12224 “Ultrasound Image Modes”
5a	>	HAS ACQ CONTEXT	CODE	EV (111031, DCM, "Image View")	1	U		BCID 5 "Transducer Approach"
5b	>>	HAS ACQ CONTEXT	CODE	EV (111032, DCM, "Image View Modifier")	1-n	U		BCID 6 "Transducer Orientation" BCID 7 "Ultrasound Beam Path"
6	>	CONTAINS	CONTAINER	DT (55112-7, LN, "Summary")	1	M		
7	>>	CONTAINS	NUM	EV (130611, DCM, "Shear Wave Speed")	1	M		
7b	>>>	HAS PROPERTIES	NUM	EV (386136009, SCT, "Standard deviation")	1	U		
7c	>>>	HAS PROPERTIES	NUM	EV (373099004, SCT, "Median")	1	U		
7d	>>>	HAS PROPERTIES	NUM	EV (130614, DCM, "Interquartile Range of population")	1	U		
7e	>>>	HAS PROPERTIES	NUM	EV (130615, DCM, "Interquartile Range to Median Ratio of population")	1	M		
8	>>	CONTAINS	NUM	EV (110830, DCM, "Elasticity")	1	M		
8b	>>>	HAS PROPERTIES	NUM	EV (386136009, SCT, "Standard deviation")	1	U		

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
8c	>>>	HAS PROPERTIES	NUM	EV (373099004, SCT, "Median")	1	U		
8d	>>>	HAS PROPERTIES	NUM	EV (130614, DCM, "Interquartile Range of population")	1	U		
8e	>>>	HAS PROPERTIES	NUM	EV (130615, DCM, "Interquartile Range to Median Ratio of population")	1	M		
9	>>	CONTAINS	NUM	EV (130612, DCM, "Shear Wave Dispersion Slope")	1	U		
9b	>>>	HAS PROPERTIES	NUM	EV (386136009, SCT, "Standard deviation")	1	U		
9c	>>>	HAS PROPERTIES	NUM	EV (373099004, SCT, "Median")	1	U		
9d	>>>	HAS PROPERTIES	NUM	EV (130614, DCM, "Interquartile Range of population")	1	U		
9e	>>>	HAS PROPERTIES	NUM	EV (130615, DCM, "Interquartile Range to Median Ratio of population")	1	M		
10	>	CONTAINS	CONTAINER	DT (125007, DCM, "Measurement Group"	1-n	M		
11	>>	HAS OBS CONTEXT	TEXT	EV (125010, DCM, "Identifier")	1	M		
12	>>	CONTAINS	INCLUDE	DTID 5X02 “Shear Wave Elastography Measurement”	1	M		
13	>	CONTAINS	CONTAINER	DT (Newcode01, DCM, "Reference Measurement Group")	1	M		
14	>>	CONTAINS	INCLUDE	DTID 5X02 “Shear Wave Elastography Measurement”	1	M		

Content Item Descriptions

Row 7	The nominal Shear Wave Speed for the tissue of interest.
Rows 7b-7e	These values are a statistical description of Shear Wave Speed measurements in Row 10 from which the value in Row 7 was derived.
Row 11	The identifier is used to distinguish the different measurement ROIs. For example, the identifier might be used as a column header when displaying the measurements from all the ROIs in a table.

TID 5X02 Shear Wave Elastography Measurement

A shear wave elastography measurement, and related values, associated with a point or region in an ultrasound image.

Type: Extensible
Order: Significant
Root: No

Table TID 5X02. Shear Wave Elastography Measurement

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		HAS CONCEPT MOD	NUM	EV (130613, DCM, “ROI Depth”)	1	M		UNITS= EV (cm, UCUM, "cm")
2		HAS CONCEPT MOD	NUM	EV (131184002, SCT, "Area of defined region")	1	U		UNITS= EV (cm2, UCUM, "cm2”)
3		INFERRED FROM	SCOORD	EV (111030, DCM, "Image Region")	1	U		GRAPHIC TYPE = not {MULTIPOINT}
4		CONTAINS	NUM	EV (130611, DCM, "Shear Wave Speed"	1	M		UNITS= EV (m/s, UCUM, "m/s")
5	>	HAS CONCEPT MOD	NUM	EV (386136009, SCT, "Standard deviation")	1	M		UNITS= EV (m/s, UCUM, "m/s")
6		CONTAINS	NUM	EV (110830, DCM, "Elasticity")	1	M		UNITS= EV (kPa, UCUM, "kPa")
7	>	HAS CONCEPT MOD	NUM	EV (386136009, SCT, "Standard deviation")	1	M		UNITS= EV (kPa, UCUM, "kPa")
8		CONTAINS	NUM	EV (130612, DCM, "Shear Wave Dispersion Slope")	1	U		UNITS= EV (m/s/kHz, UCUM, "m/s/kHz")
9	>	HAS CONCEPT MOD	NUM	EV (386136009, SCT, "Standard deviation")	1	M		UNITS= EV (m/s/kHz, UCUM, "m/s/kHz")

Content Item Descriptions

Row 3	The ROI is typically a circle or square, although other shapes are not prohibited.
Rows 4, 6, 8	The value represents the mean value of the pixels contained in the ROI.
Rows 5, 7, 9	The value represents the standard deviation of the values of the pixels contained in the ROI.

Add the following UID Values to Part 6 Annex A Table A-3:

Table A-3 CONTEXT GROUP UID VALUES

Context UID	Context Identifier	Context Group Name
...	...	…
1.2.840.10008.6.1.zzcid0	**newcid0**	**General Ultrasound Report Document Titles**

1.2.840.10008.6.1.zzcid1	**newcid1**	**Elastography Sites**

Add the following codes to the following CIDs in Part 16 Annex B:

CID 5 Transducer Approach

Type: Extensible
Version: yyyymmdd

Table CID 5. Ultrasound Approach

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	24028007	Right	G-A100	C0205090
SCT	7771000	Left	G-A101	C0205091
SCT	49370004	Lateral	G-A104	C0205093
…				
DCM	**newcode02**	**Intercostal**		
DCM	**newcode03**	**Subcostal**		

Add the new General Ultrasound Report Document Titles to CID 7000 in Part 16 Annex B:

CID 7000 Diagnostic Imaging Report Document Titles

Type: Extensible
Version: yyyymmdd

Table CID 7000. Diagnostic Imaging Report Document Titles

Coding Scheme Designator	Code Value	Code Meaning	UMLS Concept Unique ID
…			
LN	47048-4	Diagnostic Interventional Radiology Report	C1831148
Include CID 12100 "Vascular Ultrasound Report Document Titles"			
Include CID newCID0 "General Ultrasound Report Document Titles"			

Add the following CIDs to Part 16 Annex B:

CID newcid0 General Ultrasound Report Document Titles

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML
Type: Extensible
Version: yyyymmdd
UID: 1.2.840.10008.6.1.zzcid0

Table CID newcid0. General Ultrasound Report Document Titles

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
LN	25061-3	Ultrasound Report		C0882213
LN	39453-6	US Tendon Report		
LN	24601-7	US Breast Report		
LN	38036-0	US Kidney Report		
LN	28614-6	US Liver Report		
LN	24884-9	US Prostate (transrectal) Report		
LN	24859-1	US Pancreas Report		
LN	24990-4	US Spleen Report		
LN	24907-8	US Shoulder Report		
LN	25002-7	US Scrotum and Testicle Report		
LN	25010-0	US Thyroid Report		

CID newcid1 Elastography Sites

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML
Type: Extensible
Version: yyyymmdd
UID: 1.2.840.10008.6.1.zzcid1

Table CID newcid1. Elastography Sites

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	61352006	Achilles Tendon		
SCT	76752008	Breast	T-04000	C0006141
SCT	64033007	Kidney	T-71000	C0022646
SCT	10200004	Liver	T-62000	C0023884
SCT	41216001	Prostate	T-92000	C0033572
SCT	15776009	Pancreas	T-65000	C0030274
SCT	18033002	Patellar Tendon		
SCT	78961009	Spleen	T-C3000	C0037993
SCT	245100002	Tendon of Rotator Cuff of Shoulder		
SCT	40689003	Testis	T-94000	C0039597
SCT	69748006	Thyroid	T-B6000	C0040132

Add the following Definitions to Annex D

DICOM Code Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")

Code Value	Code Meaning	Definition
newcode01	Reference Measurement Group	A grouping of related measurements and calculations that share a common context and that serves as a reference against which similar measurement groups are compared.
newcode02	Intercostal	Between adjacent ribs
newcode03	Subcostal	Below the ribs
newcode04	Relevant Patient Conditions	Currently present patient conditions which might be relevant to the current context.

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