



RSNA 2016 –

**Knowledge Representation of Prostatic
Sector Anatomy from PI-RADS in Standard
Lexicons**

David Clunie (dclunie@dclunie.com)

PixelMed Publishing

Background & Disclosures

- Owner, PixelMed Publishing, LLC
- Consultant to NCI QIICR project
- Consultant to Carestream, GE, Curemetrix, MDDX
- Editor of DICOM Standard

Application

- Multiparametric Magnetic Resonance Imaging (mpMRI) is increasingly used to evaluate prostate cancer
- Reporting systems that standardize the features, locations and recommended action have been devised
- The most recent of these is the Prostate Imaging and Report and Data System Version 2 (PI-RADS v2)
- Such reports and supporting evidence will be encoded in a structured form and anatomical locations need a standard encoding

Precise localization of ROIs

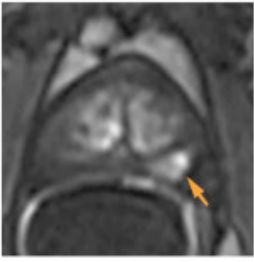
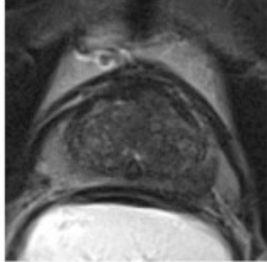
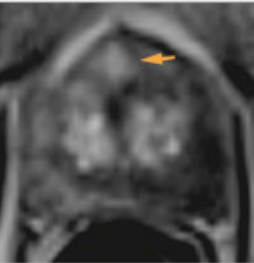
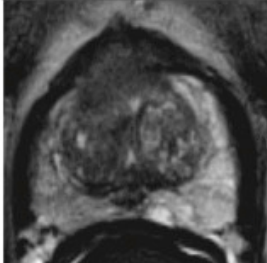
- For reproducibility of reader performance
- Comparisons with a pathological reference
- Assess/improve regional specificity
- Improve the communication of results
- Draw attention to suspicious regions
- For targeted biopsies or therapy
- To improve staging

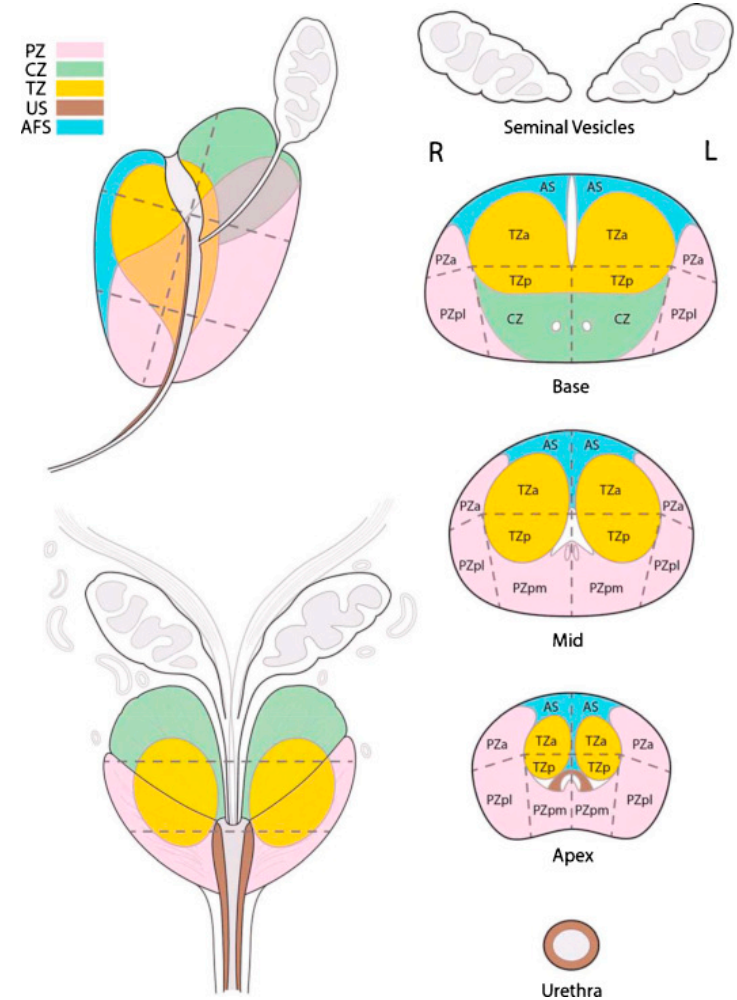
Localization Models

- EU Consensus Paper – 16 regions
- EU Consensus Paper – 27 regions
- PI-RADS v2 – 39 regions

- Whether or not such granular localization is practical for routine reporting is out of scope of this discussion

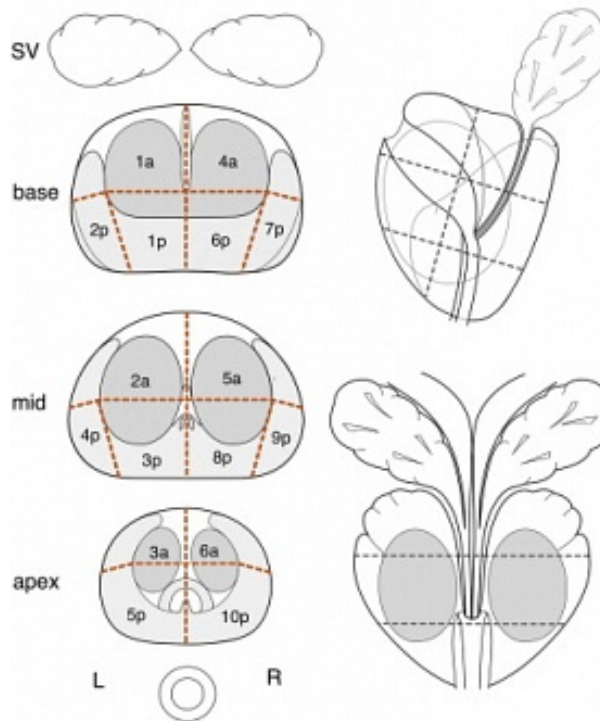
Weinreb et al. *PI-RADS Prostate Imaging - Reporting and Data System: 2015, Version 2. Eur Urol. 2016 Jan;69(1): 16–40.*

Positive	Focal (arrow), and; earlier than or contemporaneously with enhancement of adjacent normal prostatic tissues, and; corresponds to suspicious finding on T2W and/or DWI	
Peripheral Zone		
Transition Zone		



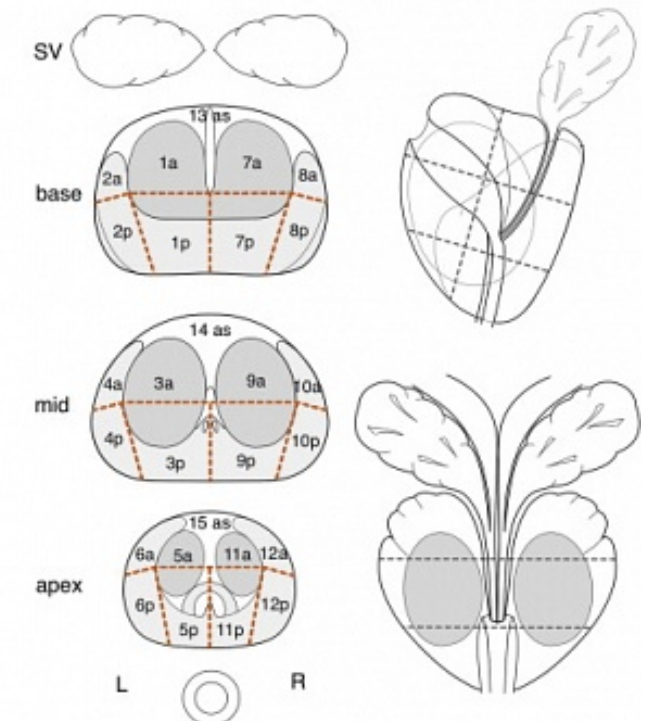
Dickinson et al. Magnetic resonance imaging for the detection, localisation, and characterisation of prostate cancer: recommendations from a European consensus meeting. European urology. 2011;59(4): 477–94.

A Sixteen Regions of Interest



Ten posterior (p) glandular regions - mediolobar and lateral at base and mid; lobar at apex.
Six anterior (a) glandular and stromal regions.

B Twenty-seven Regions of Interest



Twelve posterior (p) and twelve anterior (a) glandular regions - mediolobar and lateral at base, mid and apex.
Three anterior stroma (as) central regions.

Knowledge Extraction

- If granular localization is used ...
- How does one extract more general knowledge?
- E.g., Apex L TZp “Left posterior apical transition zone of prostate”, is:
 - Left
 - Apical
 - Posterior
 - Transition zone
- Need not only codes, but “ontology” (relationships)

Encoding

- Narrative reports may use full name or abbreviations
- Structured reports with semantically extractable information need codes
- Codes should be standard so as to be interoperable
- Common schemes:
 - SNOMED CT
 - Foundational Model of Anatomy (FMA)
 - NCI Thesaurus
 - RadLex (radiology-specific)

Methods

- Evaluated FMA, SNOMED CT, NCIIt and RadLex for current content – all lacking the necessary specificity
- Selected FMA as basis and Protégé as tool
- Extended FMA with new concepts:
 - sub-classes of existing concepts
 - regional spatial relationships (“posterior to”, etc.)
 - “disjoint from” relationships
- Offered result to FMA, SNOMED CT, NCIIt, RadLex

Protégé

Class
Hierarchy

Annotations

Description

The screenshot displays the Protégé ontology editor interface. The browser address bar shows the URL: `http://purl.org/sig/ont/fma_4.2.0_plus99PMPProstate.owl`. The main window is titled "fma_4.2.0_plus99PMPProstate" and contains several panes:

- Class hierarchy:** A tree view showing the hierarchy of classes. The selected class is "Posterior part of left side of apical part of transition zone of prostate".
- Annotations:** A list of annotations for the selected class, including a label in English and a 99PIRADS type.
- Description:** A detailed description of the selected class, including its equivalent to, subclasses, and members.

The class hierarchy pane shows a list of classes, with the selected class highlighted in blue. The description pane shows the following information:

- Equivalent To:** None.
- SubClass Of:**
 - 'posterior to' some 'Anterior part of left side of apical part of transition zone of prostate'
 - 'regional part of' some 'Left side of apical part of transition zone of prostate'
 - 'Subdivision of transition zone of prostate'
- SubClass Of (Anonymous Ancestor):**
 - 'has dimension' value true
 - 'dimension value "3-dimension"^^string
 - 'has mass' value true
 - 'has boundary' value true
 - 'has inherent 3-D shape' value true
 - 'physical state' value "Solid"^^string
- Members:** None.
- Target for Key:** None.
- Disjoint With:**
 - 'Posterior part of right side of apical part of transition zone of prostate'
 - 'Anterior part of left side of apical part of transition zone of prostate'
- Disjoint Union Of:** None.

At the bottom of the window, there is a status bar that reads: "No Reasoner set. Select a reasoner from the Reasoner menu" and a checkbox for "Show Inferences" which is checked.

Protégé

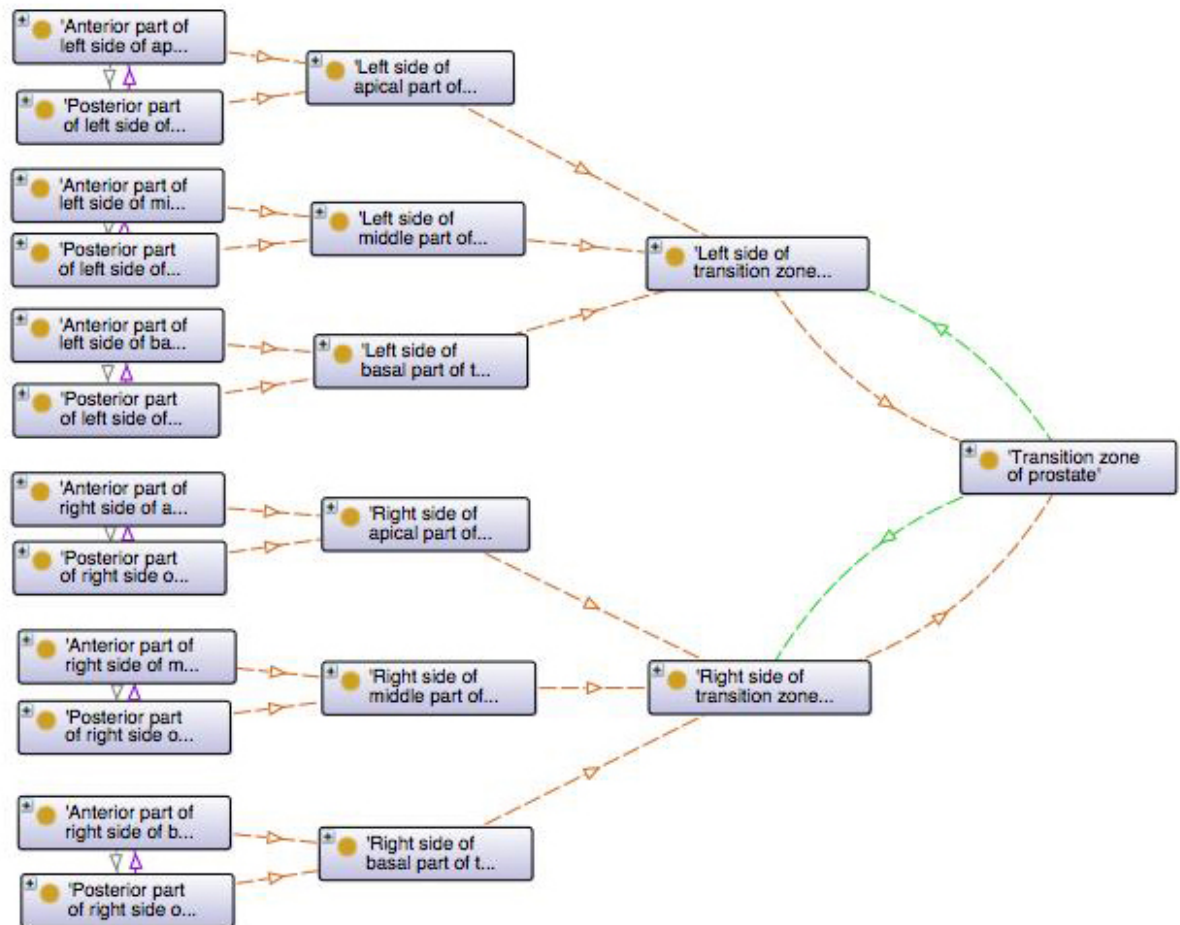
Spatial Relations

The screenshot shows the Protégé ontology editor interface. The browser address bar displays the URL: `http://purl.org/sig/ont/fma_4.2.0_plus99PMPProstate.owl`. The main window is divided into several panes:

- Class hierarchy:** Shows a tree of classes. The selected class is `'Posterior part of left side of apical part of transition zone of prostate'`. It is highlighted in blue. A red arrow points to this class in the hierarchy.
- Annotations:** Shows the annotations for the selected class, including a label in English and the URI `99PIRADs`.
- Description:** Shows the description of the selected class, including its equivalent to other classes and its subClassOf relationships. A red arrow points to the `'Subdivision of transition zone of prostate'` class in the `SubClass Of` list.
- Members:** Shows the members of the selected class, including various spatial relations like `'Anterior part of left side of apical part of transition zone of prostate'`.

At the bottom of the window, there is a status bar that reads: "No Reasoner set. Select a reasoner from the Reasoner menu" and a checkbox for "Show Inferences" which is checked.

Transition Zone Class Hierarchy shown in OntoGraf



FMA browser

xiphoid.biostr.washington.edu/fma/fmabrowser-hierarchy.html?search=Subdivision of transition zone of prostate&entry

Search

David Clunie's B... Imaging Informatic... FOSS Patents Dalai's PACS Blog Life as a Healthcar... MotorcycleGuy Blog Internet Archive: ... Ahier Moehrke

Home Clear display and history Search

Graphical class selector

Upper classes

is regional part of
Left side of apical part of transition zone of prostate

is constitutional part of

is member of

has superclass (is a)
Subdivision of apical part of transition zone of prostate

Posterior part of left side of apical part of transition zone of prostate

Add to list

has regional part

has constitutional part

has member

Details of current class

Posterior part of left side of apical part of transition zone of prostate

FMA ID
328775

PIRADSv2
Apex L TZp

List Settings

The screenshot shows a web browser window with the FMA browser interface. The browser's address bar shows the URL: xiphoid.biostr.washington.edu/fma/fmabrowser-hierarchy.html?search=Subdivision of transition zone of prostate&entry. The browser's search bar is empty. The browser's toolbar shows various icons for navigation and search. The browser's tabs show several open pages, including 'David Clunie's B...', 'Imaging Informatic...', 'FOSS Patents', 'Dalai's PACS Blog', 'Life as a Healthcar...', 'MotorcycleGuy Blog', 'Internet Archive: ...', 'Ahier', and 'Moehrke'. The browser's content area shows the FMA browser interface. The interface has a top navigation bar with 'Home', 'Clear display and history', and a search bar. Below the navigation bar is a 'Graphical class selector' section. The main content area is divided into several sections. On the left, there is a vertical sidebar labeled 'Upper classes' with a right-pointing arrow. The main content area contains several boxes representing class relationships. The top row has three boxes: 'is regional part of' with the text 'Left side of apical part of transition zone of prostate', 'is constitutional part of', and 'is member of'. Below these is a horizontal bar with 'has superclass (is a)' and the text 'Subdivision of apical part of transition zone of prostate'. In the center, there is a large box with the text 'Posterior part of left side of apical part of transition zone of prostate' and an 'Add to list' button. Below this are three more boxes: 'has regional part', 'has constitutional part', and 'has member'. On the right, there is a vertical sidebar labeled 'Details of current class' with a left-pointing arrow. This sidebar contains the following information: 'Posterior part of left side of apical part of transition zone of prostate', 'FMA ID 328775', 'PIRADSv2 Apex L TZp'. At the bottom of the interface, there are two buttons: 'List' on the left and 'Settings' on the right.

SNOMED CT - Structure of ...

browser.ihtsdotools.org/?perspective=full&conceptId=716933002&edition=en-edition&release=v20160731&serve

IHTSDO SNOMED CT Browser

Release: International Edition 20160731 | Perspective: Full | Feedback | About

© IHTSDO 2016 v1.33.1

Taxonomy | Search | Favorites | Refset

Search

Options

Search Mode: Partial matching search mode

Status: Active components only

Group by concept

Filter results by Language

english 3

Filter results by Semantic Tag

body structure 3

Filter results by Module

SNOMED CT core 3
module (core metadata concept)

Type at least 3 characters ✓ Example: shou fra

sterior apical part of transition zone of left half prostate

3 matches found in 0.13 seconds.

Structure of posterior apical part of transition zone of left half prostate	Structure of posterior apical part of transition zone of left half prostate (body structure)
Entire posterior apical part of transition zone of left half prostate (body structure)	Entire posterior apical part of transition zone of left half prostate (body structure)
Structure of posterior apical part of transition zone of left half prostate (body structure)	Structure of posterior apical part of transition zone of left half prostate (body structure)

All 3 results are displayed

Concept Details

Summary | Details | Diagram | Expression | Refsets | Members | References

Stated | Inferred

Parents

- Structure of apical part of transition zone of left half prostate (body structure)
- Structure of posterior section of prostate (body structure)

Structure of posterior apical part of transition zone of left half prostate (body structure)

SCTID: 716933002

716933002 | Structure of posterior apical part of transition zone of left half prostate (body structure) |

- Structure of posterior apical part of transition zone of left half prostate (body structure)
- Structure of posterior apical part of transition zone of left half prostate
- Left posterior apical part of transition zone of prostate

Laterality → Left

Children (1)

- Entire posterior apical part of transition zone of left half prostate (body structure)

SNOMED CT - Structure of ...

browser.ihstools.org/?perspective=full&conceptId=716933002&edition=en-edition&release=v20160731&serve

IHTSDO SNOMED CT Browser Release: International Edition 20160731 Perspective: Full Feedback About ihstdo Delivering SNOMED CT

© IHTSDO 2016 v1.33.1

Taxonomy Search Favorites Reset

Search

Options

Search Mode: Partial matching search mode

Status: Active components only

Group by concept

Filter results by Language

english 3

Filter results by Semantic Tag

body structure 3

Filter results by Module

SNOMED CT core 3
module (core metadata concept)

Type at least 3 characters ✓ Example: shou fra

sterior apical part of transition zone of left half prostate

3 matches found in 0.13 seconds.

Structure of posterior apical part of transition zone of left half prostate	Structure of posterior apical part of transition zone of left half prostate (body structure)
Entire posterior apical part of transition zone of left half prostate (body structure)	Entire posterior apical part of transition zone of left half prostate (body structure)
Structure of posterior apical part of transition zone of left half prostate (body structure)	Structure of posterior apical part of transition zone of left half prostate (body structure)

All 3 results are displayed

Concept Details

Concept Details

Summary Details Diagram Expression Refsets Members References

Stated Inferred

Download

716933002
Structure of posterior apical part of transition zone of left half prostate (body structure)

716929009
Structure of apical part of transition zone of left half prostate (body structure)

717005008
Structure of posterior section of prostate (body structure)

272741003
Laterality (attribute)

7771000
Left (qualifier value)

```

graph TD
    A["716933002  
Structure of posterior apical part of transition zone of left half prostate (body structure)"] --> B["716929009  
Structure of apical part of transition zone of left half prostate (body structure)"]
    A --> C["717005008  
Structure of posterior section of prostate (body structure)"]
    A --> D["272741003  
Laterality (attribute)"]
    D --> E["7771000  
Left (qualifier value)"]
  
```


NCI Thesaurus

https://nciterns.nci.nih.gov/ncitbrowser/pages/concept_details.jsf?dictionary=NCI_Thesaurus&version=16.09d

David Clunie's B... Imaging Informatic... FOSS Patents Dala's PACS Blog Life as a Healthcar... MotorcycleGuy Blog Internet Archive: ... Ahier Moehrke

NIH NATIONAL CANCER INSTITUTE www.cancer.gov

NCI Term Browser EVS Enterprise Vocabulary Services

Terminologies Value Sets Mappings

NCIthesaurus
Version: 16.09d (Release date: 2016-09-26)

Left posterior apical transition zone of prostat

Contains
 Exact Match
 Begins With
 Name
 Code
 Property
 Relationship

[Advanced Search](#)

[Hierarchy](#) | [Value Sets](#) | [Visited Concepts](#) [Help](#)

Quick Links

[View in Hierarchy](#) | [View History](#) | [View Graph](#) | [Add to Cart](#) | [Suggest Changes](#)

Left Posterior Apical Transition Zone of Prostate (Code C128579)

Terms & Properties **Synonym Details** Relationships Mappings View All

Terms & Properties

Preferred Name: Left Posterior Apical Transition Zone of Prostate

Definition: The region of the prostate that is located on the anatomical left side of the posterior portion of the apical division of the transition zone.

Label: Left Posterior Apical Transition Zone of Prostate

NCI Thesaurus Code: C128579 ([Search for linked caDSR metadata](#)) ([search value sets](#))

Synonyms & Abbreviations: ([see Synonym Details](#))

Apex L TZp
Left Posterior Apical Transition Zone of Prostate

External Source Codes: None

Other Properties:

Name	Value (qualifiers indented underneath)
code	C128579
Contributing_Source	PI-RADS
Semantic_Type	Body Location or Region

Additional Concept Data:
Defined Fully by Roles: No

https://nciterns.nci.nih.gov/ncitbrowser/pages/concept_details.jsf?dictionary=NCI_Thesaurus&version=16.09d&code=C128579&ns=null&type=properties&key=null&b=1&n=0&vse=null

UMLS Terminology Browser -- x

Secure https://uts.nlm.nih.gov/metathesaurus.html#C4274173;0;1;CUI;2016AB;EXACT_MATCH;CUI;*

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Welcome back, dclunie

Unified Medical Language System

UMLS Terminology Services
Metathesaurus Browser

UTS Home Applications SNOMED CT Resources Downloads Documentation UMLS Home

Search Tree Recent Searches

Term CUI Code

apical transition zone of prostate

Release: 2016AB

Search Type: Word

Source: All Sources
AIR
ALT
AOD
AOT

Search Results (13)

- [C4274100](#) Apical transition zone of prostate
- [C4273855](#) Right apical transition zone of prostate
- [C4274176](#) Left apical transition zone of prostate
- [C4274099](#) Right posterior apical part of transition zone of prostate
- [C4274131](#) Right anterior apical part of transition zone of prostate
- [C4274173](#) Left posterior apical part of transition zone of prostate
- [C4274174](#) Left anterior apical part of transition zone of prostate
- [C4274127](#) Entire posterior apical part of transition zone of prostate
- [C4274129](#) Entire posterior apical part of transition zone of prostate (body structure)
- [C4274130](#) Entire anterior apical part of transition zone of prostate
- [C4274132](#) Entire apical part of transition zone of left half prostate
- [C4274172](#) Entire anterior apical part of transition zone of right half prostate
- [C4274175](#) Entire apical part of transition zone of right half prostate

Basic View Report View Raw View

- Concept: [C4274173] Left posterior apical part of transition zone of prostate
- Semantic Types
 - [Body Part, Organ, or Organ Component](#) [T023]
- Atoms (3) string [AUI / RSAB / TTY / Code]
 - Left posterior apical part of transition zone of prostate [A27169836/SNOMEDCT_US/PT/716933002]
 - Structure of posterior apical part of transition zone of left half prostate [A27172680/SNOMEDCT_US/SY/716933002]
 - Structure of posterior apical part of transition zone of left half prostate (body structure) [A27169299/SNOMEDCT_US/FN/716933002]
- Contexts (391)

Copyright | Privacy | Accessibility | Freedom of Information Act | National Institutes of Health | Health & Human Services

pirads_euconsensus_fma_s...

https://docs.google.com/spreadsheets/d/1XgJpE6YhBzZkKOLFXQpeE6R8zGxB_RYkMIhoqRqF39A/edit?pli=1#gid=

pirads_euconsensus_fma_snomed_umls_table

File Edit View Insert Format Data Tools Add-ons Help Last edit was 8 days ago

Comments Share

311009

	E	F	G	H	I	J	K	L
1	FMA	SRT	SCIID	Request ID	PIRADS v2	16 regions	27 regions	DICOM Synonym
2	19387	T-93010	74308000		R SV	R SV	R SV	Right seminal vesicle
3	19388	T-93020	42320003		L SV	L SV	L SV	Left seminal vesicle
4	19733	R-FFFD9	717027004		US	US (?)	US (?)	Male external urethral sphincter
5	302539	RO-00017	716891004	676408	none	ignored	13as	Basal anterior fibromuscular stroma of prostate
6	302542	R-FFFE0	716908000	676715	none	ignored	14as	Middle anterior fibromuscular stroma of prostate
7	302546	RO-0001B	716925003	676732	none	ignored	15as	Apical anterior fibromuscular stroma of prostate
8	328773	R-FFFC1	716928001	676735	none	3a	5a	Right apical transition zone of prostate
9	328769	R-FFFA9	716929009	676736	none	6a	11a	Left apical transition zone of prostate
10	328761	RO-00006	716930004	676737	Apex R TZa	part-of Apex R TZ (3a)	part-of Apex R TZ (5a)	Right anterior apical transition zone of prostate
11	328763	R-FFFF3	716932007	676739	Apex R TZp	part-of Apex R TZ (3a)	part-of Apex R TZ (5a)	Right posterior apical transition zone of prostate
12	328795	R-FFFE5	716931000	676738	Apex L TZa	part-of Apex L TZ (6a)	part-of Apex L TZ (11a)	Left anterior apical transition zone of prostate
13	328775	RO-00014	716933002	676740	Apex L TZp	part-of Apex L TZ (6a)	part-of Apex L TZ (11a)	Left posterior apical transition zone of prostate
14	328780	R-FFFBE	716894007	676701	none	1a	1a	Right basal transition zone of prostate
15	328755	RO-00020	716895008	676702	none	4a	7a	Left basal part transition zone of prostate
16	328793	RO-00000	716896009	676703	Base R TZa	part-of Base R TZ (1a)	part-of Base R TZ (1a)	Right anterior basal transition zone of prostate
17	328799	R-FFFB1	716898005	676705	Base R TZp	part-of Base R TZ (1a)	part-of Base R TZ (1a)	Right posterior basal transition zone of prostate
18	328785	R-FFFD6	716897000	676704	Base L TZa	part-of Base L TZ (4a)	part-of Base L TZ (7a)	Left anterior basal transition zone of prostate
19	328789	R-FFFB7	716899002	676706	Base L TZp	part-of Base L TZ (4a)	part-of Base L TZ (7a)	Left posterior basal transition zone of prostate
20	328757	R-FFFB6	716911004	676718	none	2a	3a	Right middle transition zone of prostate
21	328762	R-FFFD5	716912006	676719	none	5a	9a	Left middle transition zone of prostate
22	328800	R-FFFF4	716913001	676720	Mid R TZa	part-of Mid R TZ (2a)	part-of Mid R TZ (3a)	Right anterior middle transition zone of prostate
23	328787	R-FFFC9	716915008	676722	Mid R TZp	part-of Mid R TZ (2a)	part-of Mid R TZ (3a)	Right posterior middle transition zone of prostate
24	328784	RO-00013	716914007	676721	Mid L TZa	part-of Mid L TZ (5a)	part-of Mid L TZ (9a)	Left anterior middle transition zone of prostate
25	328786	R-FFFAB	716916009	676723	Mid L TZp	part-of Mid L TZ (5a)	part-of Mid L TZ (9a)	Left posterior middle transition zone of prostate
26	328802	RO-00018	716902004	676709	none	2p	none	Right basal peripheral zone of prostate

pirads_euconsensus_fma_snomed_u

Sum: 718249526 Explore

1

Table CID n001. Prostate Sector Anatomy from PI-RADS v2

2
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Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID	FMA ID	PI-RADS v2 Abbreviation	NCI Thesaurus
SRT	R-FFFFC	Central zone of left half prostate	716901006		302475	Base L CZ	C128587
SRT	R-FFFD0	Central zone of right half prostate	716900007		302473	Base R CZ	C128593
SRT	R0-00025	Left anterior apical peripheral zone of prostate	716937001		328760	Apex L PZa	C128575
SRT	R-FFFE5	Left anterior apical transition zone of prostate	716931000		328795	Apex L TZa	C128578
SRT	R0-00001	Left anterior basal peripheral zone of prostate	716905002		328753	Base L PZa	C128588
SRT	R-FFFD6	Left anterior basal transition zone of prostate	716897000		328785	Base L TZa	C128589
SRT	R-FFFB0	Left anterior middle peripheral zone of prostate	716920008		328768	Mid L PZa	C128600
SRT	R0-00013	Left anterior middle transition zone of prostate	716914007		328784	Mid L TZa	C128603
SRT	R-FFFD6	Left apical anterior fibromuscular stroma of prostate	716927006		328772	Apex L AS	C128574

CID 6301 Prostate Sector Anatomy from PI-RADS v2

dicom.nema.org/medical/dicom/current/output/chtml/part16/sect_CID_6301.html

David Clunie's B... Imaging Informatic... FOSS Patents Dalai's PACS Blog Life as a Healthcar... MotorcycleGuy Blog Internet Archive: ... Ahier Moehrke Electronic Health ... Fairhaven, The R...

DICOM PS3.16 2016e - Content Mapping Resource

CID 6301 Prostate Sector Anatomy from PI-RADS v2

[Prev](#) **B DCMR Context Groups (Normative)** [Next](#)

[PS3.16](#) > [DCMR Context Groups \(Normative\)](#) > Prostate Sector Anatomy from PI-RADS v2

CID 6301 Prostate Sector Anatomy from PI-RADS v2

Note

From [\[PI-RADS v2\]](#).

Type:

Extensible

Version:

20161106

Table CID 6301. Prostate Sector Anatomy from PI-RADS v2

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID	FMA ID	PI-RADS v2 Abbreviation	NCI Thesaurus
SRT	R-FFFFC	Central zone of left half prostate	716901006		302475	Base L CZ	C128587
SRT	R-FFFD0	Central zone of right half prostate	716900007		302473	Base R CZ	C128593
SRT	R0-00025	Left anterior apical peripheral zone of prostate	716937001		328760	Apex L PZa	C128575
SRT	R-FFFFE5	Left anterior apical transition zone of prostate	716931000		328795	Apex L TZa	C128578
SRT	R0-00001	Left anterior basal peripheral zone of prostate	716905002		328753	Base L PZa	C128588
SRT	R-FFFFD6	Left anterior basal transition zone of prostate	716897000		328785	Base L TZa	C128589
SRT	R-FFFFB0	Left anterior middle peripheral zone of prostate	716920008		328768	Mid L PZa	C128600

prostate Highlight All Match Case Whole Words 1 of 8 matches

Conclusions

- PI-RADS V2 and EU Consensus sector anatomy now coded in FMA, SNOMED CT and NCI Thesaurus
- DICOM now includes values sets and codes for all three schemes – usable in Structured Reports and Segmentations
- UMLS will inherit since it regularly incorporates SNOMED CT, FMA and NCI Thesaurus
- RadLex expected to follow soon
- FMA and SNOMED CT include partology, and FMA includes spatial relationships – allows for interrogation of common parents and attributes

Acknowledgements

- This project was supported by funding from National Institutes of Health, National Cancer Institute, through grant U24 CA180918 (Quantitative Image Informatics for Cancer Research, QIICR)
- QIICR (BWH) – Andrey Fedorov
- SNOMED CT(IHTSDO) – Yongsheng Gao
- FMA (Univ. Wash. Seattle) – Todd Detwiler, Onard Mejino
- NCI Thesaurus – Teri Quinn, Lori Whiteman