Compressed SENSE ……..1 Year Update

Ruth Pearson
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Compressed SENSE – First experiences

Philips 3T Ingenia Static MRI with in-bore experience
Installed 2017
Compressed SENSE 3 month trial autumn 2018

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Compressed SENSE….1 year update

- Patient throughput and image quality during 3 month trial
- Patient feedback
- Throughput results with CS compared to pre-CS
- Application of CS to other examinations

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Compressed SENSE

Sensitivity Encoding

SENSE using parallel imaging and coil sensitivity reference scans

+

Compressed Sensing

Under-sampling data which is then reconstructed and filtered

Acceleration technique resulting in faster scan times and / or increased quality

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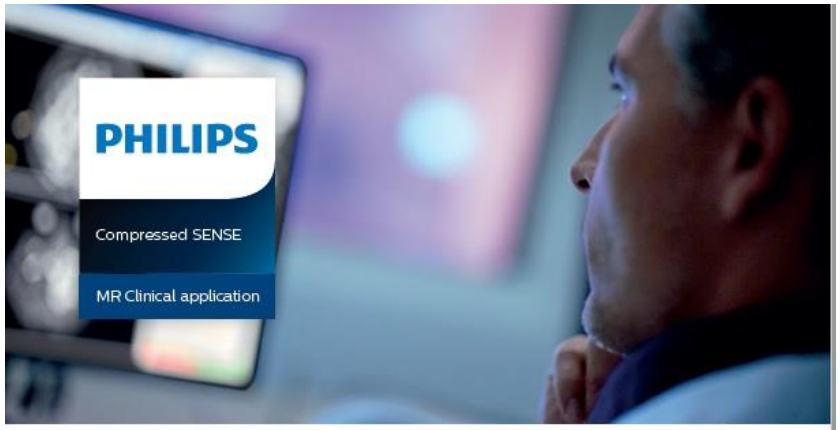

Compressed SENSE

Speed done right. Every time.

Liesbeth Geerts-Ossevoort, PhD; Elwin de Weerdt, PhD; Adri Duijndam, PhD; Gert van IJperen, PhD; Hans Peeters, PhD; Mariya Doneva, PhD; Marco Nijenhuis; Alan Huang, PhD

Since its introduction, MR has been challenged by matters of speed. Today, the imperative to shorten MR exams without impeding image quality has become even more urgent, because an increase in chronic conditions has led to a growing use of MR, which when combined with declining reimbursements has created a need for a paradigm shift in productivity[1,2]. This white paper explains the main principles of Compressed SENSE and how it introduces a paradigm shift in productivity, how Compressed SENSE was designed around image quality, and how it advances productivity for clinical MR imaging.

All authors are Philips employees

More information can be found in articles on Netforum

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Compressed SENSE

‘Compressed SENSE accelerates scans by up to 50% with virtually equal image quality’

Sint-Jan Hospital in Bruges, Belgium:

30-50% decrease in scan time

30% most sequences with same image quality
50% high contrast with same image quality
50% other examinations with image quality compromise

https://www.philips.co.uk/healthcare/product/HCNMRF203/compressed-sense---brain-mr-clinical-applications?elqTrackId=090d3444b16c4373bfb9247299392082&elqaid=1274&elqat=2#_watch

Knee

Sense 1.2
4min 2secs

CS 2.5
1min 57secs

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Knee

SENSE 1.3
2mins 45secs

CS 2
1min 45secs

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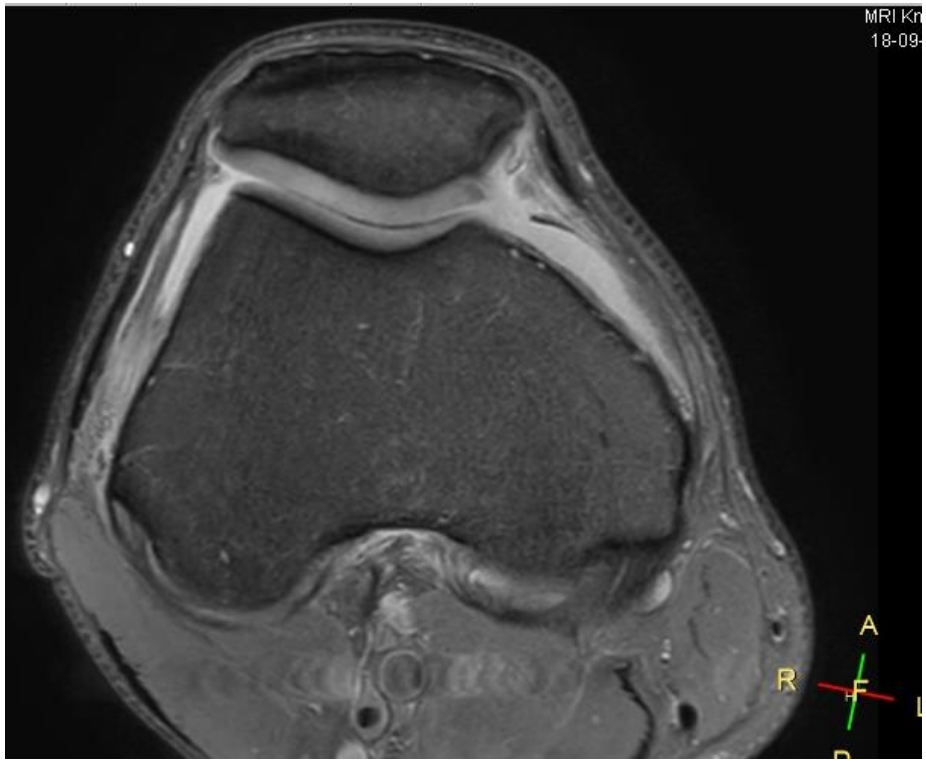
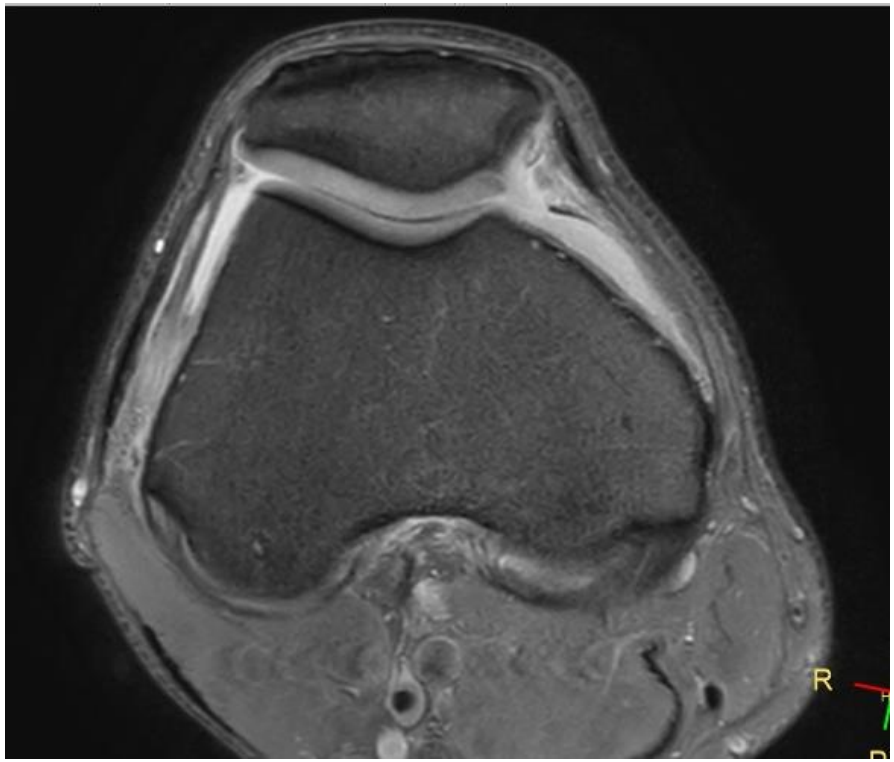
Knee



No SENSE
2mins 45secs



CS 2
1min 25secs

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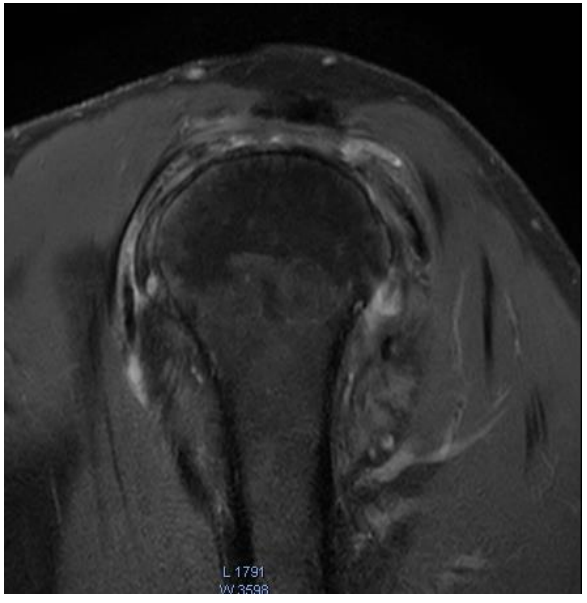
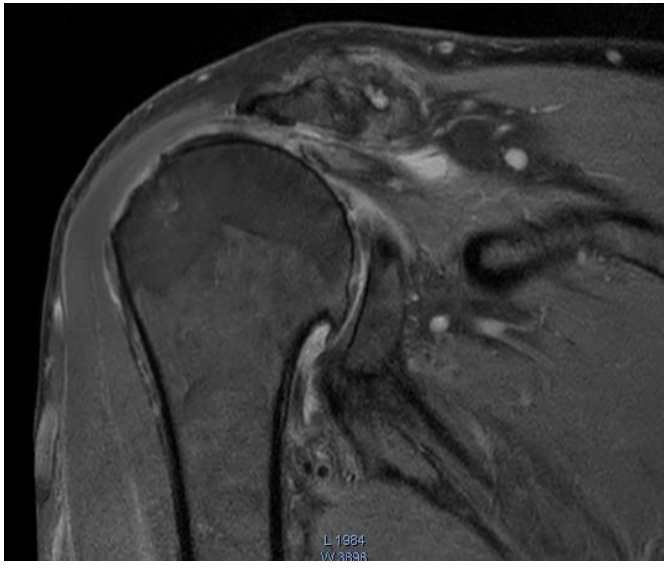
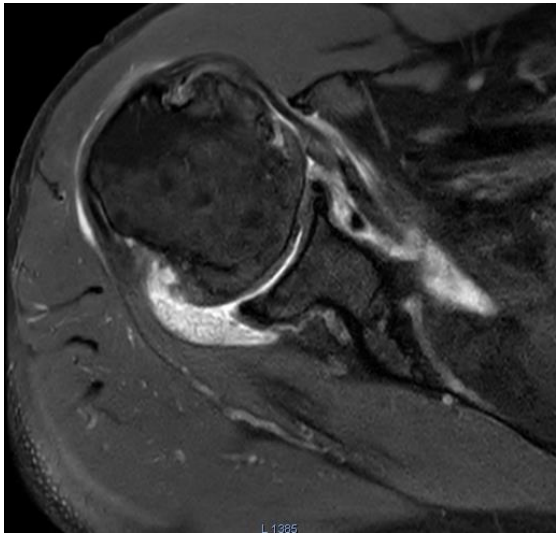
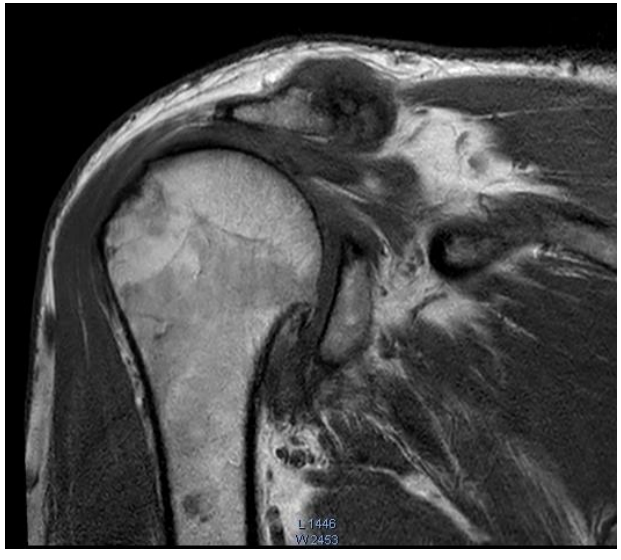
Shoulder

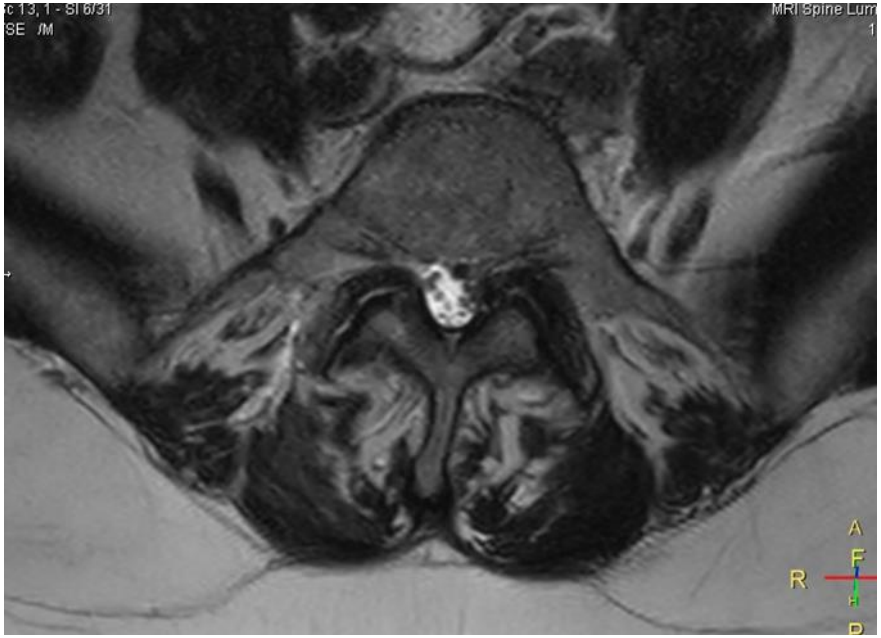




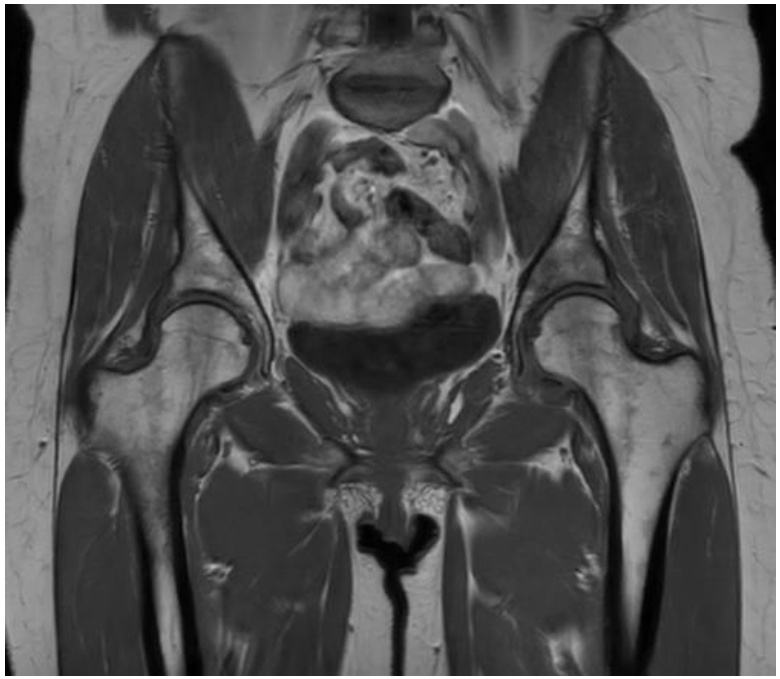




Compressed SENSE



CS 2
2min 26secs



CS 2.5
2min 23secs

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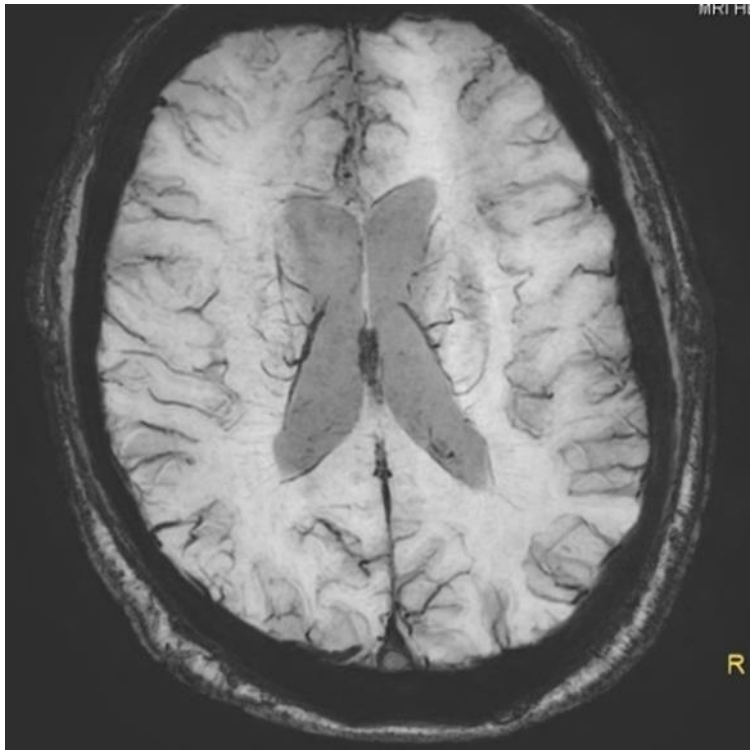
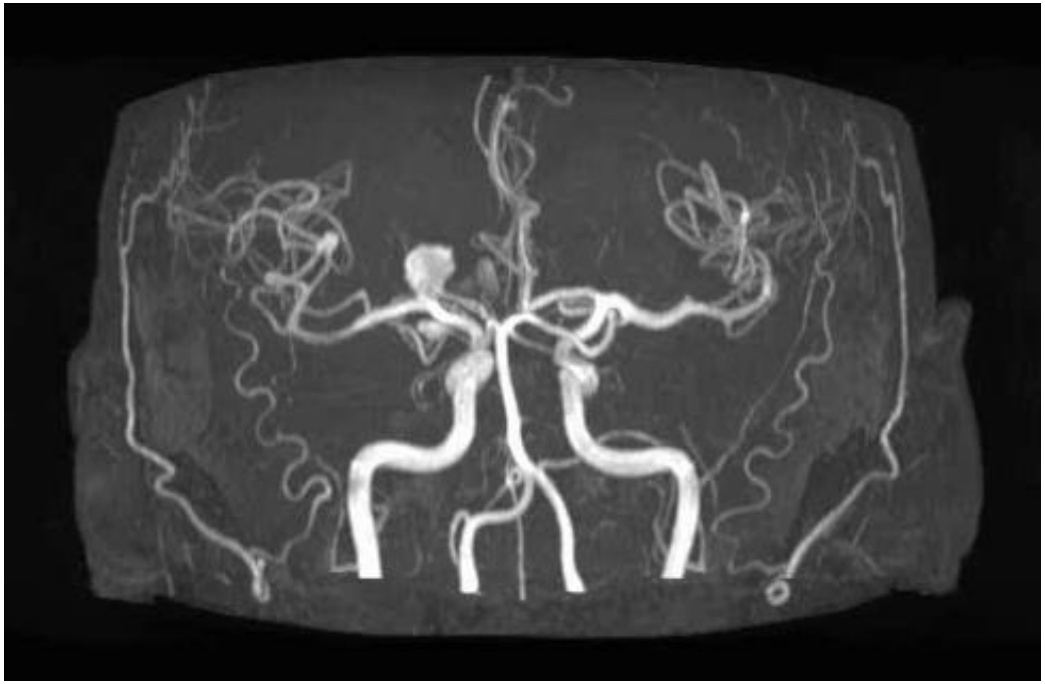
Compressed SENSE



CS 5
2min 47secs



CS2
2mins

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Compressed SENSE
Time Saving

	Standard examination	Compressed Sense
Knee	12 mins	6 mins
Shoulder	17 mins	9 mins
Ankle	22 mins	13 mins
L-spine	21 mins	16 mins
Brain (4 sequences)	14 mins	8 mins

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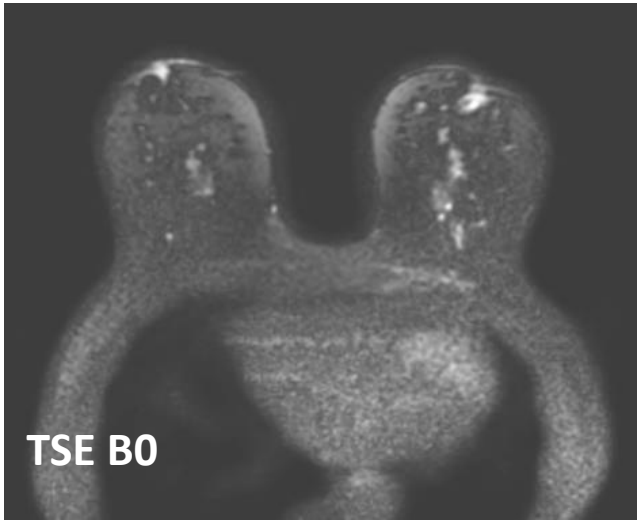
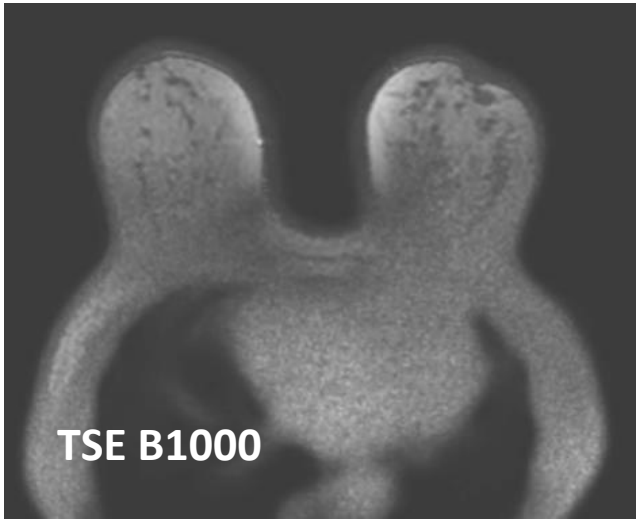
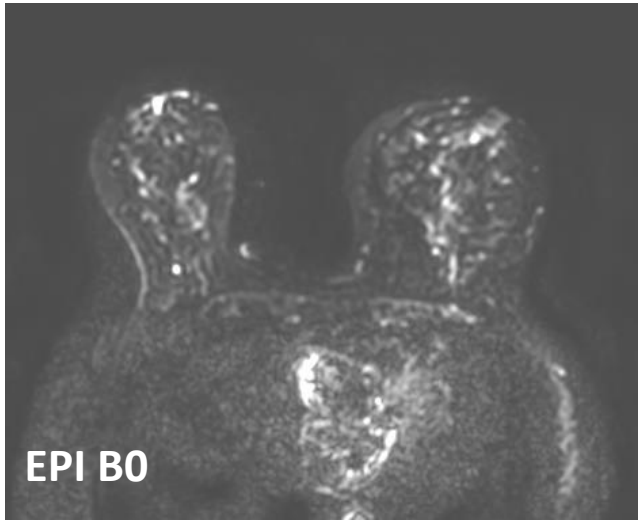
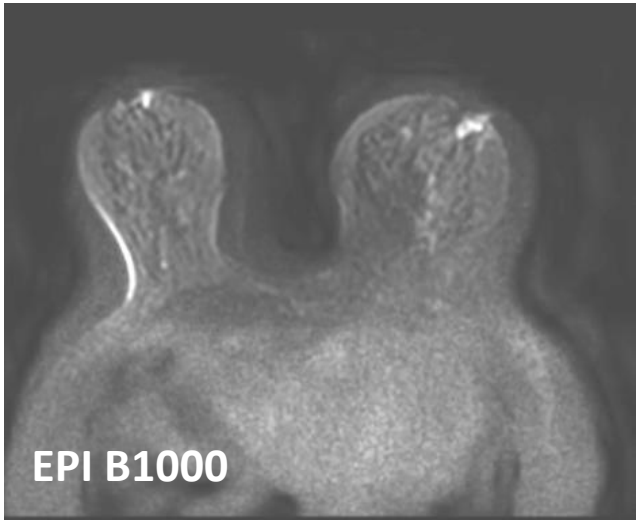
Breast

EPI	TSE
SENSE 3	CS 4
2 NSA	6 NSA
2.2x2.2 acq resolution	1.97x2.21 acq resolution
1.2x1.2 recon resolution	1.47x1.47 recon resolution
2mm slice thickness 5mins 26secs	4 mm slice thickness 6mins

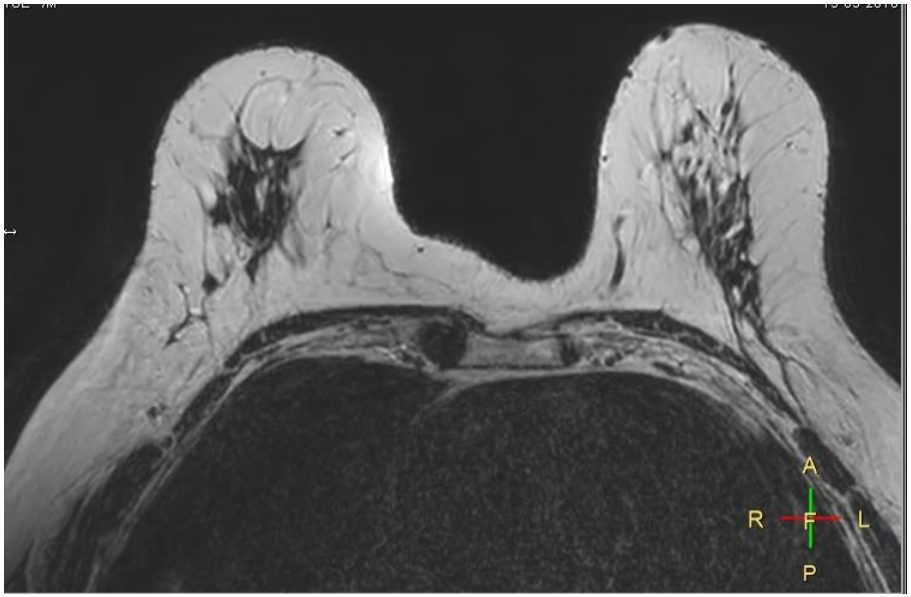

TSE B0


TSE B1000

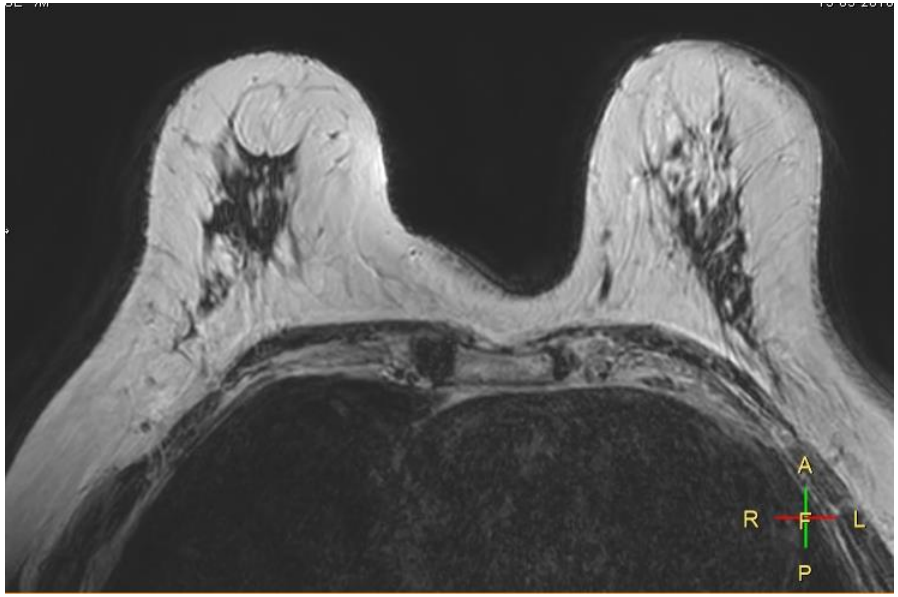

EPI B0


EPI B1000

Breast



CS 12
ACQ 0.8X0.72X1.8
RECON 0.63X0.63X0.9
3min 54



SENSE 3
ACQ 0.8X0.82X1.8
RECON 0.63X0.63X0.9
6min 32

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Patient Comments

Question
1. Have you had an MRI scan before?
2. Were you anxious about having an MRI scan today?
3. Were you offered a choice of coloured room lighting before your scan?
3a. If 'Yes' to the above question, did this make a positive difference to your scan?
4. Were you offered a choice of video images to watch during your scan (only available for some scans)
5. Were you able to watch the video images during your scan?
5a. If 'Yes' to the above question, did this make a positive difference to you?

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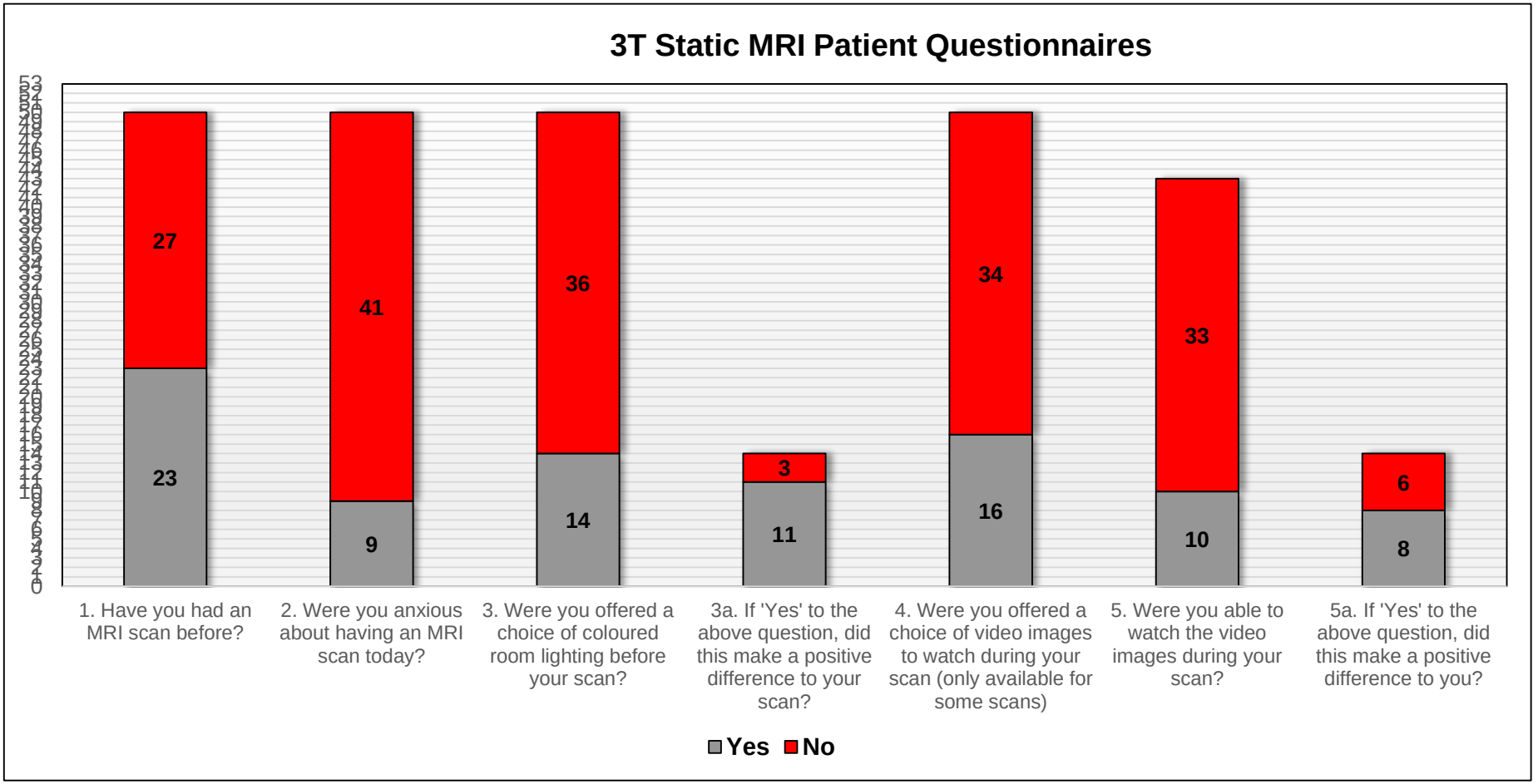
3T Static MRI Patient Questionnaires
27
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1. Have you had an MRI scan before?
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5. Were you able to watch the video images during your scan?
5a. If 'Yes' to the above question, did this make a positive difference to you?
Yes
No

If you have had an MRI scan before, how did your experience today differ from your previous scan(s)?

Scans now are much quicker, the video images take away the impression of the close proximity of the tunnel roof.

The gurney was more comfortable to lay on & the machine much wider & therefore comfortable for my size.

A lot more room/airy/more light

Very quick.

Very positive experience - offered video & radio. Calm, professional & caring staff. Not claustrophobic myself but can see how this would be a positive for anyone anxious or nervous about having an MRI.

Different part of body so difficult to compare, but very clear about process. Friendly & efficient staff & comfortable during scan.

The helmet was less constrictive.

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Results after 3 month trial

MSK and routine brain appointment slots reduced to 20mins

Weekly throughput comparison with previous year:
Additional 17-20 body parts per week

No changes made to

- Breast list
- One stop clinic sessions
- Research
- Abdomen and pelvis (male / female)

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Patient Throughput
2017 compared to 2019

Number of Examinations performed on the 3T							
	Jan	**Feb**	**Apr**	**Jul**	**Aug**	**Sep**	**Total**
3T scans in 2017	455	395	390	310	490	476	**2516**
3T scans in 2019	571	539	503	643	569	604	**3429**
Number increase in scans	**116**	**144**	**113**	**333**	**79**	**128**	**913**
Average Increase	**20.3%**	**26.7%**	**22.5%**	**51.8%**	**13.9%**	**21.2%**	**26.6%**

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Patient Throughput
2017 compared to 2019

Number of Examinations performed on the 3T Grouped by Body Part							
	Jan	**Feb**	**Apr**	**Jul**	**Aug**	**Sep**	**Total**
Shoulders 2017	32	24	21	13	24	26	**140**
Shoulders 2019	42	36	32	38	30	36	**214**
Increase in Shoulder scans	**10**	**12**	**11**	**25**	**6**	**10**	**74**
Average increase in shoulder scans	**23.8%**	**33.3%**	**34.4%**	**65.8%**	**20.0%**	**27.8%**	**34.6%**

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Patient Throughput
2017 to 2019

	% CHANGE
Ankle	46% to 64% increase
Breast	45% to 67% increase
Brain	37% to 76% increase
Knees *	10% to 60%
Shoulder	20% to 65%
Pelvis	40%-80%

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Compressed SENSE….1 year update

- Additional work from local NHS trust
- Additional scanner time available for research

- CS utilised for efficiency

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Prostate Waiting List

Long waiting list at local NHS Trust for staging MRI scans

Agreement to scan prostate examinations using their protocol with no report

Up to 11 patients per week

Protocol:
Sag T2w SFOV
Cor T2w SFOV
Ax T2w SFOV
DWI 500,1000
DWI 2000

Ax T1w whole pelvis

☒ Antispasmodic

☒ I.V. contrast agent

>30mins examination time?

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Prostate Waiting List

	Standard	Compressed Sense
Sag T2w multi-vane	5mins 13	No CS
Cor T2w SFOV	**5min 47**	**3mins**
Ax T2w SFOV	**6mins**	**3min 38**
DWI b500/b1000	5min 48	No CS
DWI b2000	5min 37	No CS
Ax T1w pelvis	**3min 30**	**1min 16**
TOTAL EXAMINATION TIME	**>32 mins**	**25mins**

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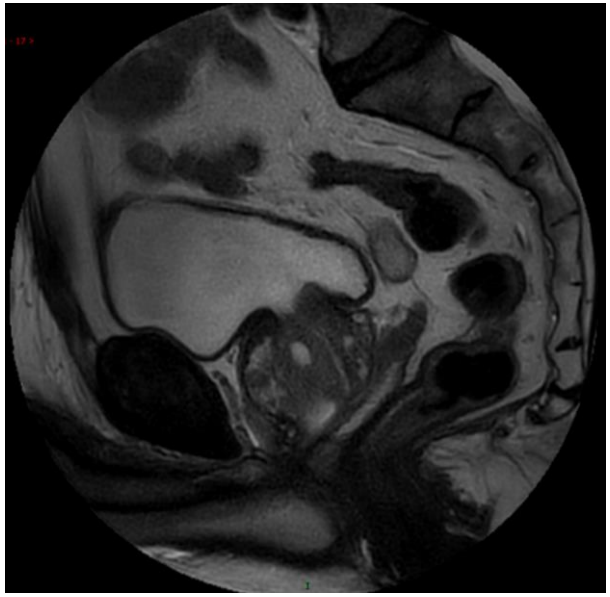
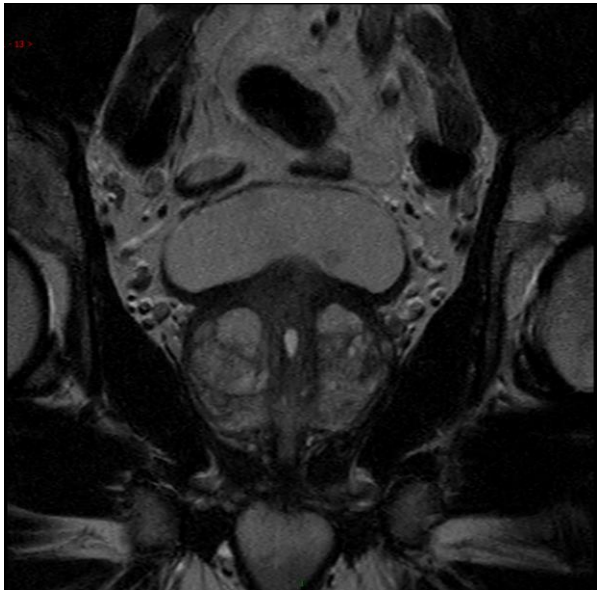
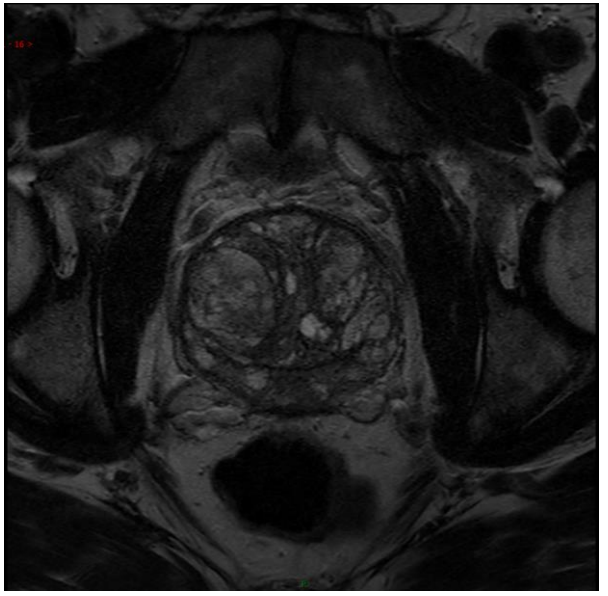
Prostate Waiting List







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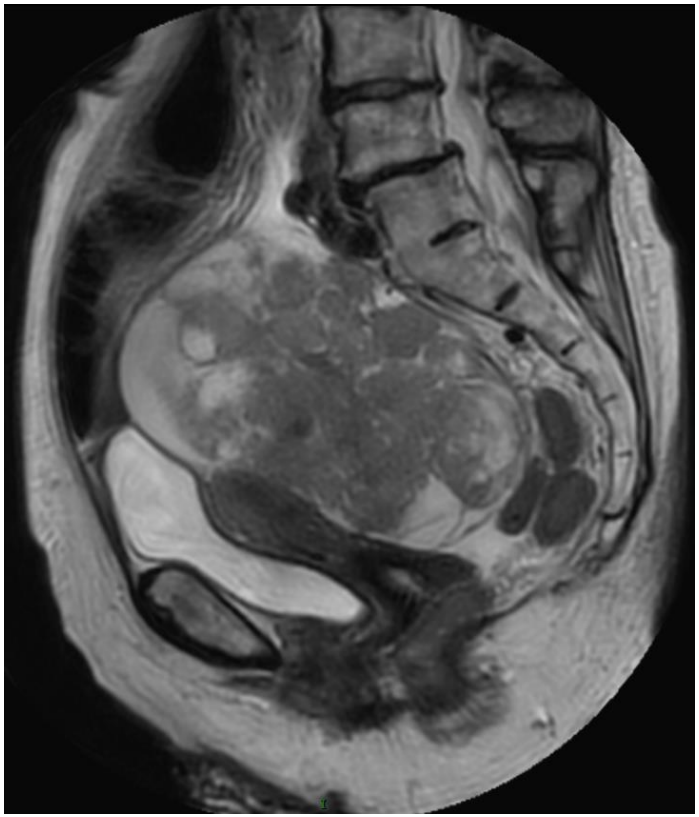
MRI in Ovarian Cancer

The impact of multi-parametric MRI on the Staging and Management of Patients with suspected or confirmed ovarian cancer



Comparing CT and mpMRI

- Diagnostic accuracy
- Cost

Aim to avoid unnecessary cancer surgery or suboptimal surgery options

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MRI in Ovarian Cancer

The impact of multi-parametric MRI on the Staging and Management of Patients with suspected or confirmed ovarian cancer

Protocol:

Sag T2w TSE pelvis
Cor T2w TSE pelvis

Ax T2w chest/abdo/pelvis
Ax T1w DIXON chest/abdo/pelvis
Ax DWI chest/abdo/pelvis
} 3 stacks

Cor T2w chest/abdo LFOV

Dynamic Ax T1w DIXON

Standard: 33mins
CS: 25mins

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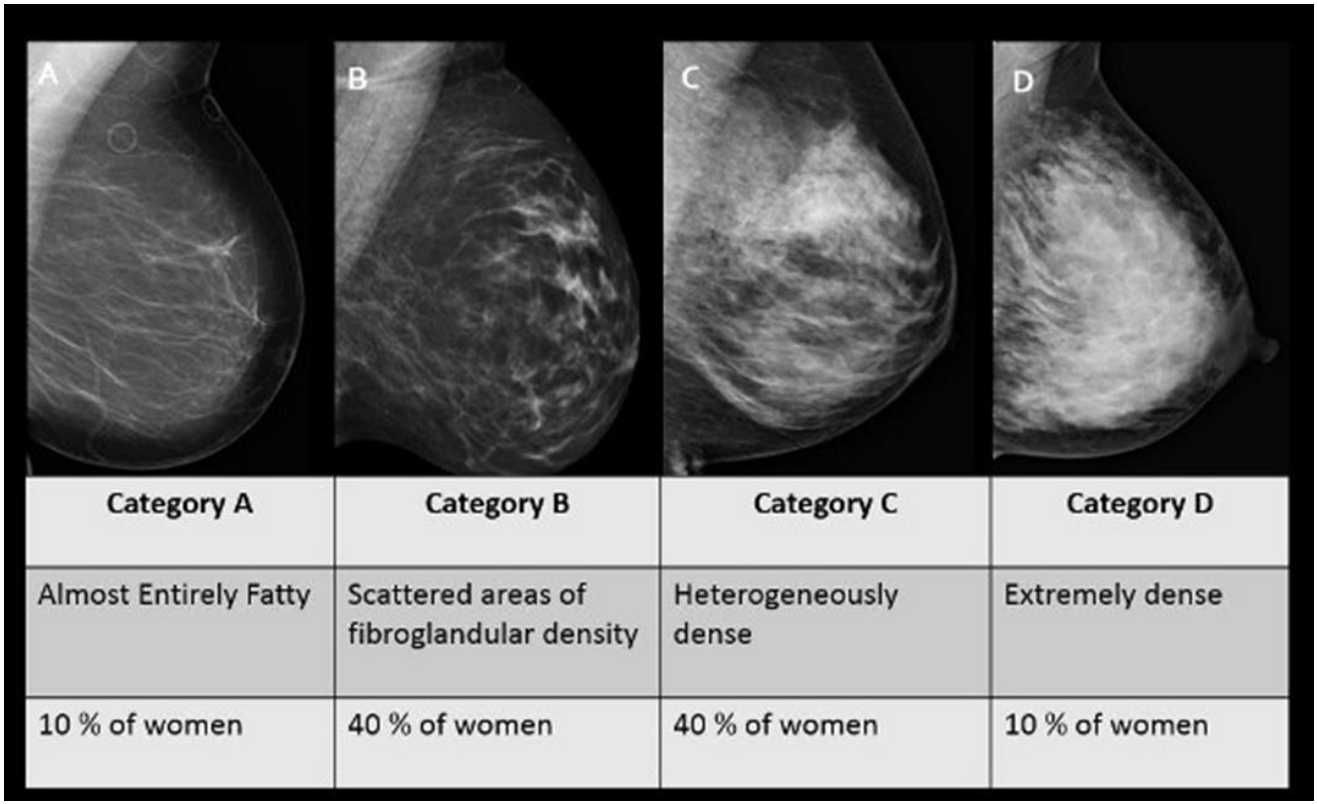
Breast

Abbreviated Breast Protocol For Imaging Dense Breasts



Category A	Category B	Category C	Category D
Almost Entirely Fatty	Scattered areas of fibroglandular density	Heterogeneously dense	Extremely dense
10 % of women	40 % of women	40 % of women	10 % of women

https://www.uwhealth.org/files/uwhealth/images/breast_care/dense-breast-tissue-chart-600.jpg

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Abbreviated Breast Protocol

Alternatives to routine mammogram:

- Hand held or automated ultrasound
- Contrast enhanced spectral mammography
- Contrast enhanced MRI (routine clinical scanning protocol)

Abbreviated MRI protocol:

- Only for patients with dense breasts at routine mammography screening
- Age 50-70
- MRI supplementary to routine mammograms

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Abbreviated Breast Protocol

<10 min scan time
20 min appointment

Axial T2w TSE (2D)

Dynamic C.E. Dixon
3 phases (pre + 2 post)
60sec dynamic time
recon: MIP
Subtraction

Standard: 12mins
CS: 5min 40mins

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Compressed SENSE….1 year update

- Shorter examination times for routine scans
- Increased throughput
- Additional local waiting list work
- More time available for research studies
- Minimise scan time for long research protocol
- Maintain patient satisfaction

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Thank you

Statistics - Fiona Deane

Patient questionnaire analysis - Karen Hackling-Searle

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