

 **Royal Brompton & Harefield** 
NHS Foundation Trust

A lifetime of specialist care

**Assessment of Ventricular
Function**
Dr. Alison Duncan
MB BS BSc MRCP PhD

Royal Brompton Hospital


2, 3 & 4, 5 & 6, 7 & 8, 9 & 10, 11 & 12, 13 & 14, 15 & 16, 17 & 18, 19 & 20, 21 & 22, 23 & 24, 25 & 26, 27 & 28, 29 & 30, 31 & 32, 33 & 34, 35 & 36, 37 & 38, 39 & 40, 41 & 42, 43 & 44, 45 & 46, 47 & 48, 49 & 50, 51 & 52, 53 & 54, 55 & 56, 57 & 58, 59 & 60, 61 & 62, 63 & 64, 65 & 66, 67 & 68, 69 & 70, 71 & 72, 73 & 74, 75 & 76, 77 & 78, 79 & 80, 81 & 82, 83 & 84, 85 & 86, 87 & 88, 89 & 90, 91 & 92, 93 & 94, 95 & 96, 97 & 98, 99 & 100, 101 & 102, 103 & 104, 105 & 106, 107 & 108, 109 & 110, 111 & 112, 113 & 114, 115 & 116, 117 & 118, 119 & 120, 121 & 122, 123 & 124, 125 & 126, 127 & 128, 129 & 130, 131 & 132, 133 & 134, 135 & 136, 137 & 138, 139 & 140, 141 & 142, 143 & 144, 145 & 146, 147 & 148, 149 & 150, 151 & 152, 153 & 154, 155 & 156, 157 & 158, 159 & 160, 161 & 162, 163 & 164, 165 & 166, 167 & 168, 169 & 170, 171 & 172, 173 & 174, 175 & 176, 177 & 178, 179 & 180, 181 & 182, 183 & 184, 185 & 186, 187 & 188, 189 & 190, 191 & 192, 193 & 194, 195 & 196, 197 & 198, 199 & 200, 201 & 202, 203 & 204, 205 & 206, 207 & 208, 209 & 210, 211 & 212, 213 & 214, 215 & 216, 217 & 218, 219 & 220, 221 & 222, 223 & 224, 225 & 226, 227 & 228, 229 & 230, 231 & 232, 233 & 234, 235 & 236, 237 & 238, 239 & 240, 241 & 242, 243 & 244, 245 & 246, 247 & 248, 249 & 250, 251 & 252, 253 & 254, 255 & 256, 257 & 258, 259 & 260, 261 & 262, 263 & 264, 265 & 266, 267 & 268, 269 & 270, 271 & 272, 273 & 274, 275 & 276, 277 & 278, 279 & 280, 281 & 282, 283 & 284, 285 & 286, 287 & 288, 289 & 290, 291 & 292, 293 & 294, 295 & 296, 297 & 298, 299 & 300, 301 & 302, 303 & 304, 305 & 306, 307 & 308, 309 & 310, 311 & 312, 313 & 314, 315 & 316, 317 & 318, 319 & 320, 321 & 322, 323 & 324, 325 & 326, 327 & 328, 329 & 330, 331 & 332, 333 & 334, 335 & 336, 337 & 338, 339 & 340, 341 & 342, 343 & 344, 345 & 346, 347 & 348, 349 & 350, 351 & 352, 353 & 354, 355 & 356, 357 & 358, 359 & 360, 361 & 362, 363 & 364, 365 & 366, 367 & 368, 369 & 370, 371 & 372, 373 & 374, 375 & 376, 377 & 378, 379 & 380, 381 & 382, 383 & 384, 385 & 386, 387 & 388, 389 & 390, 391 & 392, 393 & 394, 395 & 396, 397 & 398, 399 & 400, 401 & 402, 403 & 404, 405 & 406, 407 & 408, 409 & 410, 411 & 412, 413 & 414, 415 & 416, 417 & 418, 419 & 420, 421 & 422, 423 & 424, 425 & 426, 427 & 428, 429 & 430, 431 & 432, 433 & 434, 435 & 436, 437 & 438, 439 & 440, 441 & 442, 443 & 444, 445 & 446, 447 & 448, 449 & 450, 451 & 452, 453 & 454, 455 & 456, 457 & 458, 459 & 460, 461 & 462, 463 & 464, 465 & 466, 467 & 468, 469 & 470, 471 & 472, 473 & 474, 475 & 476, 477 & 478, 479 & 480, 481 & 482, 483 & 484, 485 & 486, 487 & 488, 489 & 490, 491 & 492, 493 & 494, 495 & 496, 497 & 498, 499 & 500, 501 & 502, 503 & 504, 505 & 506, 507 & 508, 509 & 510, 511 & 512, 513 & 514, 515 & 516, 517 & 518, 519 & 520, 521 & 522, 523 & 524, 525 & 526, 527 & 528, 529 & 530, 531 & 532, 533 & 534, 535 & 536, 537 & 538, 539 & 540, 541 & 542, 543 & 544, 545 & 546, 547 & 548, 549 & 550, 551 & 552, 553 & 554, 555 & 556, 557 & 558, 559 & 560, 561 & 562, 563 & 564, 565 & 566, 567 & 568, 569 & 570, 571 & 572, 573 & 574, 575 & 576, 577 & 578, 579 & 580, 581 & 582, 583 & 584, 585 & 586, 587 & 588, 589 & 590, 591 & 592, 593 & 594, 595 & 596, 597 & 598, 599 & 600, 601 & 602, 603 & 604, 605 & 606, 607 & 608, 609 & 610, 611 & 612, 613 & 614, 615 & 616, 617 & 618, 619 & 620, 621 & 622, 623 & 624, 625 & 626, 627 & 628, 629 & 630, 631 & 632, 633 & 634, 635 & 636, 637 & 638, 639 & 640, 641 & 642, 643 & 644, 645 & 646, 647 & 648, 649 & 650, 651 & 652, 653 & 654, 655 & 656, 657 & 658, 659 & 660, 661 & 662, 663 & 664, 665 & 666, 667 &

Circumferential fibres

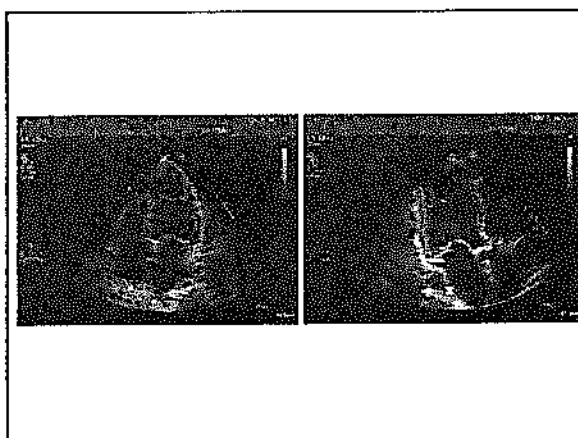
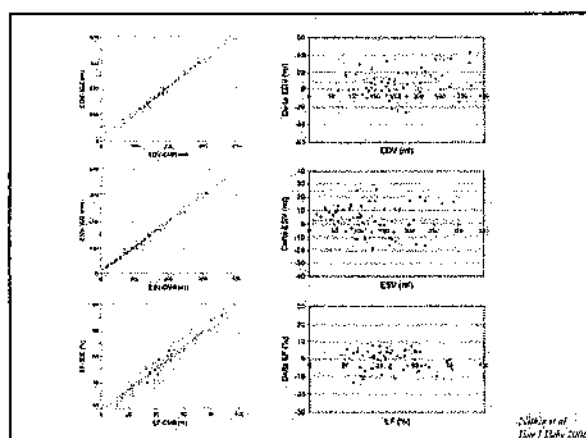
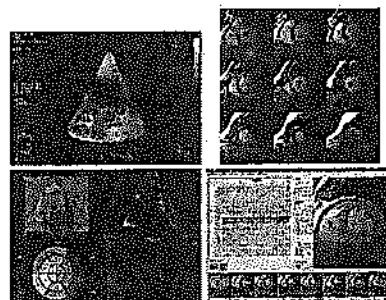


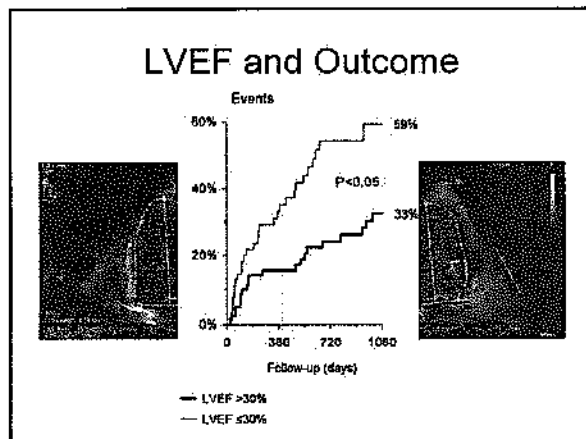
Calculation of LVEF



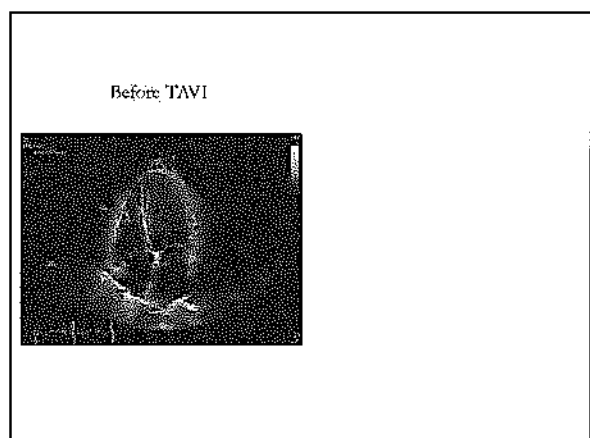
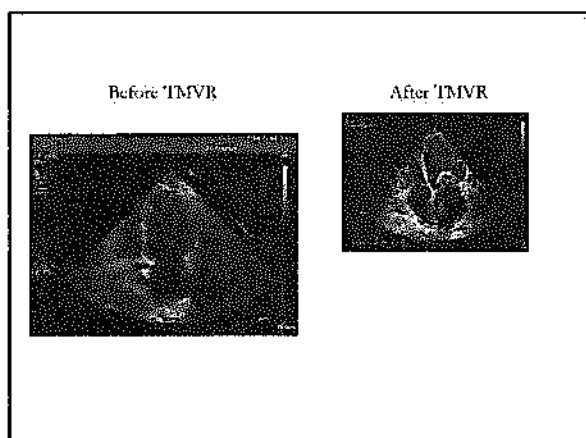
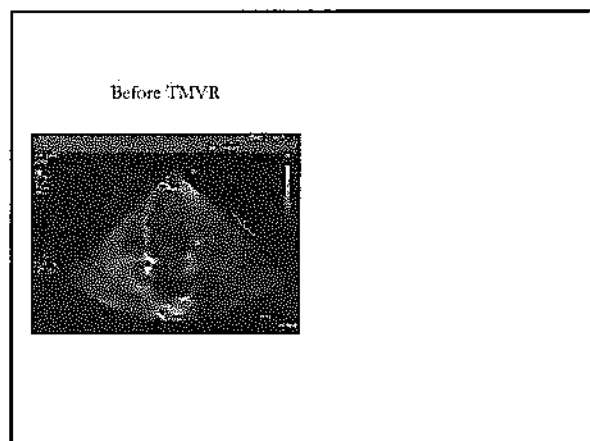
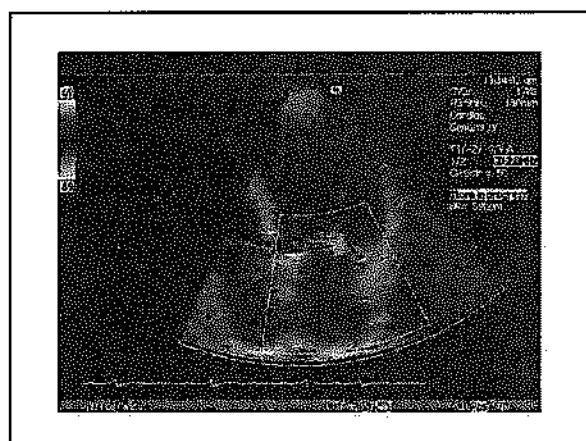
- Modified biplane Simpson's rule
- Measures EDV and ESV (ml)
- Calculated EF (%) $\frac{EDV - ESV}{EDV} \times 100$

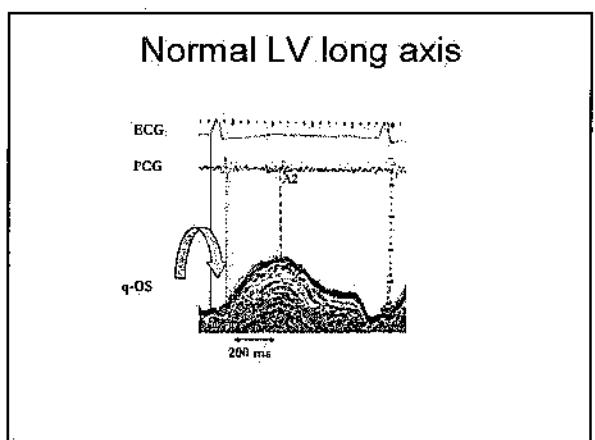
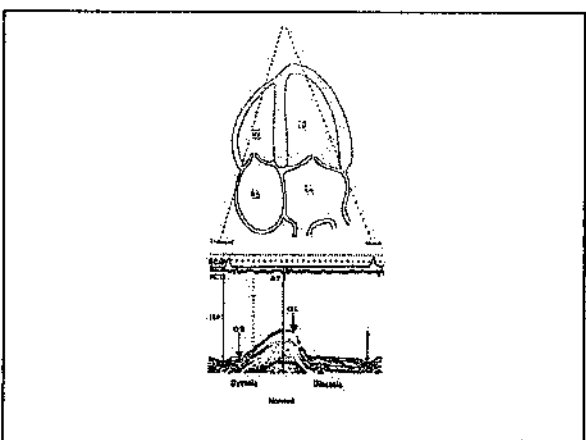
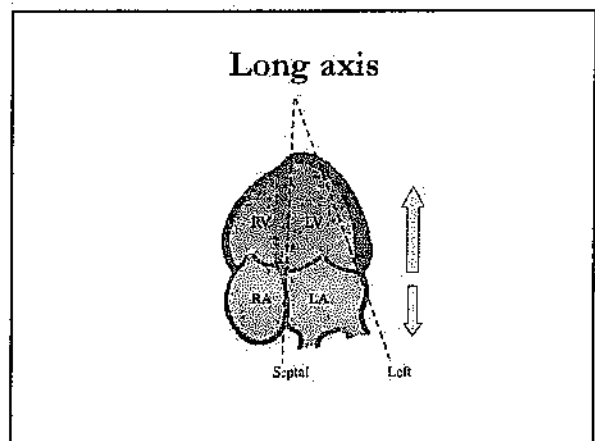
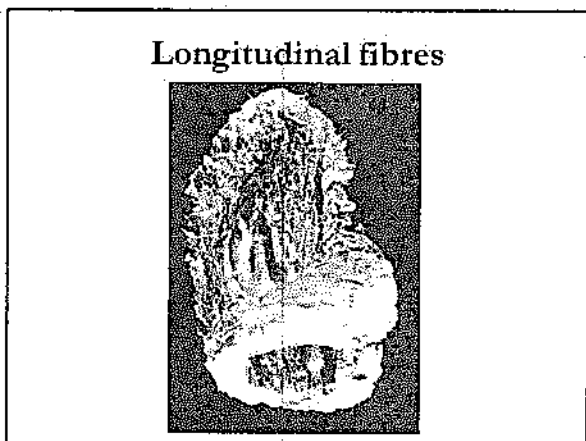
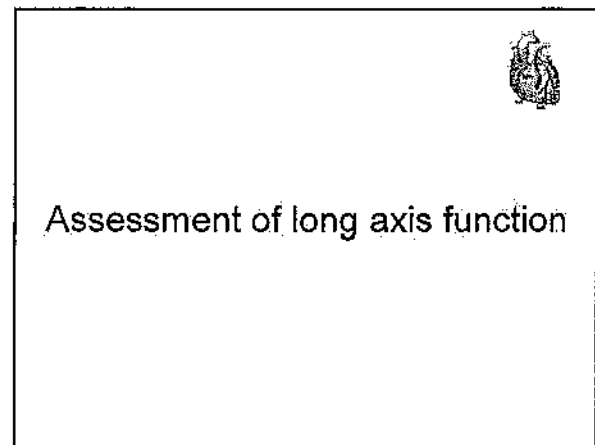
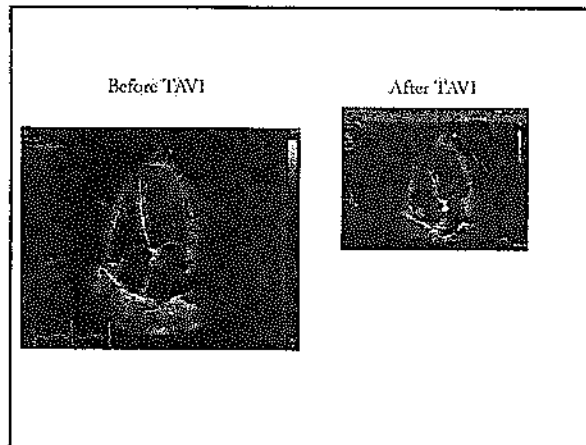
3D Assessment of LV function



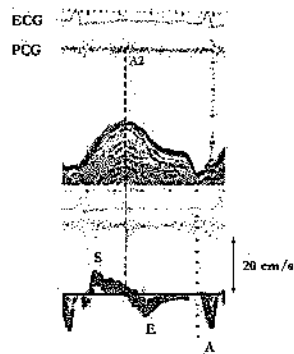


LVEF is NOT systolic function

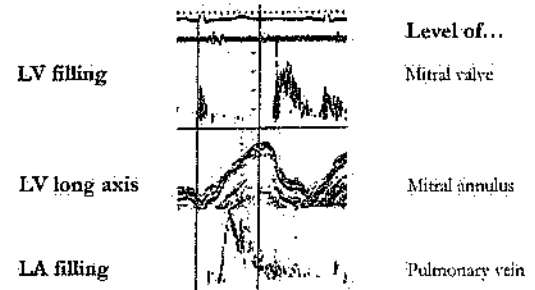




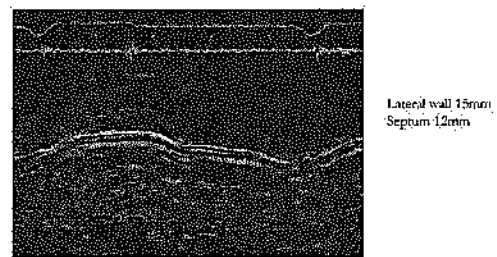
Normal LV long axis velocity



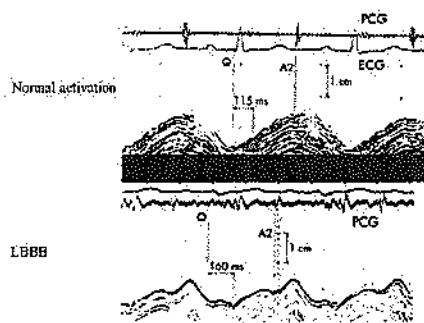
Relation between long axis and LA & LV filling



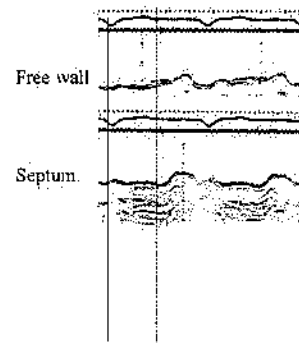
Restrictive LV disease



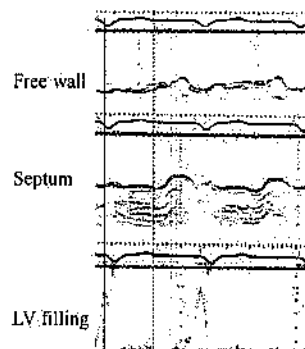
Intermittent LBBB



Severe LV long axis asynchrony



Severe LV long axis asynchrony

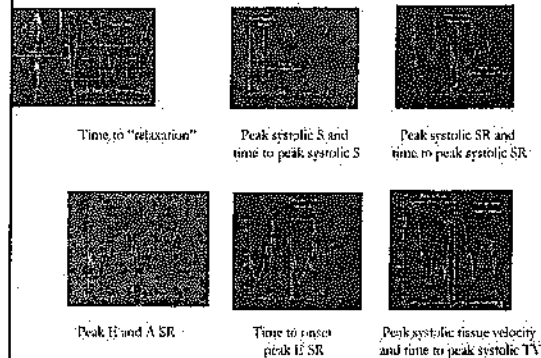


Strain and Strain Rate

- Measures of myocardial deformation
- Uses
 - Assessment of resting LV and RV function
 - Myocardial viability during low-dose dobutamine infusion
 - Stress testing for ischaemia
 - Follow up of treatment response
- Limitations
 - Evidence base is limited
 - Technically challenging
 - Clinical availability
 - Susceptible to artefact



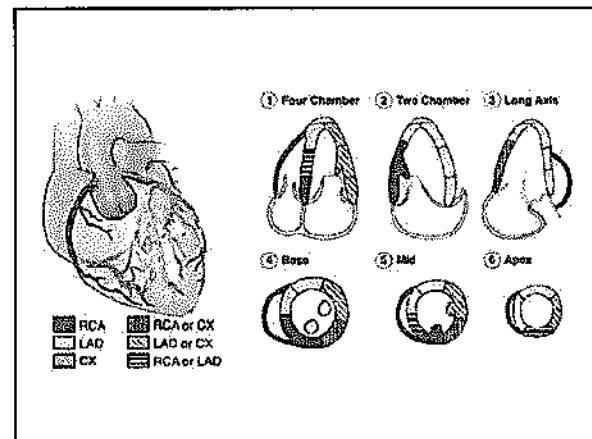
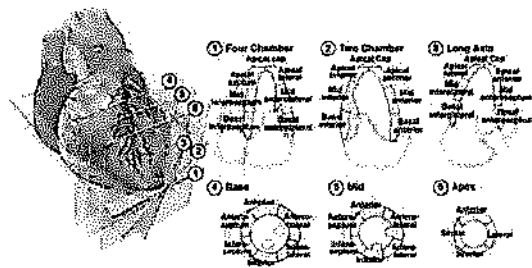
What to Measure?



Assessment of regional wall motion abnormalities



17-segment model



Wall motion score analysis

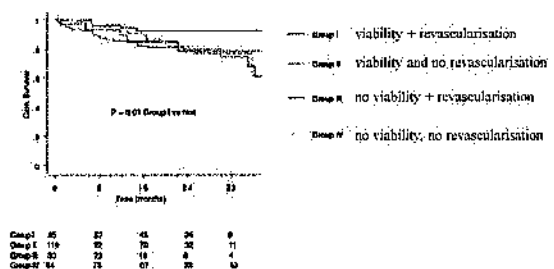
ASE criteria

Schiller et al. J Am Soc Echocardiogr 1989;2:358-367

Wall motion score

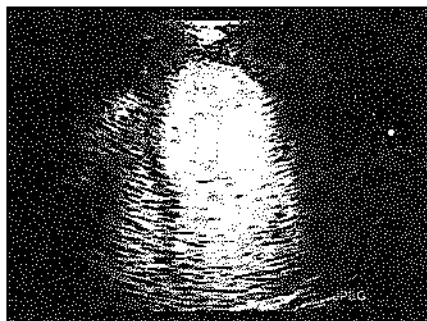
- 1 normal ($\uparrow$ systolic thickness $>50\%$)
- 2 hypokinesis ($\uparrow$ systolic thickness $<40\%$)
- 3 akinesis ($\uparrow$ systolic thickness $<10\%$)
- 4 dyskinesis (outward systolic motion + wall thinning)
- 5 aneurysmal (outward systolic systole, wall thinning, diastolic deformation)

Viability During DSE Predicts Survival



Ufret et al. JACC 1995;32:221-6

Use of LV contrast



M-mode assessment of LV function



M-mode assessment of LV function

- Amplitude
- Velocities (shortening and lengthening)
- Timing
- Incoordination

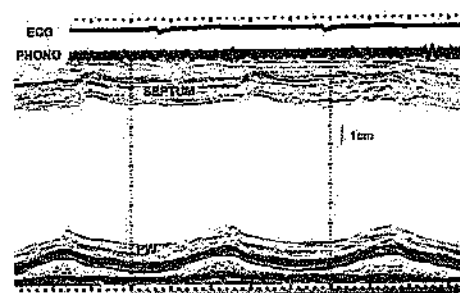
Minor axis



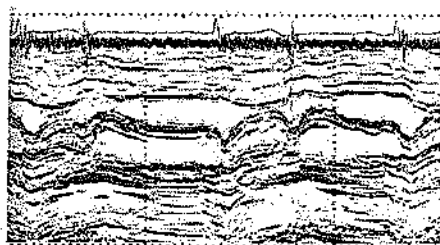
Normal values for cardiac chambers

M-mode parameter	Range
LV EDD (cm)	4.0 - 5.6 cm
LV ESD (cm)	2.0 - 4.0 cm
I/V S diastole (cm)	0.7 - 1.2 cm
PW diastole (cm)	0.7 - 1.2 cm

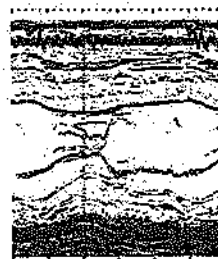
DCM



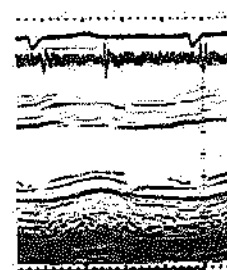
SAM

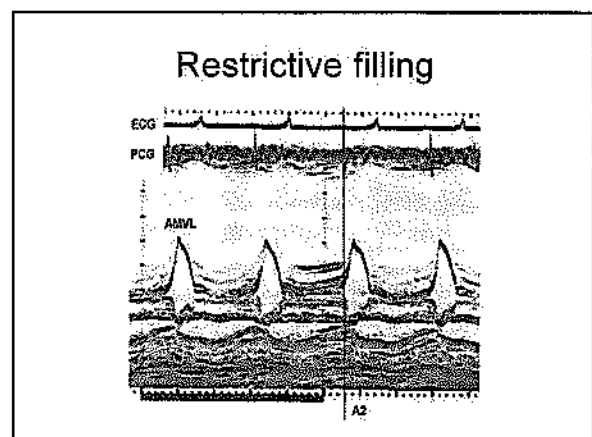
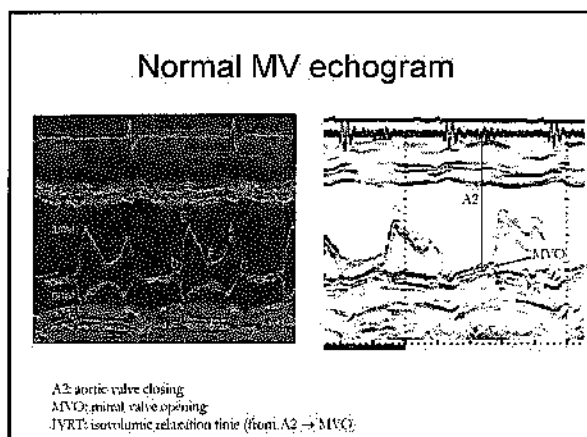
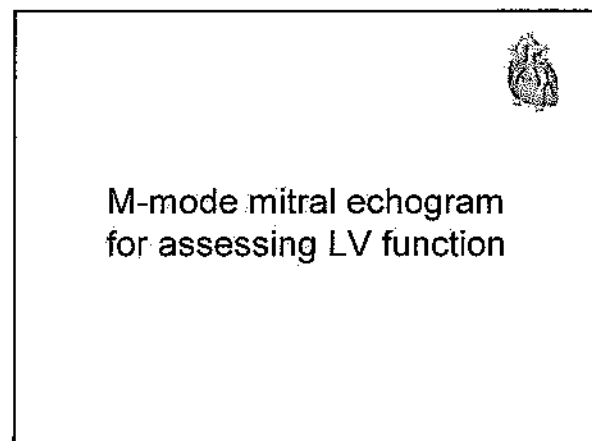
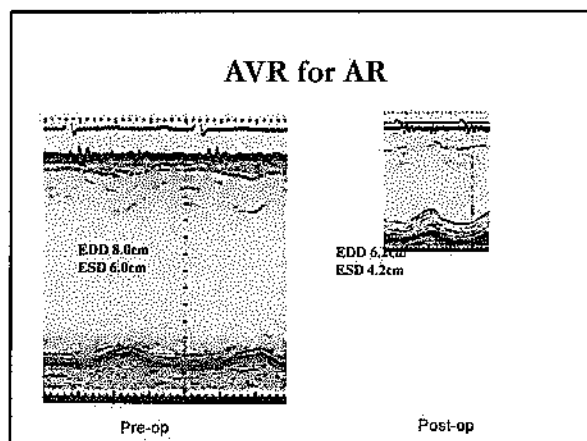
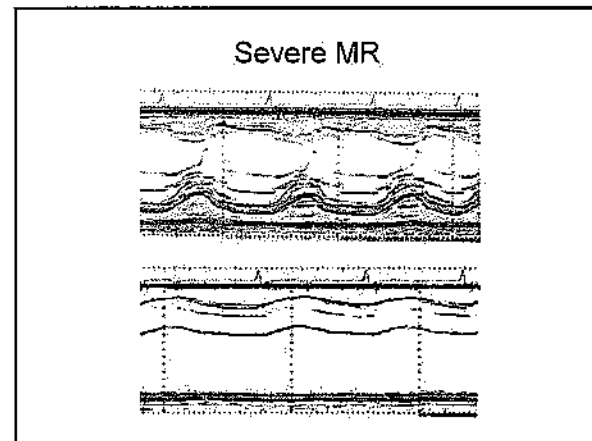
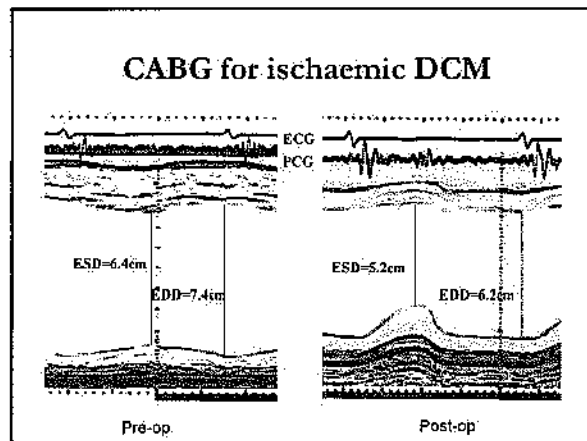


HCM

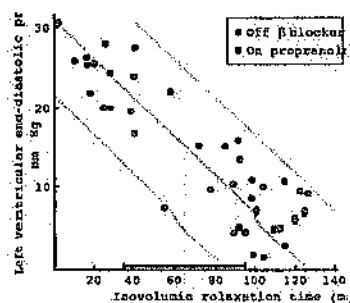


Amyloid





Relation between IVRT and LVEDP



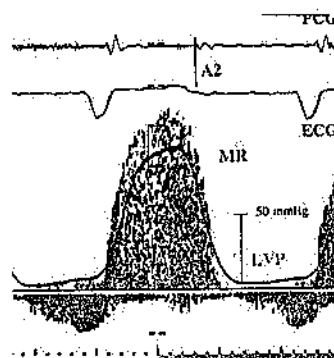
Sharma et al. Heart 2001;85:271-275



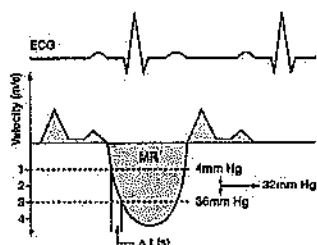
Doppler Assessment of LV function

Doppler Assessment of LV function

1. Peak dP/dt
2. Stroke volume
3. Cardiac output

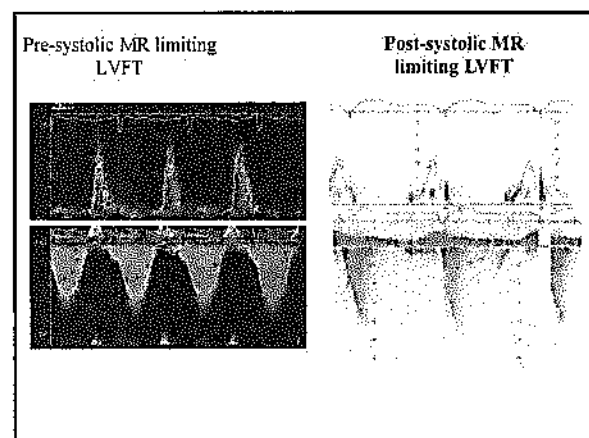
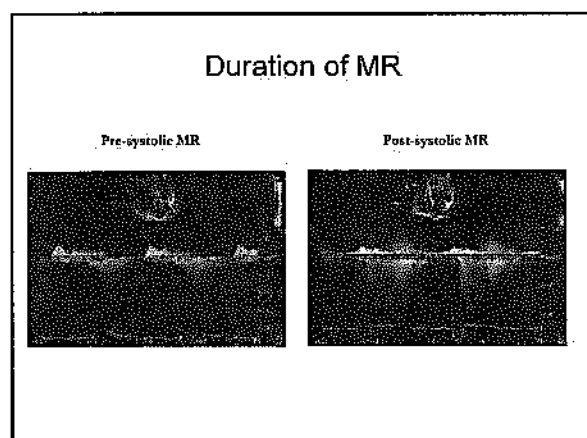
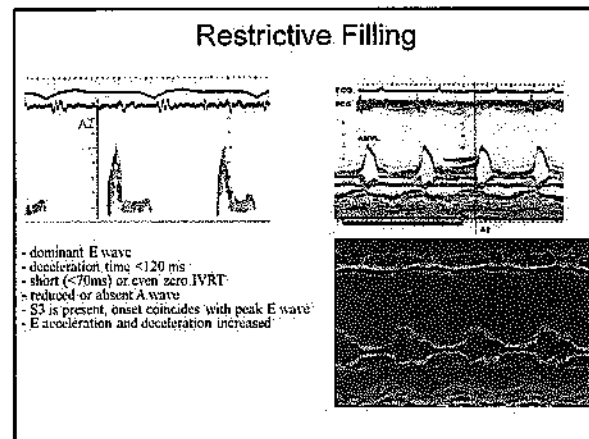
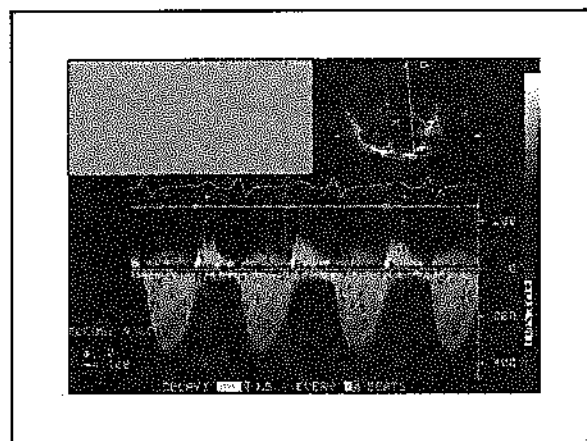
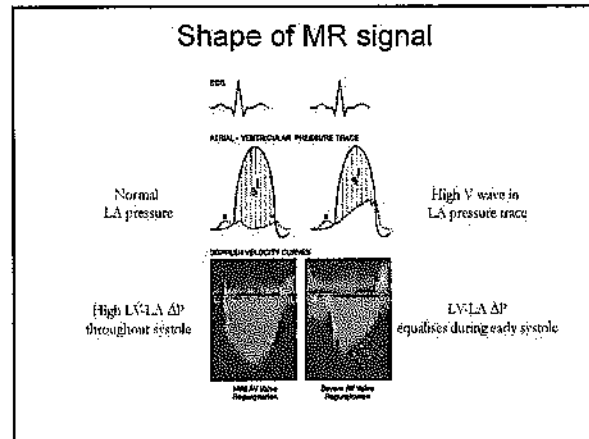
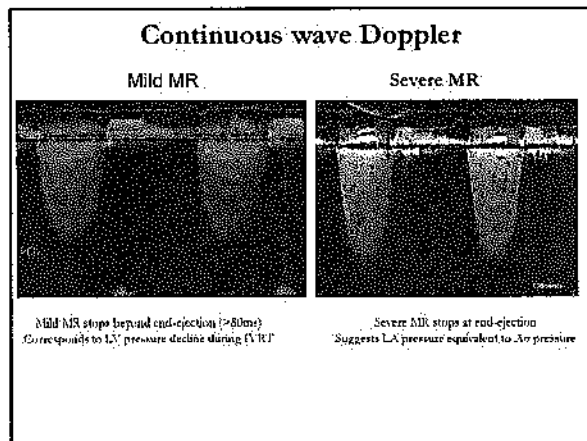


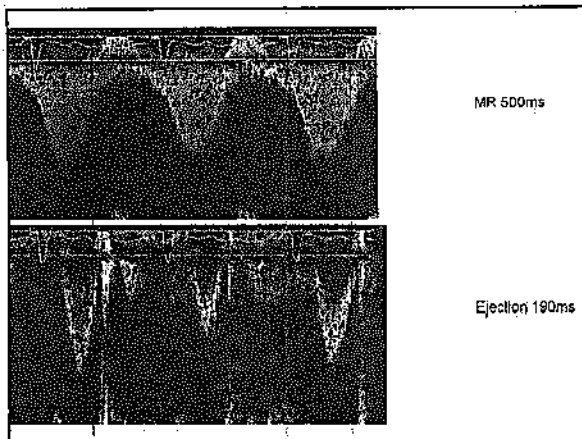
Calculation of peak dP / dt



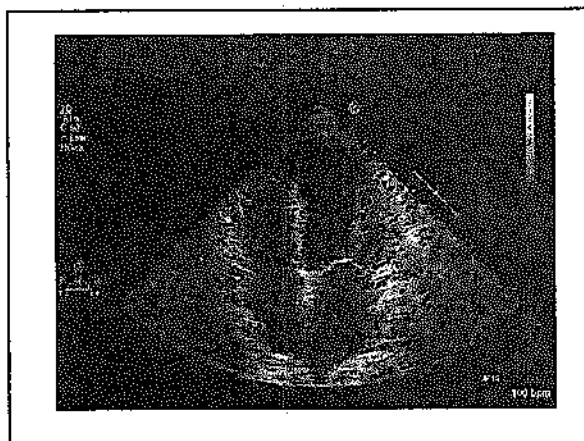
Clinical significance of dP/dt

LV systolic function	Time for LV to generate 32mmHg	dP/dt (mmHg/sec)
Normal	<27ms	>1200
Mild-moderate dysfunction	27-40ms	800-1200
Severe dysfunction	>40ms	<800

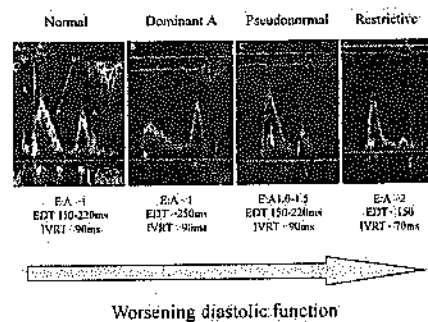




Assessing LV function: diastolic filling



Examples of different LV filling patterns



Assessing LV ventricular function: BSE guidelines

Descriptive terms and statements

Assessing LV function....	
1. Cavity size	Normal, dilated, small
2. Wall thickness	Normal, concentric LVH, asymmetric LVH
3. Ventricular mass	Normal, borderline, increased
4. Ventricular shape	Normal, aneurysmal, pseudoaneurysmal
5. Global systolic function	Normal, low normal, decreased (mild, moderate, severe)

Descriptive terms and statements

<i>Assessing LV function....</i>	
6. Regional systolic function	Normal, hypokinetic, akinetic, dyskinetic, scar, asynchronous
7. Diastolic filling	Normal, abnormal (impaired relaxation, pseudonormal, restrictive), elevated LA / end-diastolic pressure
8. LVOT	No obstruction, septal hypertrophy, sub-aortic membrane, SAM
9. Thrombus	Present / absent
10. Mass (tumour)	Present / absent

Diagnostic statements

Appearances suggestive of....

- Myocardial infarction
- Hypertrophic cardiomyopathy
- Dilated cardiomyopathy
- Restrictive cardiomyopathy
- Hypertensive heart disease
- Infiltrative heart disease
- LV volume overload
- Other

Measurements and calculations

	<i>Measure</i>	<i>Calculate</i>
1. LV cavity size and systolic function	LVEDD, LVESD, LVEDV, LVESV	FS, EF
2. LV wall thickness	IVSd, IVSs, PWd, PWs	
3. LVOT	LVOT diameter	LVOT area
4. LVOT outflow	V _{max} , VTI	SV
5. LV filling	IVRT, EDT, E, A	E/A ratio

Conclusion

- In the assessment of LV function....
- LV systolic *and* diastolic function are important
- Forget not that the LV has both a minor axis and a long axis!