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Ejection fraction

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In cardiovascular physiology, **ejection fraction** ($\mathbf{E_f}$) is the fraction of blood pumped out of the right and left ventricles with each heart beat. The term *ejection fraction* applies to both the right and left ventricles; one can speak equally of the *left ventricular ejection fraction* (**LVEF**) and the *right ventricular ejection fraction* (**RVEF**). RVEF and LVEF may vary widely from one another incumbent upon physiologic state. Ventricular Dyssynchrony represents pathology in which the LVEF and RVEF combined may be less than 100%. Without a qualifier, the term *ejection fraction* refers specifically to that of the left ventricle. Its reverse operation is the injection fraction.

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Overview

By definition, the volume of blood within a ventricle immediately before a contraction is known as the end-diastolic volume. Similarly, the volume of blood left in a ventricle at the end of contraction is end-systolic volume. The difference between end-diastolic and end-systolic volumes is the stroke volume, the volume of blood ejected with each beat. Ejection fraction (E_f) is the fraction of the end-diastolic volume that is ejected with each beat; that is, it is stroke volume (SV) divided by end-diastolic volume (EDV):

$$E_f = \frac{SV}{EDV} = \frac{EDV - ESV}{EDV}$$

Normal values

In a healthy 70-kg (154-lb) man, the SV is approximately 70 ml and the left ventricular EDV is 120 ml, giving an ejection fraction of 70/120, or 0.58 (58%).

Right ventricular volumes being roughly equal to those of the left ventricle, the ejection fraction of the right ventricle is normally equal to that of the left ventricle within narrow limits.

Measure	Typical value	Normal range
end-diastolic volume (EDV)	120 ml[1]	65□ - 240 ml[1]
end-systolic volume (ESV)	50 ml[1]	16 - □143 ml[1]
stroke volume (SV)	70 ml	55 - 100 ml
ejection fraction (E_f)	58%	55 to 70%[2]
heart rate (HR)	72 bpm	
cardiac output (CO)	4.9 L/minute	4.0 - 8.0 L/min[3]

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Healthy individuals typically have ejection fractions between 50% and 65%.[4] However, normal values depend upon the modality being used to calculate the ejection fraction, and some sources consider an ejection fraction of 55-75% to be normal. Damage to the muscle of the heart (myocardium), such as that sustained during myocardial infarction or in cardiomyopathy, impairs the heart's ability to eject blood and therefore reduces ejection fraction. This reduction in the ejection fraction can manifest itself clinically as heart failure.

The ejection fraction is one of the most important predictors of prognosis; those with significantly reduced ejection fractions typically have poorer prognoses. However, recent studies have indicated that a preserved ejection fraction does not mean freedom from risk.[5][6]

The QT interval as recorded on a standard Electrocardiogram is generally agreed to be an exemplary display of depolarization of the ventricles. Widening of the QT interval is a reliable and inexpensive method in determination of mismatched flow states between the RV and LV.

Measurement

Ejection fraction is commonly measured by echocardiography, in which the volumes of the heart's chambers are measured during the cardiac cycle. Ejection fraction can then be obtained by dividing stroke volume by end-diastolic volume as described above.

Accurate volumetric measurement of performance of the right and left ventricles of the heart is inexpensively and routinely echocardiographically interpreted worldwide as a ratio of Dimension between the ventricles in Systole and Diastole. For example, a ventricle in greatest dimension could measure 6cm while in least dimension 4cm. Measured and easily reproduced beat to beat for ten or more cycles, this ratio may represent a physiologically normal EF of 60%. Mathematical expression of this ratio can then be interpreted as the greater half as Cardiac Output and the lesser half as Cardiac input.

Other methods of measuring ejection fraction include cardiac MRI, fast scan cardiac computed axial tomography (CT) imaging, ventriculography, Gated SPECT, and the MUGA scan. A MUGA scan involves the injection of a radioisotope into the blood and detecting its flow through the left ventricle. The historical gold standard for the measurement of ejection fraction is ventriculography.

See also

- Cardiac output
- Heart failure

References

1. ^ ***a b c d*** Assessment of Left Ventricular Parameters Using 16-MDCT: Results Authors: Thomas Schlosser, Konstantin Pagonidis, Christoph U. Herborn, Peter Hunold, Kai-Uwe Waltering, Thomas C. Lauenstein, and Jörg Barkhausen. Am J Roentgenol. 2005;184(3):765-773. Values:
   - **End-diastolic volume** (left ventricular) - average 118 and a range of 65□ - 239ml and
   - **End-systolic volume** (left ventricular) - average 50.1 and range, 16 - □143 mL:
   - Also, ejection fraction was estimated in this study to be average 59.9% ± 14.4%; range, 18 - □76%, but secondary source (see above) is used in this article instead.
2. ^ Page 41 in: O'Connor, Simon (2009). *Examination Medicine (The Examination)*. Edinburgh: Churchill Livingstone. ISBN 0-7295-3911-3.

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3. ^ Edwards Lifesciences LLC > Normal Hemodynamic Parameters – Adult 2009
4. ^ Cotran, Ramzi S.; Kumar, Vinay; Fausto, Nelson; Nelso Fausto; Robbins, Stanley L.; Abbas, Abul K. (2005). *Robbins and Cotran pathologic basis of disease*. St. Louis, Mo: Elsevier Saunders. pp. 602. ISBN 0-7216-0187-1.
5. ^ Owan TE, Hodge DO, Herges RM, Jacobsen SJ, Roger VL, Redfield MM (July 2006). "Trends in prevalence and outcome of heart failure with preserved ejection fraction". *N. Engl. J. Med.* **355** (3): 251–9. doi:10.1056/NEJMoa052256. PMID 16855265. http://content.nejm.org/cgi/pmidlookup?view=short&pmid=16855265&promo=ONFLNS19.
6. ^ Bhatia RS, Tu JV, Lee DS, *et al.* (July 2006). "Outcome of heart failure with preserved ejection fraction in a population-based study". *N. Engl. J. Med.* **355** (3): 260–9. doi:10.1056/NEJMoa051530. PMID 16855266. http://content.nejm.org/cgi/pmidlookup?view=short&pmid=16855266&promo=ONFLNS19.