International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

Determination of the C-LDL SERIC Concentration Comparison of a Direct Method and the Formula of Friedwald

Hicham Chemsi[1, α], Samir Ibenmoussa[1], Naima Khlil[1]

[1]Biochemistry Laboratory, LC-BENS Research Laboratory, Casablanca FMPC Faculty of Medicine and Pharmacy, Hassan II University, Casablanca, Morocco

[1]α Biochemistry Laboratory, LC-BENS Research Laboratory, Ibn Rochd Hospital University Of Casablanca, FMPC, Faculty of Medicine and Pharmacy, Hassan II University, Casablanca, Morocco

Abstract: ***Introduction: LDL cholesterol (C-LDL) is the essential lipoprotein marker in assessing the risk of atherosclerosis. In common practice, it is estimated by Friedewald's formula. The objective of this study is to compare the determination of this biochemical parameter using the Friedwald formula against the direct dosage. Patients and methods: This is a cross-sectional study, comparing the results obtained by the direct dosage of C-LDL to those estimated by the Friedwald formula. The data collection was done randomly in accordance with the criteria for including the required variables. The statistical analyses were carried out on the SPSS V10 software at the risk of 5%. Results: A total of 447 patients included 259 (58%) diabetics and 188 (48%) non-diabetics. The median age of the population was 54 [45-64] with a male predominance 54% (S/R H/F-1.1). The average levels of total cholesterol and HDL cholesterol were 1.77 -0.45g/L and 0.44 -0.11g/L, respectively, the median glycerid level was 1.15 [0.87-1.52] g/L. There was no statistically significant difference between the average serum concentrations obtained by the methods studied, the average cholesterol-LDL per calculation of the Friedewald formula was 1.08 - 0.38g/L versus 0.97 - 0.37 g/L of dosed C-LDL (p -0.05). Conclusion: Variations in triglyceride concentrations and total cholesterol showed no impact on LDL-cholesterol values for each of the methods studied.***

Keywords: Cholesterol-LDL, Friedewald Formula, Direct Methods, Comparison

1. Introduction

The assessment of atherogenic risk is based on the assessment of the proportions of atherogenic and antiatherogenic lipoproteins, through the determination of levels of LDL-cholesterol (C-LDL) and HDL cholesterol (C-HDL). C-LDL is a key component of the lipid balance, as the recommendations take into account its value in determining cardiovascular risk management. An accurate dosage of this parameter is necessary. The accuracy of the Friedewald Formula (FF) is closely dependent on the accuracy of the parameters taken into account, total cholesterol (CT), triglycerides (TG), C-HDL. Direct dosing methods are also considered reference methods. The objective of this study is to compare the determination of serum C-LDL concentration by a direct method to the FF's estimate of C-LDL in order to assess analytical performance and to show the value of using one method over the other.

2. Patients and Methods

This is a comparative cross-sectional study conducted at the Biochemistry Laboratory. We analyzed 447 serum samples whose preanalytic phase was followed correctly with a blood sample taken by venous puncture on fasting patients for 12 hours on compliant tubes. After centrifugation and verification of the absence of suspended particles, the samples were distributed in aliquotes and stored according to the terms described on the supplier's instructions regarding the dosage of C-LDL. The inclusion criteria for patients were age, sex, CT, TG, C-HDL, Glycemia and HbA1c. The serum quantitative dosage of lipid balance parameters was performed by enzymatic colorimetry after passing a quality check (2 levels) on Abbott's Architect ci8200. C-LDL was dosed by a direct method called homogeneous and estimated by calculation according to the FF: C-LDL (g/L) - Total cholesterol - C-HDL - TG/5 when triglyceridemia < 3.4 g/L, as indicated in the nomenclature of medical biology acts. The study was limited to this condition (TG<3.4 g/L) to allow the calculation of C-LDL by the FF without error. The statistical analysis is carried out by the software SPSS V10.0 at the risk of 5% to show the different distributions of each parameter compare the averages and finally deduce the correlation between the two methods studied.

3. Results

Our study population was about 447 patients. The median age is 54 [45-64] years with a slight male predominance 238 (54%) and 209 (46%) female. The calculated average of total cholesterol was 1.77±0.45 g/L, the C-HDL is 0.43±0.11g/L with a median triglycerides of 1.15 [0.87-1.52] g/L. The calculated and measured C-LDL averages were 1.08±0.37g/l and 0.98±0.37 g/l, respectively. The results also showed a staff of 258 (58%) diabetics versus 188 (42%) non-diabetics. The calculated average of glyc hemoglobin was 6.3%. (Table I).

Table I: Demographic characteristics and results of biological exploration of the study population

Variables	*Results*
Age (year)	54 [45-64] *
Sex • Male • Female	 238 (54)** 209 (46)**
Total cholesterol (g/L)	1,77 ± 0,45 ***
Triglycerides (g/L)	1,15 [0,87–1,52] *
C-HDL (g/L)	0,43 ± 0,11 ***
C-LDL Calculed (g/L)	1 ,08 ± 0,37 ***

C-LDL Mesured (g/L)	0,98 ± 0,37 ***
Glycemia (g/L)	1,13 [0,92-1,57] *
Glycemia (1,26 g/L)	
• Diabetics	259 (58) **
• Non diabetics	188 (42) **
HbA1c (%)	6,3 [5,7-7,7]

* Median [1Q, 3Q]
** Values expressed in size and percentage
*** Average values - standard deviation

The two distributions of the C LDL dosed and calculated were Gaussian, hence the interest in expressing them on average ± standard deviation (Figures 1.2).

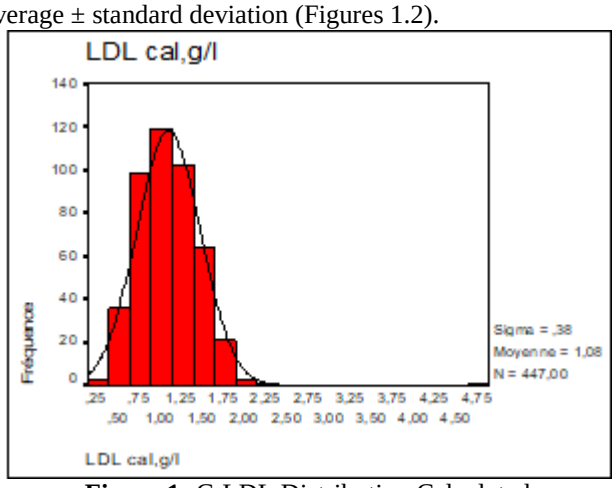

Figure 1: C-LDL Distribution Calculated

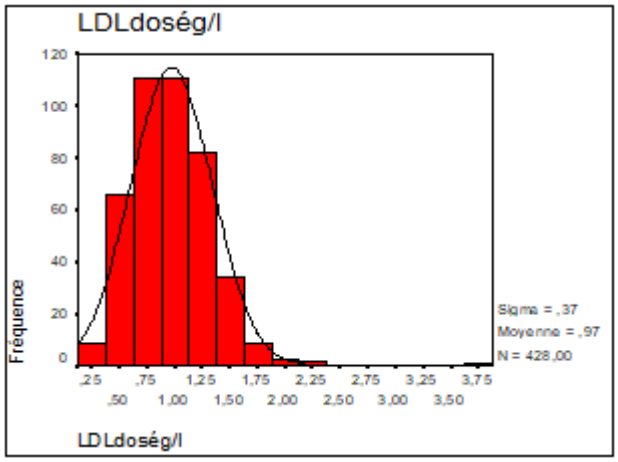

Figure 1 : C-LDL Distribution Mesured

There was no statistically significant difference between the average serum concentrations obtained by the methods studied: C-LDL Friedewald 1.08 ± 0.37 g/L (0.42 ± 0.14 mmol/L) versus 0.97 ± 0.37 g/L (1.16 ± 0.14 mmol/L) C-LDL dosed. Variations in triglycerides and total cholesterol did not show any impact on C-LDL values for each of the methods studied (p>0.05) (Table II).

Table II: Comparison LDL calculated and LDL dosed

Variables	Average ± standart deviation	p
LDL Calculed (g/L)	1,08 ± 0,37	
LDL Mesured (g/L)	0,97 ± 0,37	p> 0,05

Table III shows from statistical use in software (Pearson correlation) that there is a very good link between the two averages of LDL cholesterol dosed and calculated by showing a correlation factor of 0.895. The distribution of LDL-C directly measured as well as the LDL-C calculation using the Friedwald equation (FF) was considered to be graphically normal.

Table III: Correlation between calculated and measured LDL

Corrélations

		LDL cal,g/l	LDLdoség/l
LDL cal,g/l	Corrélation de Pearson	1,000	,895**
	Sig. (bilatérale)	.	,000
	N	447	428
LDLdoség/l	Corrélation de Pearson	,895**	1,000
	Sig. (bilatérale)	,000	.
	N	428	428

**. La corrélation est significative au niveau 0.01 (bilatéral).

The graph shows the different dosage points of our population with those calculated with the FF. The method of calculating the C-LDL level was strongly correlated with a measure with the use of Pearson coefficient and Linear Regression (Figure 3).

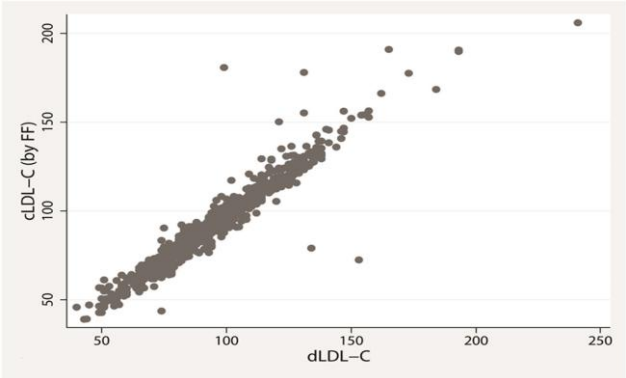

Figure 3: Correlation between calculated and dosed LDL cholesterol showing the different dosing points of the study population

4. Discussion

The purpose of this study is to answer which of the two methods will be used to calculate C-LDL levels, the Friedewald equation (FF) or direct measurement of C-LDL using a homogeneous dosage, to screen our population for the evaluation and follow-up of dyslipidemia. A good correlation between the C-LDL directly measured and calculated by the Friedwald formula has been statistically demonstrated (r = 0.89). This is consistent with other studies, which report a correlation of C-LDL using the C-LDL formula measured by different homogeneous dosage parameters ranging from 0.77 to 0.98 [1]. Significant differences in the results of studies comparing calculations with direct dosages are directly and primarily due to the wide variability in lipid/lipoprotein levels of the population as well as for the different reagents and techniques used for direct dosing. The calculation of LDL-C by the Friedwald formula remains the most widely used method and is widely used in studies for predicting the risk of cardiovascular disease. In adults, many researchers support the direct measurement option only when C-LDL by the formula is unreliable, this usually occurs in the presence of high triglycerides, especially greater than 3.4 g/L [2]. In

Framingham Offspring Study, which studied populations with and without chronic heart disease, most cases with chronic heart disease had the C-LDL level dosed above the recommended target. The researchers concluded that direct measurement of C-LDL levels should be limited only to patients with hypertriglyceridemia (up 3.4 g/L) [3].Several direct methods are currently available to measure C-LDL, but there are no specific spaces assessing their predictive performance against clinical events, the potential benefits of direct dosing may be better accurate as it is not affected by the presence of an increase in triglyceride concentrations [4]. In a study conducted in Algeria, the results of reproducibility yielded coefficients of variation of 3.87% and 3.47% (direct C-LDL) vs. 5.41% and 6.25% (calculated C-LDL). The direct dosage also showed a total error of less than 12% contrary to the calculation [5]. Direct dosing is therefore the only method that meets NCEP's recommendations for analytical performance. The correlation between the two methods on 105 plasma samples for TG-3.4 g/L values is satisfactory with a correlation coefficient r - 0.926. However, the correlation between these two methods is satisfactory for TG values of 3.4 g/L and the FF therefore remains usable [5]. Another study showed that C-LDL by FF differed significantly from direct dosage and the difference was 9.1% ; this resulted not only from the misclassification of many patients with hyperlipidemia, but also from greater differences when they have higher triglyceride levels [6]. Similarly, the largest absolute difference due to the increase in triglycerides between C-LDL using FF and direct dosing resulted in the loss of goal-achieving in half of patients with cardiovascular disease or equivalent cardiovascular disease when the formula calculation was used [7]. In an Indian population, FF use is underestimated from C-LDL levels when TG-2 g/L levels and calculated C-LDL concentrations were below 0.7g/L. In contrast, when the levels of C-LDL dosed were greater than 1.3g/L, the calculation of C-LDL was overestimated in more than 70% of cases. The best C-LDL computational correlation with direct C-LDL dosage was observed at triglyceride levels between 1 and 1.5 g/L [8]. In a recent study of more than 1,000,000 adult samples with TG-4.0g/L, FF use tends to underestimate C-LDL levels compared to direct measurements [9].

5. Conclusion

Our study found that the analytical performance in the accuracy and accuracy of direct C-LDL dosing on our analyzer or calculation with FF met NCEP's recommendations. However, the correlation between these two methods is satisfactory for TG-3.4 g/L values and Friedwald's formula therefore remains usable. The results obtained by this comparison of averages and correlation between the two methods have shown great reliability for assessing atherogenic risks, therefore this formula remains to date a practice in care facilities and an economic advantage in order to reduce the cost of lipid balance.

6. Conflicts of interest

Conflicts of interest: None

References

[1] J. Martins, S.A. Olorunju, L.M. Murray, T.S. Pillay, Comparison of equations for the calculation of LDL-cholesterol in hospitalized patients, Clin. Chim. Acta 444 (2015) 137–142
[2] M. Nauck, G.R. Warnick, N. Rifai, Methods for measurement of LDL-cholesterol: a critical assessment of direct measurement by homogenous assays versus calculation, Clin. Chem. 48 (2002) 236–254
[3] S. Otokozawa, M. Ai, B.F. Asztalos, et al. Direct assessment of plasma low density lipoprotein and high-density lipoprotein cholesterol levels and coronary heart disease: results from the Framingham offspring study, Atherosclerosis 213 (2010) 251–255
[4] Nauck M, Warnick GR, Rifai N. Methods for measurement of LDL-cholesterol: a critical assessment of direct measurement by homogeneous assays versus calculation. Clin Chem 2002; 48:236–254. [PubMed: 11805004]
[5] M. Zendjabil, O. Abbou Diabetes and Metabolism, Vo.41, A78-A79 Published in issue: March2015
[6] K.R. Jun, H.I. Park, S. Chun, H. Park, W.K. MinEffects of total cholesterol and triglyceride on the percentage difference between the LDL-C concentration measured directly and calculated using the Friedewald formula Clin. Chem. Lab. Med., 46 (2008), pp. 371-375
[7] C.C. Lindsey, M.R. Graham, T.P. Johnston, C.G. Kiroff , A. FreshleyA clinical comparison of calculated versus direct measurement of low-density lipoprotein cholesterol level Pharmacotherapy, 24 (2004), pp. 167-172
[8] S. Kannan, S. Mahadevan, B. Ramji, et al.LDL-cholesterol: Friedewald calculated versus direct measurement-study from a large Indian laboratory database Indian J. Endocrinol. Metab. 18 (2014), pp. 502-504
[9] S.S. Martin, M.J. Blaha, M.B. Elshazly, E.A. Brinton, P. P. Toth, J.W. McEvoy, et al. Friedewald-estimated versus directly measured low-density lipoprotein cholesterol and treatment implications J. Am. Coll. Cardiol., 62 (8) (2013), pp. 732-739