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Category:
Scientific Program

Title:
Use of Common Carotid Intima-Media Thickness measured by Ultrasound Echo-tracking in Cardiovascular Risk Stratification before Non-cardiac Surgery in Low-risk Category: A Research Idea

Topic:
Perioperative Medicine

Abstract Text:
Background:

Preoperative cardiac risk stratification algorithms aim to reduce postoperative morbidity and mortality. They typically use a Bayesian approach to identify a low-risk category group who can go for surgery without further testing. A recent study found that three popular prediction models disagreed 29% of the time by which patients were categorized as low risk (<1%) [1]. Hence, an approach to strengthen and optimize the Bayesian risk indices is needed [2]. Common Carotid Intima-Media Thickness (CCIMT) measured by Ultrasound is a surrogate marker for atherosclerosis and quantifies atherosclerotic burden in entire vascular tree. Two variables of particular interest i.e. CCIMT-z score and vascular age help in such quantification [3]. From a clinical series in an outpatient cardiology clinic, information obtained from CCIMT was explored for feasibility in risk stratification.

Methods:

As a part of clinical or wellness care, CCIMT was measured by B-mode ultrasonography using 3-13 MHz linear probe. An accurate method called 'echo-tracking' that relies on automated edge detection by radiofrequency signal processing of ultrasound was used (Figure). From a series of 44 cases, 22 were segregated who would otherwise qualify for low-risk category should they present for preoperative evaluation for noncardiac surgery. CCIMT z scores and percentiles for vascular age were computed based on population-based normal values at different ages in either gender. A multivariate linear regression analysis was done with CCIMT z score as dependent variable and following as independent variables: body mass index (BMI), waist-to-height ratio (WHR), total cholesterol HDL ratio (TC-HDL ratio) and serum vitamin D3 levels. According to American Society of Echocardiography, a CCIMT z score of ≥1.96 equivalent to ≥97.5 percentile is defined as highly abnormal that requires immediate attention and further evaluation.

Results: Mean (SD) for age were 48 years (12) and there were equal number of men and women. Of the independent variables tested, TC-HDL ratio was significantly associated with increased CCIMT z score (p=0.0134). A simple linear regression analysis using only the TC-HDL ratio yielded the model:
IMT_Zscore = -0.1149 + (0.3400 x TC-HDL_Ratio)
The p value for the slope was 0.0033 and correlation coefficient was 0.5976 and R square was 0.3571. There were four cases in this low-risk group who had z score ≥1.96.

Discussion:

CCIMT appears to be useful as part of shared decision making to determine if long-term survival is important with respect to the decision to operate. Preoperative statin therapy and close monitoring with troponin may be considered to reduce immediate perioperative risk. Hence, potential application of CCIMT in cardiac risk stratification appears promising. A suitable model to predict the CCIMT z score using readily available clinical and laboratory variables could be developed in the research setting. In addition, scope of substituting vascular age for chronological age and/or categorizing individuals with Z score ≥1.96 as having severe systemic disease in existing risk stratification algorithms may be explored.
We believe that the suggested approach would provide better insights for future research in the area.

Optional Images:

References:

1. Glance LG, Faden E, Dutton RP, Lustik SJ, Li Y, Eaton MP, Dick AW. Impact of the Choice of Risk Model for Identifying Low-risk Patients Using the 2014 American College of Cardiology/American Heart Association Perioperative Guidelines. Anesthesiology 2018;129:889900.
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USE OF COMMON CAROTID INTIMA-MEDIA THICKNESS MEASURED BY ULTRASOUND ECHO-TRACKING IN CARDIOVASCULAR RISK STRATIFICATION BEFORE NON-CARDIAC SURGERY IN LOW-RISK CATEGORY: A RESEARCH IDEA

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ABSTRACT

Background: Preoperative cardiac risk stratification algorithms aim to reduce postoperative morbidity and mortality. They typically use a Bayesian approach to identify a low-risk category group who can go for surgery without further testing. A recent study found that three popular prediction models disagreed 29% of the time by which patients were categorized as low risk (<1%) [1]. Hence, an approach to strengthen and optimize the Bayesian risk indices is needed [2]. Common Carotid Intima-Media Thickness (CCIMT) measured by Ultrasound is a surrogate marker for atherosclerosis and quantifies atherosclerotic burden in entire vascular tree. Two variables of particular interest i.e. CCIMT-z score and vascular age help in such quantification [3]. From a clinical series in an outpatient cardiology clinic, information obtained from CCIMT was explored for feasibility in risk stratification.

Methods: As a part of clinical or wellness care, CCIMT was measured by B-mode ultrasonography using 3-13 MHz linear probe. An accurate method called 'echo-tracking' that relies on automated edge detection by radiofrequency signal processing of ultrasound was used (Figure). From a series of 44 cases, 22 were segregated who would otherwise qualify for low-risk category should they present for preoperative evaluation for noncardiac surgery. CCIMT z scores and percentiles for vascular age were computed based on population-based normal values at different ages in either gender. A multivariate linear regression analysis was done with CCIMT z score as dependent variable and following as independent variables: body mass index (BMI), waist-to-height ratio (WHR), total cholesterol HDL ratio (TC-HDL ratio) and serum vitamin D3 levels. According to American Society of Echocardiography, a CCIMT z score of ≥1.96 equivalent to ≥97.5 percentile is defined as highly abnormal that requires immediate attention and further evaluation.

Results: Mean (SD) for age were 48 years (12) and there were equal number of men and women. Of the independent variables tested, TC-HDL ratio was significantly associated with increased CCIMT z score (p=0.0134). A simple linear regression analysis using only the TC-HDL ratio yielded the model: IMT_Zscore = -0.1149 + (0.3400 x TC-HDL_Ratio). The p value for the slope was 0.0033 and correlation coefficient was 0.5976 and R square was 0.3571. There were four cases in this low-risk group who had z score ≥1.96

Discussion: CCIMT appears to be useful as part of shared decision making to determine if long-term survival is important with respect to the decision to operate. Preoperative statin therapy and close monitoring with troponin may be considered to reduce immediate perioperative risk. Hence, potential application of CCIMT in cardiac risk stratification appears promising. A suitable model to predict the CCIMT z score using readily available clinical and laboratory variables could be developed in the research setting. In addition, scope of substituting vascular age for chronological age and/or categorizing individuals with Z score ≥1.96 as having severe systemic disease in existing risk stratification algorithms may be explored. We believe that the suggested approach would provide better insights for future research in the area.

1. Glance LG, Faden E, Dutton RP, Lustik SJ, Li Y, Eaton MP, Dick AW. Impact of the Choice of Risk Model for Identifying Low-risk Patients Using the 2014 American College of Cardiology/American Heart Association Perioperative Guidelines. Anesthesiology 2018;129:889-900.
2. Fleisher LA. Preoperative Cardiac Evaluation before Noncardiac Surgery: Reverend Bayes's Risk Indices and Optimal Variables. Anesthesiology. 2018;129(5):867-8
3. Engelen L, Ferreira I, Stehouwer CD, Boutouyrie P, Laurent S, Reference Values for Arterial Measurements C. Reference intervals for common carotid intima-media thickness measured with echotracking: relation with risk factors. Eur Heart J 2013;34:2368-80.

Scanning for CCIMT

- Longitudinal view of CCA
- Tuning Fork Appearance
- Double line sign in far wall of CCA which represent intima and media

INTRODUCTION

Introduction:

- Preoperative cardiac risk stratification algorithms aim to reduce postoperative morbidity and mortality
- They typically use a Bayesian approach to identify a low-risk category group who can go for surgery without further testing
- Separation of *low-risk* (<1%) from *elevated-risk* (≥1%) is the key decision point in the ACC/AHA guidelines for preoperative evaluation for non-cardiac surgery A recent study found that three popular prediction models disagreed 29% of the time by which patients were categorized as low risk (<1%) [1]. The three popular models are
  1. The Revised Cardiac Risk Index (Lee et al. Circulation 1999;100:1043-9.
  2. The American College of Surgeons National Surgical Quality Improvement Program Surgical Risk Calculator (Bilimoria et al. J Am Coll Surg 2013;217:833
  3. Risk calculator for prediction of cardiac risk after surgery. Gupta et al. Circulation 2011;124:381
- Hence, an approach to strengthen and optimize the Bayesian risk indices is needed [2].
- Common Carotid Intima-Media Thickness (CCIMT) measured by ultrasound is a surrogate marker for atherosclerosis and quantifies atherosclerotic burden in entire vascular tree.
- As CCIMT increases with age , absolute values are difficult to interpret in a given individual. Hence, two objective variables of particular interest i.e. CCIMT-z score and vascular age help in such quantification [3].
- From a clinical series in an outpatient cardiology clinic, information obtained from CCIMT was explored for feasibility in risk stratification.

CCIMT (µm) Increases with Age

Standard CCIMT values in Men							*** Standard CCIMT values in Women						
Age	Mean	SD	*	Age	Mean	SD	***	Age	Mean	SD	*	Age	Mean	SD
30	480	84	*	73	703	123	***	30	471	79	*	73	685	115
31	485	85	*	74	708	124	***	31	476	80	*	74	690	116
32	490	86	*	75	714	125	***	32	481	81	*	75	695	116
33	495	87	*	76	719	126	***	33	486	82	*	76	699	117
34	500	88	*	77	724	127	***	34	491	83	*	77	704	118
53	599	105	*	96	823	144	***	53	585	98	*	96	799	134
54	604	106	*	97	828	145	***	54	590	99	*	97	804	135
55	610	107	*	98	833	146	***	55	595	100	*	98	809	135
56	615	108	*	99	838	147	***	56	600	101	*	99	814	136
57	620	109	*	100	844	148	***	57	605	102	*	100	819	137

Concept of z score & Vascular Age

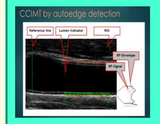
- CCIMT increases progressively with age
- Absolute IMT value may be difficult to interpret in a given individual.
- Hence a better metric in such cases would be z score, the general formula for which is

$$z = \frac{x - \mu}{\sigma}$$

μ = Mean, σ = Standard Deviation

(observed IMT- expected IMT for age and gender) / SD IMT for that age and gender

- Vascular Age The vascular age may be quantified by comparing an individual's IMT against the mean CCIMT (50th percentile) in the standard age-IMT table.



The technique enhances Accuracy & Reliability

Echo-tracking and auto-edge detection

1. Real time radiofrequency processing of ultrasound
2. Region of interest (ROI) is 1.5 cm starting from 1 cm of vertical reference line just proximal to carotid bulb
3. A table along side of image gives measurements of last 6 cardiac cycles
4. Good quality measurement indicators: SD less than 10 and A thick green overlay within ROI
5. The method is inherited by Esaote **ART.LAB** experience and now available in all MyLab series of Esaote (Italy) ultrasound machines

METHODS and RESULTS

Methods: As a part of clinical or wellness care, CCIMT was measured by B-mode ultrasonography using 3-13 MHz linear probe. An accurate method called 'echo-tracking' that relies on automated edge detection by radiofrequency signal processing of ultrasound was used . From a series of 44 cases, 22 were segregated who would otherwise qualify for low-risk category should they present for preoperative evaluation for noncardiac surgery. CCIMT z scores and percentiles for vascular age were computed based on population-based normal values at different ages in either gender. A multivariate linear regression analysis was done with CCIMT z score as dependent variable and following as independent variables: body mass index (BMI), waist-to-height ratio (WHR), total cholesterol HDL ratio (TC-HDL ratio) and serum vitamin D3 level

Risk based on CCIMT Thickness

Z score	Percentile	Cardiac Risk Stratification*
<-0.675	< 25th	lower than the expected
-0.625 to <0.625	25th <75th	Unchanged risk
≥ 0.625 to <1.960	75th to <97.5	Increased risk
≥ 1.960	≥ 97.5th	Very high risk

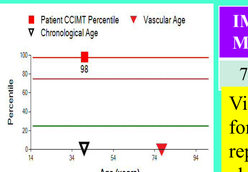
As per American Society of Echocardiography Task Force Guidelines

A CCIMT z score of ≥1.96 equivalent to ≥97.5 percentile is defined as highly abnormal that requires immediate attention and further evaluation.

Results:

- Mean (SD) for age were 48 years (12) and there were equal number of men and women.
- Of the independent variables tested, TC-HDL ratio was significantly associated with increased CCIMT z score (p=0.0134).
- A simple linear regression analysis using only the TC-HDL ratio yielded the model: IMT_Zscore = -0.1149 + (0.3400 x TC-HDL_Ratio).
- The p value for the slope was 0.0033 and correlation coefficient was 0.5976 and R square was 0.3571.
- There were four cases in this low-risk group who had z score ≥1.96

A website designed by the first author (SM), www.suhitam.com/vascularage takes four input variables i.e. age, gender and CCIMT in µm of either sides and yields a clinically useful report . The algorithm uses maximum CCIMT of the two sides. Report of a male individual aged 40 years with CCIMT values of 700 and 730 µm respectively on right and left sides, will be as follows:



IMT-Meas	IMT-Std	Z-score	Percentile	Vasc age	Risk Grade
730	532	2.21	98	78	4

Visitors of the website can login using '*visitor*' for both user id and password to view representative cases with different risk grades

DISCUSSION and REFERENCES

Discussion

- Potential application of CCIMT in cardiac risk stratification appears promising. A suitable model to predict the CCIMT z score using readily available clinical and laboratory variables could be developed in the research setting. In addition, scope of substituting vascular age for chronological age and/or categorizing individuals with Z score ≥1.96 as having severe systemic disease in existing risk stratification algorithms may be explored. We believe that the suggested approach would provide better insights for future research in the area.
- CCIMT has the potential to be incorporated into shared decision making [4] to provide information on long-term survival to incorporate into the decision to operate.
- CCIMT results can also be used for the decision to implement Preoperative statin therapy and close monitoring with troponin to reduce immediate perioperative risk.
- CCIMT measurement can be performed by anesthesiologist during preoperative evaluation and expand our role as perioperative physicians. If the stated machine is not available, methods such as using electronic calipers on frozen images, other techniques of auto-edge detection available in other machines may be used. Advantages of primary care taker in direct visualization of intima , the abnormality of which is responsible for vascular events, is obvious.
- A prospective study is planned by the authors to identify determinants of CCIMT in healthy individuals. Protocol summary may be viewed from a clinical trial registry using 'ccimt' in the key word search **http://ctri.nic.in/Clinicaltrials/advancesearchmain.php**

References

1. Glance LG, Faden E, Dutton RP, Lustik SJ, Li Y, Eaton MP, Dick AW. Impact of the Choice of Risk Model for Identifying Low-risk Patients Using the 2014 American College of Cardiology/American Heart Association Perioperative Guidelines. Anesthesiology 2018;129:889-900.
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4. Raymond BL, Wanderer JP, Hawkins AT, Geiger TM, Ehrenfeld JM, Stokes JW,McEvoy MD. Use of the American College of Surgeons National Surgical Quality Improvement Program Surgical Risk Calculator During Preoperative Risk Discussion: The Patient Perspective. Anesth Analg 2019;128:643-50.

Author disclosures: Conflicts of Interest: None