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Influence of radial anatomy on pain experienced during transradial coronary angiography

Mark Hensey *, Edel Cronin, Patrick Owens

University Hospital Waterford, Dunmore Road, Waterford, Ireland

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ABSTRACT

Background: The transradial route has become the primary approach for coronary angiography with the presence of radial artery anomalies found to be 10–20%. There has been limited study on the influence of these anomalies on procedural pain. Our aims were to determine local prevalence of the high radial origin (HRO) anatomical variant; to investigate factors influencing transradial procedural pain; and to determine if HRO specifically was associated with increased pain.

Methods: Radial artery anatomy was characterized by arteriography in sequential patients undergoing angiography. Patients were asked to mark their perceived procedural pain on a visual analog scale, which was converted to a pain score.

Results: 382 patients were enrolled, 5 were excluded. There were 259 males (68.7%) and 118 females (31.3%). HRO was present in 51 patients (13.5%). Overall mean pain score was 2.6 (SD 2.5). HRO was associated with a higher mean pain score than normal anatomy (3.3 (SD 2.9) vs. 2.4 (SD 2.4) $p = 0.027$). HRO was not associated with increased procedural failure, screening time or procedure time. When pain score was dichotomized into mild pain (<4.0) and moderate-to-severe pain (≥4.0), HRO was associated with almost double the frequency of moderate-to-severe pain (37.2% vs. 21.1%, $p = 0.012$). Using a logistic regression model, only female gender, younger age and HRO remained significant predictors of moderate-to-severe pain.

Conclusions: There was significantly increased pain in patients with HRO without increased procedure/screening time or procedural failure. Female gender and younger age were also found to be significant predictors of increased pain.

1. Introduction

Coronary angiography is an important diagnostic and therapeutic procedure in modern cardiology practice. The trans-radial approach has overtaken the trans-femoral approach to coronary access in recent years, due to the rare incidence of serious complications at the puncture site, elimination of the need to limit the patient's activity and the possibility of early patient discharge [1,2].

Radial artery anatomy has previously been shown to vary with resultant variation in procedure success, with anomalies found in approximately 10–20% of the population [3–5]. Anatomical anomalies include high radial origin (HRO), radial loops, radial tortuosity, radial stenosis and lusoria subclavian artery. The most common anomaly found in previous studies was HRO, with a rate of 7–8% [3–5]. These anomalies make the procedure more difficult for the operator and, more importantly, can make it more uncomfortable for the patient. They have been found to result in failure to complete the intended procedure, with a rate of approximately 7% in anomalous radial anatomy versus 2–3% in the normal population [3–5].

The pain experienced by patients during angiography has mainly been studied in relation to use of various anesthetic techniques, and radial artery spasm [6–8]. There has, however, been limited study into the area of pain related to anomalous anatomy, or other factors.

The aims of this study were to determine prevalence of the high radial origin anatomical variant in our local population; to investigate factors that influence procedural pain; and to determine if HRO specifically was associated with increased pain scores.

2. Methods

The study was carried out in a tertiary referral centre performing approximately 1600 coronary procedures per year, in one cardiac catheterization laboratory. Ethical approval was granted by the institutions ethics committee prior to commencement of the study. All operators in this laboratory use the radial approach as their default access route. All consecutive patients scheduled to undergo elective coronary angiography, ±PCI were consented and recruited into the study. Exclusion criteria were patients undergoing emergency angiography; patients scheduled a priori to undergo angiography via the femoral approach; patients who were pregnant or breastfeeding; and patients who refused consent. Patients were recruited over a four-month period.

* Corresponding author at: 23 Londonbridge Road, Sandymount, Dublin 4, Ireland.
E-mail address: hensey99@hotmail.com (M. Hensey).

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Patients went on to have their coronary procedure as intended. All operators in the institution were included in the study and the procedure was carried out according to the first operator's preferences. This included use of sedation, composition of radial cocktail, use of GTN and choice of both sheath and catheter size. Subcutaneous lidocaine was used in all patients for local anesthesia and a hydrophilic (Terumo) sheath was used. Catheters were guided with a 0.35 cm J-tipped guidewire.

At the end of the procedure, radial artery anatomy was characterized by an arteriogram taken using the final coronary catheter used, as it was withdrawn to the level of the axillary artery. The definition of the anatomical category used was evidence from the angiogram of:

(a) The origin of the radial artery arising from the brachial artery (which had to be clearly visualized) at or above the mid-point of the shaft of humerus (HRO), (Fig. 1), or
(b) The origin of the radial artery from the brachial artery at the level of the antecubital fossa, with clear delineation of the bifurcation into the radial, ulnar, and interosseous arteries (normal), (Fig. 2).

In the recovery room, and within 5 min of the completion of the procedure, the patients' discomfort was assessed by use of a visual analog score (VAS), which was administered by nursing staff. The VAS has been used in several studies as an objective means of measuring pain [6,8,9]. Patients were asked to mark their perceived pain throughout the procedure on an ungraduated 10 cm line. 'No pain' was represented by 0 cm and 'worst pain imaginable' was represented by 10 cm. This was measured in cm and converted to a pain score of 0–10.

Additional clinical and demographic variables were obtained and recorded in a patient study form, including procedural variables, such as choice of catheter, total screening and procedure time, and use of pharmacological agents either as a 'radial cocktail' or as adjunctive analgesia or vasodilators.

3. Statistical analysis

Data was collected on individual case record forms, and transferred to a computer spreadsheet (Excel, Microsoft Corp., California). Continuous variables are expressed as mean (standard deviation). Continuous variables were compared using Student's t-test. Categorical variables were compared using Fisher's Exact test for 2×2 comparisons, or otherwise the Chi square test. Pain severity was dichotomized on a score of less than 4.0, representing mild pain, and greater than or equal to 4.0, representing moderate/severe pain. The interaction and independence of explanatory variables on the categorical definition of mild vs. moderate/severe pain was explored using a backward logistic regression model, where a p value of 0.05 was used to determine significance, and retention in the model. Data analysis was undertaken using SPSS (IBM, California) statistical software package.

4. Results

In total, 382 patients were enrolled and 384 procedures were performed (290 angiograms, 94 interventions). Two patients had two separate procedures, only their first procedure was included in the analysis. Five patients were excluded as radial artery anatomy was not accurately characterized due to inadequate angiographic imaging. Of the remaining group of 377 patients, HRO was present in 51 patients (13.5%). No other anatomical variants were found. There were 259 males (68.7%) and 118 females (31.3%). The mean age of the cohort was 64.7 (SD 12.7) years. Descriptive characteristics for the cohort are shown in Table 1.

Overall mean pain score was 2.6 (SD 2.5). Mean pain score was 2.4 (SD 2.4) in normal anatomy and 3.3 (SD 2.9) in HRO ($p = 0.027$). Procedural time (26.6 (SD 17.5) min vs. 22.1 (SD 15.4) min) and screening time (7.3 (SD 7.2) min vs. 6.1 (SD 6.0) min) did not differ significantly between patients with normal anatomy and HRO, respectively. Pain scores did not differ significantly according to the first operator. There was one failed diagnostic angiogram due to subclavian tortuosity and one failed PCI post-diagnostic angiogram due to radial artery spasm; both of these were in patients with normal radial artery anatomy. The summary of clinical variables is seen in Table 2. Females showed a higher preponderance of HRO, but this did not reach statistical significance.

HRO was associated with a higher pain score, but not with an overall increase in screening or procedure time. When the pain score was dichotomized into mild pain (pain score < 4.0) and moderate-to-severe pain (pain score ≥ 4.0), HRO was associated with a significantly greater frequency of moderate to severe pain compared to normal anatomy (37.2% vs. 21.1%, $p = 0.012$, χ^2 test). Table 3 gives the univariate predictors of higher pain scores.

The independent predictors for an increased pain score were determined using a logistic regression model, with pain dichotomized to <4.0 and ≥ 4.0 entered as the dependent variable, and age, height and weight entered as continuous explanatory variables, and gender, sheath size, catheter size, angiogram vs. PCI as procedure performed, presence or absence of hypertension, diabetes, smoking status, pre-procedural administration of verapamil or nitrates intra-radially, presence of the HRO anatomy, and administration of pre-procedural sedation entered

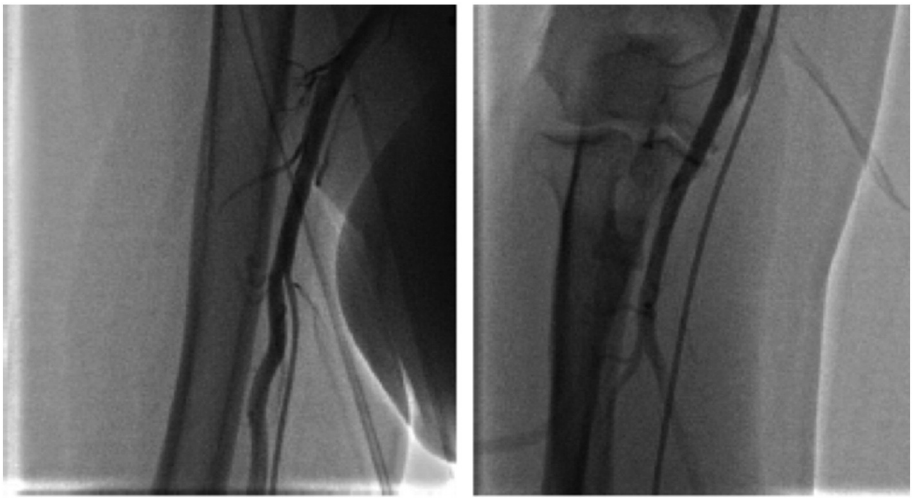

Fig. 1. High radial origin — origin of radial artery above the mid-point of the humerus with ongoing brachial artery giving rise to interosseous and ulnar arteries.