CHRONIC TOTAL OCCLUSION OF NATIVE CORONARY ARTERIES -PERCUTANEOUS CORONARY INTERVENTION STILL A SAFE AND EFFECTIVE OPTION

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ABSTRACT

Objective: To study the results and complications of percutaneous coronary intervention (PCI) in chronic total occlusion (CTO) of native coronary arteries at a newly established cardiac hospital.

Study Design: Retrospective case studies from hospital database.

Place and Duration of Study: This retrospective study was done at Army Cardiac Centre, Lahore, January 2009 to January 2014 (Five years initial experience).

Patients and Methods: Army Cardiac Centre Lahore is a tertiary care cardiac hospital with state of the art cardiac catheterization laboratories, cardiac operation theatres and attached facilities. The duration of this study has covered its initial 5 years of inception. PCI record of all the CTO's were retrieved from the hospital database and data was analyzed for different variables which included age, gender, duration of disease, distribution of coronary lesions in CTO, number of successful angioplasties in different coronary arteries having CTO, number of un-successful angioplasties in different coronary arteries having CTO, mortality, and number of major acute coronary events.

Results: Out of a total of 1870 PCI's performed, 210 (11%) had CTO. Males 177 (84.2%) dominated the study as against 33 (15.8%) females. Age of the patients ranged from 31-90 years with a mean age of 60.5 years. Group I of relatively younger age patients (31 – 70 years) had better success rate 153 (73%) as against Group II of elderly age (70-90 years) 57(43%). Overall success rate was 70% (147 out of 210). Out of 147 successful PCI, 141 (95.9%) had stenting while 6(4.1%) patients had Percutaneous Old Balloon Angioplasty (POBA) only – primarily due to failure of stent to cross the lesion. Left Anterior Descending artery (LAD) – clearly dominated the vessel which was most successfully intervened, which was 77(52.3%), followed by Right coronary artery (RCA) 52(35.3%), Circumflex artery 14 (9.5%), Obtuse marginal branch (OM) 02 (1.3%), Diagonal branch (D) 01(0.68%), and Left main stem protected (LMS) 01(0.68%). Out of total of 63(30%) unsuccessful PCI's LAD comprised of 28(44.7%), RCA 22(34.9%), Circumflex artery 6(9.5%), OM 3(4.7%), D 2 (3.1%), and LMS protected 2(3.1%).

Conclusion: Although tedious and time consuming, PCI to CTO is a safe and effective option for revascularization.

Keywords: CTO (chronic total occlusion), PCI (Percutaneous coronary intervention), CABG (Coronary artery bypass grafting).

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INTRODUCTION

Chronic total occlusions (CTOs) has been posing a challenging task to the interventional Cardiologists, which becomes even more daunting if old, calcified, long segments CTO with or without bridging collaterals are to be opened. Recent research has innovated newer devices for softening more resilient CTO. This includes an ultrasound device for breaking fibrous cap by blunt micro dissection. Another device has also been developed for differentiating between plaque and normal vessel wall which in necessary for a secure wiring of CTOs¹. It has been observed that approximately 30% of all coronary angiograms in patients with Coronary artery disease (CAD) will show a CTO, tempting a cardiologist to open this occluded artery by percutaneous coronary intervention (PCI). The driving force behind attempting PCI in a CTO is that even if it remains unsuccessful, the back up support of cardiac surgeons with their armament of

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coronary artery bypass grafting surgery (CABG) usually relieves the patients' sufferings.

PATIENTS AND METHODS

This retrospective study was done at Army Cardiac Centre Lahore from January 2009 to January 2014. Study subjects were patients who had undergone percutaneous coronary intervention (PCI) on a CTO of native coronary artery. Hospital database was used to retrieve all the relevant information of the study subjects.

Inclusion criteria were all CTOs on native coronary arteries who have unacceptable levels of coronary symptoms despite appropriate medical therapy. Thus they were deemed appropriate for intervention under the Appropriate Use criteria (AUC). Exclusion criteria included all patients with history of myocardial infarction in the preceding three month or with total occlusion of native coronary arteries of less than 3 months of duration.

A detailed structured proforma was developed which included detailed history specially pertaining to any acute coronary event in the previous three months as well as risk factor profile of the patients. Depending on the age of the patients, two groups were made. Group I of relatively younger age patients (31-70 years) and Group II of elderly age (70-90 years) 57(43%).

Statistical Analysis: Data was analyzed using SPSS version 13. Continuous parameters were presented as mean \pm standard deviation and compared using the student's t test or Wilcoxon rank-sum test, as appropriate. Nominal parameters were presented as percentage and compared using Pearson's chisquare test. A *p* value <0.05 was considered statistically significant.

RESULTS

A total of 1870 PCIs were performed in the stipulated period of study. 210 (11.22%) PCIs were done for CTOs. Gender distribution comprise of male 177 (84.2%) as compared to female 33 (15.8%). Age of the patients ranged from 31-90 years with a mean age of 60.5 years. Group I of relatively younger age patients

(31-70 years) has better success rate 153 (73%) as compared to Group II of elderly age (70-90 years) 57 (43%). Overall success rate was 70% (147 out of 210). Overall mean age was 60.5 years. PCI success rate was 70% (147 out of 210). Out of 147 successful PCIs, 141 had angioplasty while 6 patients and Percutaneous Old Balloon Angioplasty (POBA) due to the reason that stent could not cross the completely occluded lesion. LAD lesion clearly dominated the vessel which was the most successfully intervened artery and it amounted to 77 (52.3%) followed by Right coronary artery (RCA) 52 (35.3%) Left circumflex artery 14(9.5%), Obtuse marginal branch (OM) 02(1.3%), Diagonal branch (D) 01(0.68%), and Left main stem (LMS) protected 01(0.68%).

Unsuccessful PCIs' were 63 (30%). Out of which LAD comprised 28 (44.7%), RCA 22 (34.9%), Circumflex artery 6 (9.5%), OM 3(4.7%), D 2(0.1%), and LMS protected 2(3.1%).

Different wires were used to negotiate the CTOs lesions. Floppy wire (run through wire 43, BMW 11) was employed in 57(18.3%) of the cases. In 108 (73.76%) cases stiff wire was used and its different types were; Pilot 50-87 patients, Pilot 150–2 patients, Fielder XT–3 patients, fielder FC–3 patients, Cross it–6 patients and Conquest–2 patients. The success rate was 135 (92%) after crossing the lesion with the wire. In 8% (12) patients, large size balloons could not cross the lesion in which case small sized balloons support was necessitated to cross the occluded lesion.

Post procedure mortality was zero as were post/peri-procedure myocardial infarction, coronary perforation and patient requiring urgent coronary artery bypass graft surgery were zero.

DISCUSSION

Coronary Chronic Total Occlusion (CTO) is characterised by heavy atherosclerotic plaque burden within the coronary arteries, resulting in complete (or nearly complete) occlusion of the vessel. Although the duration of the occlusion is difficult to determine but clinically a total occlusion must be present for at least 3 months to be considered a true CTO². In routine

patients undergoing coronary angiography, incidence of CTO has been reported to be around 15-30% and 10-15% of these CTO patients are asymptomatic^{3,4}. CTO patients quite uncommonly present with acute coronary syndrome in which the culprit lesion is the CTO itself because the area supplied by the occluded vessel is often viable and functional because of the collaterals⁵⁻⁷. However in situations of increase oxygen demand these collaterals have not shown to supply enough blood and oxygen to the heart muscle.

As with any patients with stable angina, the treatment options are either to optimise medical treatment with anti-anginal drugs, and when no respite, to think about the revascularization strategies, either angioplasty or Coronary artery bypass grafting surgery (CABG). For patients diagnosed with CTO and significant concomitant left main stem or multivessel coronary artery disease (CAD), CABG is the preferable choice. The synergy between PCI with taxus and cardiac surgery (SYNTAX) trial showed that in patients with multivessel CAD, there were no major differences in death and myocardial infarction between patients treated with PCI and those treated with CABG. However PCI patients were more likely to require repeat revascularization procedure in follow up years, especially those patients with more complex CAD marked by a high SYNTAX Score (a score developed to rate the severity of CAD; the higher the score the more severe is the CAD and vice versa)⁸. CTO is a major contributor to a high SYNTAX score. In our relatively smaller study, the success rate was 70% (147), which is comparable to larger international studies on the subject. In an article Baks T et al.9-10 previously reported a procedural success rate of 72 %. In terms of PCI advantages in CTO patients there are three possible benefits; improvement in symptoms, improvement in left ventricular function and survival benefit. Despite these possible benefits the attempt rate of PCI for CTO are significantly lower than the attempts for PCI for other lesion subsets¹². In a single centre study of Mayoclinic; the procedural success rate for PCI for CTO between 1979 and 1989 was 51%13. With the introduction of coronary stents, the success rate

increased to about 70% and this rate has been consistent in several studies¹¹⁻¹³. The most common reason for failure was the inability to cross the CTO with a guide wire because CTOs comprise of different components e.g. calcium, soft atherosclerotic plaque, dense fibrous plaque and well-organised thrombus. In successful PCI (n=147), balloon angioplasty was done in 06 patients (04%), while rest (94%) underwent stent implantation, most of which were drug eluting stents compatible with contemporary practice.

The factors which predict a lower procedural success rate include length of occlusion >15 mm, duration of occlusion >3 months, presence of calcification in lesion and/or artery, and the presence of bridging collaterals.

Procedural success rate of CTO has improved over the last two decades but is still low with ante grade technique despite the introduction of new wires and devices. Newer techniques and hardware have come up to tackle this problem among which the most important is the retrograde approach. In experienced centres it is routine to engage both Left main coronary artery and Right coronary artery with the guide catheters for simultaneous injection and seeing entire coronary tree for tracing the retrograde flow in occluded artery. Thus mapping the distal segment of occluded artery.

In retrograde approach the expertise is used to access the collaterals as a mean of accessing the totally occluded artery in a retrograde fashion. The techniques for the retrograde approach are classified into four categories: (1) the kissing-wire technique (i.e to advance an antegrade stiff wire toward a retrograde one, which is a clear landmark of distal true lumen), (2) the retrograde wire crossing technique, (3) the CART technique, and (4) the reverse CART (Controlled antegrade retrograde subintimal tracking) retechnique¹⁴.

Latest equipment that has come up is the Cros Boss (Bridgepoint Medical System) and StingRay by Boston Scientific. The CrossBoss catherter (Bridgepoint Medical) is a stiff, metallic, over-the-wire catheter with a 1-mm blunt, hydrophilic-coated distal tip that can advance through the occlusion when the catheter is rotated rapidly using a proximal torque device (fast-spin technique). If the catheter enters the subintimal space, it creates a limited dissection plane making re-entry into the distal true lumen easier. The risk of perforation is low provided that the CrossBoss catheter (Bridgepoint Medical) in not advanced into the side branches. If the CTO is crossed subintimally the Stingray balloon and guide wire (Bridgepoint Medical) can be used to assist with re-entry into the distal true lumen.

Technical success was defined as restoration of TIMI 2 or 3 flows with residual stenosis less than 50%. Procedural success was defined technical success without in hospital major adverse coronary events (MACE). MACE is defined as death, Q or Nor Q wave Myocardial infarction (MI), urgent repeat PCI or urgent CABG. In hospital MACE in our study was 2% (4) compared to 5% in study by Olivari7 et al. and 3.8% in Seuro et al. which may be due to less aggressive and more careful attempts to open total occlusions.

Group I of relatively younger age patients (31-70 years) has better success rate 153 (73%) as compared to Group II of elderly age (70-90 years) 57 (43%). Overall success rate was 70% (147 out of 210). Suero¹⁵ et al. reported procedural success rates of 78.6%.

As studies have consistently shown operators experience and duration of occlusion as major determinants of success of PCI in CTO, it is hoped that with proper training and experience more CTOs can be successfully dealt with.

CONCLUSIONS

There are many factors that influence procedural success for CTOs. Probably no single determinant alone influences success or failure, but most important is operator skill set. But certainly, the available device technologies, as well as certain anatomic factors related to the CTO, such as lesion length, morphology of the CTO, and collaterals, are also important determinants.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

REFERENCES

- S.Aziz Heart 2005, 91, iii42 iii48 do i, 10,1136/hrt: 2004 058495 chronic total occlusion – a staff challenge requiring a major breakthrough: is there light at the end of the tunnel.
- Stone GW, Kandzari DE, Mehran R, Colombo A, Schwartz RS, Bailey S, Moussa I, Teirstein PS, Dangas G, Baim DS, Selmon M, Strauss BH, Tamai H, Suzuki T, Mitsudo K, Katoh O, Cox DA, Hoye A, Mintz GS, Grube E, Cannon LA, Reifart NJ, Reisman M, Abizaid A, Moses JW, Leon MB, Serruys PW. Percutaneous recanalization of chronically occluded coronary arteries: a consensus document: part I. Circulation. 2005; 112:2364–2372. FREE Full Text
- 3. Kahn JK. Angiographic suitability of catheter revascularization of total coronary occlusions in patients from a community hospital setting. Am Heart J. 1993; 126:561–564. CrossRefMedlineGoogle Scholar
- Christofferson RD, Lehmann KG, Martin GV, Every N, Caldwell JH, Kapadia SR. Effect of chronic total coronary occlusion on treatment strategy. Am J Cardiol. 2005; 95:1088–1091. CrossRefMedlineGoogle Scholar
- Hoher M, Wohrle J, Grebe OC, Kochs M, Osterhues HH, Hombach V, Buchwald AB. A randomized trial of elective stenting after balloon recanalization of chronic total occlusions. J Am CollCardiol. 1999; 34:722–729. CrossRefMedlineGoogle Scholar
- Rubartelli P, Verna E, Niccoli L, Giachero C, Zimarino M, Bernardi G, Vassanelli C, Campolo L, Martuscelli E. Coronary stent implantation is superior to balloon angioplasty for chronic coronary occlusions: sixyear clinical follow-up of the GISSOC trial. J Am CollCardiol. 2003; 41:1488–1492. CrossRefMedlineGoogle Scholar
- Olivari Z, Rubartelli P, Piscione F, Ettori F, Fontanelli A, Salemme L, Giachero C, Di Mario C, Gabrielli G, Spedicato L, Bedogni F. Immediate results and one-year clinical outcome after percutaneous coronary interventions in chronic total occlusions: data from a multicenter, prospective, observational study (TOAST-GISE). J Am CollCardiol. 2003; 41:1672–1678. CrossRefMedlineGoogle Scholar
- Serruys PW, Morice M-C, Kappetein P, Colombo A, Holmes DR, Mack MJ, Stahle E, Feldman TE, van den Brand M, Bass EJ, Van Dyck N, Leadley K, Dawkins KD, Mohr FW. Percutaneous coronary intervention versus coronary-artery bypass grafting for severe coronary artery disease (the SYNTAX Trial). N Engl J Med. 2009; 360:961–972. CrossRefMedIineGoogle Scholar
- Joyal D, Afilalo J, RinfretS. Effectiveness of recanalization of chronic total occlusions: a systematic review and meta-analysis. Am Heart J. 2010; 160:179–187. CrossRefMedlineGoogle Scholar
- 10. Baks T, van Geuns R-J, Duncker DJ, Cademartiri F, Mollett NR, Krestin GP, Serruys PW, de FeyterP. Prediction of left ventricular function after drug-eluting stent implantation for chronic total coronary occlusions. J Am CollCardiol. 2006; 47:721–725. CrossRefMedlineGoogle Scholar.
- 11. Kirschbaum SW, Baks T, van den Ent M, Sianos G, Krestin GP, Serruys PW, de Feyter P, van Geuns R-J. Evaluation of left ventricular function three years after percutaneous recanalization of chronic total coronary occlusions. Am J Cardiol.2008; 101:179–185. CrossRefMedlineGoogle Scholar
- 12. Abbott JD, Kip KE, Vlachos HA, Sawhney N, Srinivas VS, Jacobs AK, Holmes DR, Williams DO. Recent trends in the percutaneous treatment of chronic total coronary occlusions. Am J Cardiol. 2006; 97:1691–1696. CrossRefMedlineGoogle Scholar
- 13. Prasad A, Rihal CS, Lennon RJ, Wiste HJ, Singh M, Holmes DR. Trends in outcomes after percutaneous coronary intervention for chronic total occlusions: a 25-year experience from the Mayo Clinic. J Am CollCardiol. 2007; 49:1611–1618. CrossRefMedlineGoogle Scholar
- 14. Colombo A, Mikhail GW, Micher I, Iakovou I, Airoldi F, Chieffo A, et al. Treating chronic total occlusions using sub intimal tracking and reentry: the STAR technique, Catheter Cardiovascular interv. 2005;64(4);407-11 doi; 10,1002/ccd 20307 (Pub Med) (Cross Ref)
- 15. Suero JA, Marso SP, Jones PG, Laster SB, Huber KC, Giorgi LV, Johnson WL, Rutherford BD. Procedural outcomes and long-term survival among patients undergoing percutaneous coronary intervention of a chronic total occlusion in native coronary arteries: a 20-year experience. J Am CollCardiol. 2001; 38:409–414. CrossRefMedlineGoogle Scholar.

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