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Editor's Choice

It's good to talk! Changes in coronary revascularisation practice in PCI centres without onsite surgical cover and the impact of an angiography video conferencing system

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SUMMARY

Introduction: Percutaneous coronary intervention (PCI) activity has increased more than 6 fold in the last 15 years. Increased demand has been met by PCI centres without on-site surgical facilities. To improve communication between cardiologists and surgeons at a remote centre, we have developed a video conferencing system using standard internet links. The effect of this video data link (VDL) on referral pattern and patient selection for revascularisation was assessed prospectively after introduction of a joint cardiology conference (JCC) using the system. **Methods:** Between 1st October 2005 and 31st March 2007, 1346 patients underwent diagnostic coronary angiography (CA). Of these, 114 patients were discussed at a cardiology conference (CC) attended by three consultant cardiologists (pre-VDL). In April 2007, the VDL system was introduced. Between 1st April 2007 and 30th September 2008, 1428 patients underwent diagnostic CA. Of these, 120 patients were discussed at a JCC attended by four consultant cardiologists and two consultant cardiothoracic surgeons (post-VDL). Following case-matching for patient demographics and coronary artery disease (CAD) severity and distribution, we assessed the effect upon management decisions arising from both the pre- and post-VDL JCC meetings. **Results:** When comparing decision-making outcomes of post-VDL JCC with pre-VDL CC, significantly fewer patients were recommended for PCI (36.8% vs. 17.2% respectively, $p = 0.001$) and significantly more patients were recommended for surgery (21.1% vs. 48.4% respectively, $p < 0.001$). There were no significant differences in waiting times for PCI following JCC discussion; however, waiting times for surgical revascularisation were significantly reduced (140.9 ± 71.8 days vs. 99.4 ± 56.6 days respectively, $p = 0.045$).
Conclusions: The VDL system provides a highly practical method for PCI centres without onsite surgical cover to discuss complex patients requiring coronary revascularisation and significantly increases the number of patients referred for surgical revascularisation rather than PCI.

What's known
Percutaneous coronary intervention is increasingly performed in centres without onsite cardiac surgery facilities. Frequently, cases require multidisciplinary input from cardiologists and cardiac surgeons at remote sites.

What's new
Video-data link technology enables real-time case discussion between cardiologists and cardiac surgeons at remote sites and introduction of this technology significantly influences revascularisation strategy and reduces waiting list times.

Introduction

Percutaneous coronary intervention (PCI) activity has increased more than 8 fold in the last 15 years throughout the United Kingdom (1). This increased demand has been largely met by PCI centres without on-site cardiac surgical facilities. Because of this significant increase in PCI activity, the British Cardiovascular Intervention Society (BCIS) recognises the need for additional PCI centres and that the majority of these will necessarily be provided by hospitals without on-site surgical cover (2).

Complicated and severe coronary artery disease has increasingly been treated with PCI as opposed to coronary artery bypass grafting (CABG), particularly since the advent of drug eluting stents. This is despite multiple trials demonstrating increased requirement for repeat revascularisation with PCI (3–7), as well as the fact that CABG has also shown long-term mortality benefits for certain categories of

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elective patients compared with PCI (8–11). Well-defined groups of selected cases therefore warrant mandatory discussion between interventional cardiologists and cardiac surgeons before undertaking revascularisation procedures (12). This has now been stated as a clear recommendation in a set of guidelines from the Society for Cardiothoracic Surgery in Great Britain & Ireland (SCTSGBI). With interventionalists and surgeons at remote centres such case discussion is both difficult and extremely time consuming to co-ordinate. Broadly speaking, the surgical 'hub' often provides cover to a variable number of PCI 'spokes'.

To improve communication between interventional cardiologists and surgical colleagues at a remote centre, and therefore, hopefully optimise case selection for both PCI and CABG, we have developed a high definition angiogram video conferencing system using standard hospital broadband internet links. The effect of this system on referral pattern, patient selection and speed of appropriate revascularisation was assessed prospectively after introduction of a fortnightly video joint cardiac conference (JCC) using this technology, and was compared with previous practice.

Methods

The study was undertaken at Eastbourne District General Hospital, an interventional cardiology centre without on-site cardiac surgery. The nearest cardiac surgical centre is Royal Sussex County Hospital in Brighton, 19 miles or 40 min by road. The database for this study was populated by unselected patients undergoing diagnostic coronary angiography and cardiac catheterisation. The study was supported by an unrestricted research grant from Lifestream Medical Systems Ltd. The study sponsor had no involvement in collection or analysis of the data, results interpretation or preparation of the manuscript.

Video-data link technology

The Lifestream^{TM} video conferencing system allows transfer of coronary cine-angiogram loops, in real time and at high definition image quality, over a secure standard hospital broadband (100 mb) internet link. Bidirectional video/audio cameras enable live face-to-face case discussion between clinicians and their teams at both centres as 'picture-in-picture' technology, with no delay in image or sound transfer. The Lifestream^{TM} system and user interface are shown in Figure 1A and 1B.

Study population

Between 1st October 2005 and 31st March 2007, 1346 patients underwent coronary angiography (CA).

Figure 1 (A) The Lifestream Hub. (B) The Lifestream user interface

Of these 114 patients were referred for case discussion at a cardiology case conference (CC) attended by three consultant cardiologists (Pre-VDL cohort). In April 2007, the Lifestream^{TM} video data-link (VDL) was introduced. Between 1st April 2007 and 30th September 2008, 1428 patients underwent CA. Of these 120 patients were discussed at a JCC (Post-VDL cohort) attended by four consultant cardiologists and at least two consultant cardiothoracic surgeons at a remote site (Royal Sussex County Hospital, Brighton).

For all patients included in the study, baseline demographics, cardiac risk factor profile and past medical history were recorded by case note review. Cardiac catheterisation procedures were reviewed and the number of diseased vessels documented as were the presence of disease of the proximal left anterior descending artery and left main stem. Significant disease was defined as a luminal narrowing of greater than 50% (9,13). Outcome decisions with regard to patient management and revascularisation strategy from the JCC meetings for both patient cohorts (Pre-VDL and Post-VDL) were recorded. For the Pre-VDL patient cohort data were gathered retrospectively, whereas data were gathered prospectively for the post-VDL patient cohort. Data were gathered from all patients undergoing diagnostic cardiac catheterisation and not just cases discussed at the JCC meetings, to investigate any changes in referral patterns for CA over the study time period. Time from the JCC meetings to percutaneous or surgical revascularisation was recorded, as well as mortality data.

Statistical analysis and study end-points

The primary purpose of the data analyses was to determine whether there was a significant difference in revascularisation strategies between cases discussed before the introduction of the video data link and those discussed subsequently, controlling for patient demographics and coronary disease patterns. This was performed by first identifying factors that were associated with percutaneous or surgical revascularisation in univariate analyses and then using a multivariate model that controlled for significant risk factors while testing for significant differences in revascularisation strategy. Factors assessed as independent predictors included the use of the video data link, baseline demographics and coronary artery disease patterns.

Descriptive data were described using standard methods. Continuous variables are expressed as mean ± standard deviation. Comparison of groups was performed using the independent samples *t*-test and the Mann–Whitney *U*-test depending on data distribution. Categorical variables were compared using the Chi squared test or Fisher's exact test. A p value < 0.05 was considered statistically significant.

Results

In total, 2774 patients were included in the study, with mean age 67.1 ± 10.9. Gender distribution included 60.8% male patients. Past medical history included hypertension (37.0%), diabetes mellitus (11.4%), cerebrovascular disease (3.8%), current or past smoking history (48.8%), myocardial infarction (18.0%), previous PCI (10.0%) and previous CABG (5.9%). There were no significant differences in these baseline demographics for the patient cohorts before and after introduction of the VDL (Figure 2A).

Coronary angiography in the pre- and post-VDL patient cohorts demonstrated the following disease patterns: left main stem disease 5.0% vs. 6.7%, p = 0.193; proximal left anterior descending artery disease 39.8% vs. 42.4%, p = 0.357; three vessel disease 14.9% vs. 12.8%, p = 0.275; two vessel disease 17.4% vs. 19.7%, p = 0.279; impaired left ventricular function 29.9% vs. 35.5%, p = 0.064 (Figure 2B).

Cases referred to joint cardiac conference

Two hundred and thirty-four cases were referred to JCC meetings. Of these, 114 of 1346 cases were from the pre-VDL group, and 120 of 1428 cases were from the post-VDL group. Patient demographics of these two cohorts are demonstrated in Figure 3A, with no significant differences between the two groups.

Coronary angiography in the pre-VDL and post-VDL patient cohorts demonstrated the following disease patterns: left main stem disease 12.8% vs. 23.7%, p = 0.096; proximal left anterior descending

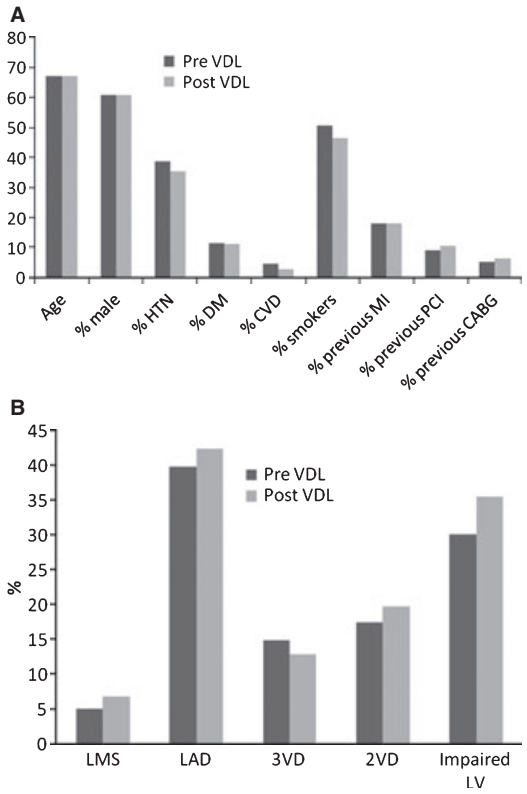

Figure 2 Patients undergoing diagnostic coronary angiography (n = 2774). (A) Patient demographics (p = ns for all comparisons). (B) Coronary disease patterns (p = 0.193, 0.357, 0.275, 0.279, 0.064 respectively)

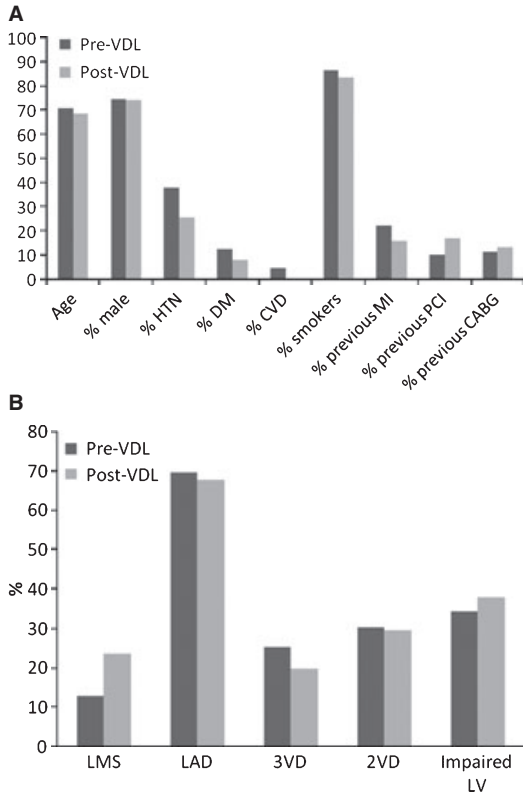

Figure 3 (A) Demographics of patients presented at JCC meetings. (B) Coronary disease patterns of patients discussed at pre- and post-VDL JCC meetings (p = 0.096, 0.819, 0.430, 0.911, 0.704 respectively)

artery disease 69.6% vs. 67.8%, p = 0.819; three vessel disease 25.3% vs. 19.7%, p = 0.43; two vessel disease 30.4% vs. 29.5%, p = 0.911; impaired left ventricular function 34.5% vs. 38.0%, p = 0.704 (Figure 3B).

Following case discussion at the pre-VDL JCC and post-VDL JCC meetings patient management decisions were as follows: medical management 15.8% vs. 18.8%, p = 0.15; PCI 36.8% vs. 17.2%, p = 0.001; surgical revascularisation 21.1% vs. 48.4%, p < 0.001; other 26.3% vs. 21.4%, p = 0.09 (Figure 4).

Multivariate analysis demonstrated that baseline demographics and coronary artery disease patterns were not independent predictors of percutaneous or surgical revascularisation, whereas discussion of cases at the VJCC as opposed to the CC was the only independent predictor of surgical revascularisation as a recommended management decision.

There were no significant differences in waiting times for PCI following JCC discussion between the pre-VDL and post-VDL patient cohorts (73.0 ± 44.6 days vs. 76.4 ± 70.8 days respectively, p = 0.849). However, there were significant differences in waiting times for surgical revascularisation following JCC

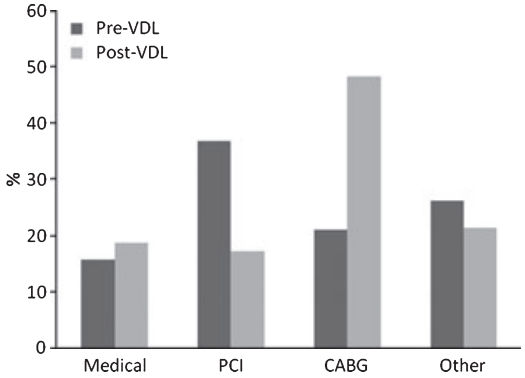

Figure 4 Management decision following JCC meetings

discussion between the pre-VDL and post-VDL (140.9 ± 71.8 days vs. 99.4 ± 56.6 days respectively, p = 0.045).

Discussion

Our study demonstrates the feasibility of conducting multidisciplinary team meetings between interventional cardiologists and cardiac surgeons at remote sites (the 'hub and spoke' concept). Over the time course of this study, there were no significant differences in baseline characteristics of patients undergoing diagnostic coronary angiography. As would be expected, more severe disease patterns were discussed at the JCC meetings compared with the general study population of patients undergoing diagnostic coronary angiography. There were, however, no significant differences between the pre-VDL and post-VDL cohorts. The introduction of the video data link system, however, significantly changed revascularisation strategies and was an independent predictor of the requirement for surgical revascularisation. Use of the video data link, therefore, not only enables patients to have the most appropriate revascularisation strategy planned but our study also demonstrated that immediate multidisciplinary case discussion significantly reduced waiting times to surgical intervention.

The guidelines of the SCTSGBI regarding the roles of multidisciplinary teams (MDT) when discussing all cases for coronary revascularisation should not be underestimated, particularly with guidelines from BCIS to the same end (2,12). As such, case discussion by MDTs is advocated to improve quality and consensus and additionally is recommended by guidelines from the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS) (14).

Relevance to clinical practice

The boundaries between surgical and interventional disease patterns are progressively (and possibly

controversially) changing. Historically, surgical revascularisation has been the recommended treatment option for severe coronary artery disease patterns, including multi-vessel and left main-stem disease).

The recently published Syntax trial is indicative of the increasingly complex coronary disease that is deemed suitable for either percutaneous or surgical revascularisation management strategies (15). This trial randomised patients with left main stem disease and/or three vessel disease to PCI or CABG. This trial showed higher levels of repeat revascularisation for PCI but similar other major adverse clinical event (MACE) rates. A pre-requisite for this study was that coronary angiogram results were reviewed by both an interventional cardiologist and cardiac surgeon together to assess whether revascularisation could be adequately achieved by either PCI or CABG. However, approximately 25% of patients screened for this study had disease patterns or comorbidities that the cardiac surgeon and interventional cardiologist agreed should only be managed by a particular revascularisation strategy.

Not concluded by the authors, but perhaps of highest importance, is the definite need for multidisciplinary discussion on a case-by-case basis. It is clear for logistical and practical reasons that this would be greatly facilitated by the use of video data links such as Lifestream™. Multi-disciplinary case discussion could theoretically be achieved by other means but would undoubtedly require either interventional cardiologists or cardiac surgeons travelling to remote sites with considerable waste of senior clinicians' time and significant expense to the NHS.

Of particular note for UK practice, BCIS guidelines recommend that 'PCI centres remote from surgical or tertiary centres should have facilities for real time image transfer to facilitate discussion and advice in individual cases' (2). Formal cardiac surgical standby was a prerequisite for PCI when the technique of coronary angioplasty was first introduced (16). However, data from the annual BCIS reports demonstrate that the need for emergency surgery fell from 2% in 1992 to 0.08% in 2007 (1,17), reflecting increasing technical expertise and safety regulation. With the consistent reductions in the need for emergency surgery, surgical cover is now provided by means of 'first available operating room', and cover is frequently provided by surgeons on standby at remote centres (15% of cases in 2004). The video data link utilised in this study also enables not only scheduled case conferences but also real time case discussion for emergency and complicated cases during the procedure itself.

Additional implications

The use of telecommunications to provide and facilitate medical care has been long acknowledged (18). The utilisation of telemedicine to improve patient care within the NHS is recognised and encouraged in Lord Darzi's NHS Next Stage Review Report (19). The Lifestream™ system and its utilisation as described in this study is one example of the vast number of ways in which patient care can be improved. The system can also be employed for a variety of other uses. In an era of significant time constraints on junior doctors' hours, education can be provided by live case demonstration of any case undertaken in the laboratory from cardiac catheterisation and complex intervention to electrophysiological studies and ablation cases. Any electronically based information or imagery, including echocardiography, computed tomography imaging or magnetic resonance imaging can be communicated to remote sites by this method.

Study limitations

This study involves comparison between two different patient populations, and whilst demographics between the groups are similar, there is the unavoidable potential of not controlling entirely for differences in patient demography and coronary artery disease patterns. There were no set criteria for referral to JCC meetings and it is possible that introduction of the video-data link changed patterns of patient referral to the JCC not accounted for in the described demographics.

Conclusions

The VDL system provides a highly practical method for PCI centres without onsite surgical cover to discuss complex patients requiring coronary revascularisation and significantly changes interventional practice patterns without hard-pressed surgeons or interventionalists being required to travel from their main work base. With the emergence of increasing numbers of PCI centres without onsite surgical cover, the routine use of the VDL system will ensure patients have adequate, early and appropriate multidisciplinary discussion guiding revascularisation management. It is now recommended that it should be mandatory for all cases fulfilling certain basic criteria for revascularisation to be discussed at a MDT/JCC. Video systems such as the one discussed here (Lifestream™) surely must represent the only real and efficient option for delivery of these requirements.

Author contributions

RA Veasey – conception and design and analysis and interpretation of data and drafting of the manuscript.

JAJ Hyde, ME Lewis, UH Trivedi, AC Cohen, GW Lloyd, SS Furniss, NR Patel – critical revision and approval of the article.

AN Sulke – critical revision of article and final approval of the manuscript submitted.

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