Lightning injury causing prolongation of the Q–T interval

A.B.D. Palmer

St. Albans City Hospital, Normandy Road, St. Albans, UK.

Summary: This case report describes the development of temporary prolongation of the Q–T interval in a patient struck by lightning. A variety of electrocardiographic changes have been documented previously in association with lightning injury; however, the changes in this patient have not previously been reported.

Introduction

Lightning injuries are an uncommon cause of admission to hospital. The effects of this injury are often multi-system, and one of the commonest organs to be affected is the heart. A number of different electrocardiographic changes have been documented; however, the following case is unusual because repolarization was predominantly affected.

Case report

Whilst playing football a 39 year old man was struck by lightning. He was rendered unconscious, but there was no history of cardiac or respiratory arrest. His only complaints were of paraesthesiae down the left arm. He had no past history of cardiovascular disease. On examination there was a burn down the left side of his neck, and exit burns on the right palm and sole of his right foot. The left eardrum was perforated and there was some tenderness in the muscles of both arms.

Initial investigations included full blood count, serum urea and electrolytes, blood sugar, liver function tests and chest X-ray – which were all normal. Electrocardiogram on admission revealed sinus rhythm with some flattening of the T-waves in leads II, III and AVF, and the Q–T interval was slightly prolonged (QTc = 0.46 s). The patient was admitted for observation.

Two days later the electrocardiogram showed marked T-wave inversion in leads II, III and AVF, and tall broad T-waves in all other leads (Figure 1). There was a markedly prolonged Q–T interval (QTc = 0.68 s). A further two days later the T-wave inversion had

persisted inferiorly, but the width of the T-waves was already diminishing (QTc = 0.5 s) (Figure 2).

No arrhythmias were observed and his observations remained stable throughout. His cardiac enzymes were slightly elevated (peak aspartate 70 IU/l, transaminase (AST) lactate dehydrogenase (LDH) 695 IU/l). Repeat calcium and potassium estimations remained within normal limits and he was on no medication. Five days after admission the patient was discharged home. One month later a repeat electrocardiogram showed there was still some T-wave inversion in leads III and AVF, but otherwise all the previous T-wave changes had returned to normal (QTc = 0.41 s) (Figure 3).

Discussion

Cardiac arrhythmias and electrocardiographic changes in association with lightning injury have been documented previously.^{1,2,3} These changes were mainly those of transient T-wave inversion and the exaggerated Q–T prolongation seen in this patient has not previously been recorded, to our knowledge. The prolonged Q–T interval and broad configuration of the T-waves suggest delayed repolarization of the ventricular myocardium.^{4,5} These changes may occur in a variety of clinical situations and be due to congenital or acquired disease states as described in a review of Q–T prolongation by Kenny & Sutton.⁶ Electrolyte disturbances, including hypocalcaemia and hypomagnesaemia, and ingestion of certain drugs such as β -blockers,⁷ amiodarone,⁸ tricyclic-antidepressants⁹ and phenothiazines, can all prolong the Q–T interval. Furthermore acute cerebral events such as skull fractures and sub-arachnoid haemorrhage may result in similar electrocardiographic changes.^{10,11} There was no evidence for any of these possible causes in the patient described.

Correspondence: A.B.D. Palmer M.R.C.P., South Wing, Dulwich Hospital, East Dulwich Grove, London SE22 8PT, UK.

Accepted: 4 March 1987

Figure 1 ECG 2 days after admission.

Figure 2 ECG 4 days after admission

Figure 3 ECG one month after discharge

Prolongation of the Q–T interval may occur in certain cardiac conditions, including cardiomyopathy, congenital heart disease and in particular myocardial ischaemic damage.^{12,13} The minimal rise in this patient's cardiac enzymes makes the diagnosis of myocardial infarction less likely and therefore the electrocardiographic changes recorded were attributed to direct electrical injury caused by the lightning strike. Similar changes due to electrical injury have been documented with cardiac pacing and after D.C. conversion.^{14,15,16}

It is well recognized that prolongation of the Q–T interval is associated with an increased risk of re-entry tachycardia, ventricular fibrillation and sudden death.^{17,18,19} We would therefore recommend routine

electrocardiographic examination in all patients with lightning injury, and continuous ECG monitoring until such Q–T prolongation has normalized. If this fails to occur then further investigation may be warranted to prevent life-threatening arrhythmias, including Holter 24-hour tape monitoring and electrophysiological studies.

When this patient was reviewed one month later most of the electrocardiographic abnormalities had returned to normal. This is consistent with previous reports of patients struck by lightning.^{1,2,3}

Acknowledgements

I am grateful to Dr M.P. Spence for permission to report on this patient.

References

1. Burda, C. Electrocardiographic changes in lightning stroke. *Am Heart J* 1966, **72**: 521–524.
2. Chia, B.L. Electrocardiographic abnormalities and congestive heart failure due to lightning stroke. *Cardiology* 1981, **68**: 49–53.
3. Jackson, S.H.D. & Parry, D.J. Lightning and the heart. *Br Heart J* 1980, **43**: 454–457.
4. Bazett, H.C. An analysis of the time-relations of the electrocardiogram. *Heart* 1920, **7**: 353–370.
5. Burgess, M.J., Green, L.S., Millar, K. *et al.* The sequence of normal ventricular recovery. *Am Heart J* 1972, **84**: 660–669.
6. R.A. Kenny & R. Sutton. The prolonged Q–T interval – a frequently unrecognised abnormality. *Postgrad Med J* 1985, **61**: 379–386.
7. Edvardsson, W. & Olsson, S.B. Effects of acute and chronic beta receptor blockade on ventricular repolarisation in man. *Br Heart J* 1981, **45**: 628–636.
8. Debbas, N.N.G., Du Cailar, C., Bexton, R.S., DeMaille, J.G., Camm, A.J. & S. Puech, P. The QT interval: a predictor of the plasma myocardial concentration of amiodarone. *Br Heart J* 1984, **51**: 316–320.
9. Burckhart, D., Raeder, E.A., Muller, R.V., Imhof, P. & Neubauer, H. Cardiovascular effects of tricyclic and tetracyclic antidepressants. *JAMA* 1978, **239**: 213–216.
10. Harries, A.D. Subarachnoid haemorrhage and the electrocardiogram – a review. *Postgrad Med J* 1981, **57**: 294–296.
11. Morgan, Z.V., Jr., Headley, R.N., Alexander, E.A. & Sawyer, G.G. Atrial fibrillation and epidural haematoma associated with lightning stroke. *N Engl J Med* 1958, **259**: 956–959.
12. El Sherif, N., Shcenlag, B.J., Lazzara, R. & Hope, R.R. Re-entrant ventricular arrhythmias in the late myocardial infarction period. Conduction characteristics in the infarction zone. *Circulation* 1977, **55**: 686–702.
13. Terranova, S. Case of myocardial infarction caused by atmospheric electrocution. *Riforme Med* 1957, **71**: 93–96.
14. Borggreffe, M., Breithardt, G., Seipel, L., Abendroth, R.R. & Yeh, H.L. Clinical electro-physiological findings in survivors of ventricular fibrillation. In Furlanello, F. and Disertori, M. (eds) *Proceedings of the 6th International Congress of Cardiology* OIC Medical Press, Florence, Italy, 1984, p 237.
15. Chatterjee, K., Harris, A., Davies, G. & Leatham, A. Electrocardiographic changes subsequent to artificial ventricular depolarisation. *Br Heart J* 1969, **31**, 770–779.
16. Rosenbaum, M.B., Blanco, H.H. Elizari, M.V., Lazzari, J.O. & Davidenko, J.M. Electronic modulation of the T wave and cardiac memory. *Am J Cardiol* 1982, **50**: 213–222.
17. Lipp, H., Pitt, A., Anderson, S.T. *et al.* Recurrent ventricular tachyarrhythmia in a patient with prolonged QT interval. *Med J Aust* 1970, **1**: 1296–1299.
18. Ratshin, R.A., Hund, D., Russel, R.O. & Rackley, C.E. QT interval prolongation, paroxysmal ventricular arrhythmia and convulsive syncope. *Ann Int Med* 1971, **75**: 919–924.
19. Schwartz, P.J., Periti, M. & Mallani, A. The long QT syndrome. *Am Heart J* 1975, **89**: 378–390.