



International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2016; 2(3): 38-45
© 2016 IJOS
www.orthopaper.com
Received: 09-05-2016
Accepted: 10-06-2016

Dr. PV Thirumalai Murugan
M.S., Ortho, Associate Professor,
Kanyakumari, Medical College,
Tamil Nadu, India.

Dr. S Shanmuganathan
M.S., Ortho, Professor, Madurai
Medical College, Tamil Nadu,
India.

Augmented plate osteosynthesis and bone grafting in aseptic non union femur with locked intramedullary nail

Dr. PV Thirumalai Murugan and Dr. S Shanmuganathan

Abstract

Intramedullary nails have been widely used to treat long bone fractures, most of which heal within the expected time. However, in some cases union fails to occur by the expected time due to various reasons. After treatment with intramedullary nails, fractures located at the metaphysis of long bones are especially prone for non union. The main reason for the non union is instability (rotational) at the fracture site.

Exchange Nailing With or Without Bone Grafting: It is the gold standard treatment in cases of non union in interlocked femur, but it has certain limitations. Plate augmentation with bone grafting eliminated the rotational instability at the fracture and additional bone grafting stimulated fracture healing. Plate augmentation and bone grafting without removing the nail had more advantages such as shorter operation time, less invasiveness and early weight bearing after surgery than plate fixation after removing the nail.

Materials and Method: Our study is a prospective study conducted from AUG 2008 to NOV 2012, involving 10 patients. All patients were primarily treated with closed intramedullary interlocking nailing for femoral shaft fractures. The mean interval between the primary interlocking nailing and the augmentative plating and bone grafting was 11 months. (Range from 6 months to 2 years).

Results: All cases were followed up every 4 weeks upto 4 month and then every two months upto 2 years. All cases started showing signs of healing from 6 weeks onwards and the fracture united radiologically at the end of 4 months without any serious complication except in one case with mild soft tissue infection which was treated with intravenous antibiotics.

Conclusion: Our study shows that augmentation plating with bone grafting gives excellent mechanical stability and improves the biology for fracture healing with less complications and less chances for resurgery

Keywords: Non union femur, delayed union, augmented plating, interlocking nail

Introduction

Intramedullary nails have been widely used to treat long bone fractures, most of which heal within the expected time. However, in some cases union fails to occur by the expected time due to various reasons. After treatment with intramedullary nails, fractures located at the metaphysis of long bones are especially prone for non union. The main reason for the non union is instability (rotational) at the fracture site.

Treatment Options

1. Dynamization
2. Bone grafting alone
3. Plate augmentation with bone grafting.
4. External fixation
5. Exchange nailing with or without bone grafting.

Dynamization

Dynamization is not applicable in all cases. For e.g., in a case of comminuted fracture, this may make the fracture site more unstable. Patient has to come for regular follow up, which is not possible in a country like ours.

It produces significant instability at the non union site and may also produce femoral shortening.

According to Wu *et al.* there is only 50% chance of union when dynamization is done in a case of non union femur.

Correspondence

Dr. PV Thirumalai Murugan
M.S., Ortho, Associate Professor,
Kanyakumari, Medical College,
Tamil Nadu, India.

Bone Grafting Alone

It is not of much use when non union is due to rotational instability at the fracture site, which is the most important reason for non union.

Exchange nailing with or without bone grafting

It is the gold standard treatment in cases of non union in interlocked femur, but it has certain limitations.

Its use is questionable in cases of comminuted fractures and fractures occurring in distal one-thirds of femur, where it does not fully eliminate the rotational instability at the non union site. It is ideal in cases of transverse and non comminuted fractures.

Minimum of 2mm larger nail should be used when an exchange nailing is done.

Rate of union after exchange nailing

1st exchange-53%-78%

2nd exchange-87%-95%

Plate Augmentation

According to study reported by Johnston, the rotational stability of the interlocking nail was 3% of that of the normal femur. Rotation of 10-15 occurred at the fracture site without resistance in the femur with intramedullary fixation.

This means that there was some limitation in the rotational stability after interlocking intramedullary fixation.

In distal one-third femoral shaft fractures or in comminuted fractures, exchange nailing with a larger diameter could not eliminate the rotational instability completely.

Plate augmentation with bone grafting eliminated the rotational instability at the fracture and additional bone grafting stimulated fracture healing. Plate augmentation and bone grafting without removing the nail had more advantages such as shorter operation time, less invasiveness and early weight bearing after surgery than plate fixation after removing the nail.

Materials and Method

Our study is a prospective study conducted from AUG 2008 to NOV 2012, involving 10 patients.

All patients were primarily treated with closed intramedullary interlocking nailing for femoral shaft fractures.

The mean interval between the primary interlocking nailing and the augmentative plating and bone grafting was 11 months. (Range from 6 months to 2 years)

Operative Technique

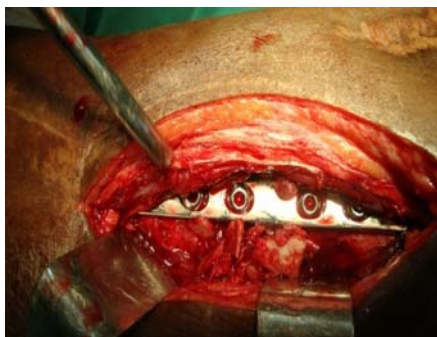
Through lateral approach, non union site was exposed.

Rotational instability at the non union site was visualized.

Femoral nail was retained in situ.

Bone graft was harvested from the ipsilateral iliac crest.

One 4.5mm broad dynamic compression plate was used with 4.5mm cortical screws.



If intramedullary nail was fixed in static mode it was changed to dynamic before augmentative plating. 6 cortical purchases (bicortical) were secured both proximal and distal to the non union site (bypassing the intramedullary nail).

Post-Operative Protocol

Knee bending exercises were started as soon as the pain subsided.

Patient was allowed partial weight bearing with crutches immediately after the pain subsided.

Sutures were removed on the 12th post op day.

Follow Up

All patients were followed once every 2 weeks in the first month, once a month thereafter.

Radiological and Functional evaluation was done at every visit.

Results

All cases were followed up every 4 weeks upto 4 month and then every two months upto 2 years. All cases started showing signs of healing from 6 weeks onwards and the fracture united radiologically at the end of 4 months without any serious complication except in one case with mild soft tissue infection which was treated with intravenous antibiotics.

Case 1

5 Months Post Operative X-Ray C/O pain on weight bearing

No evidence of any infection Oligotrophic non union.



Immediate Post Op X-Ray



At 6 Months Follow Up



Case 2

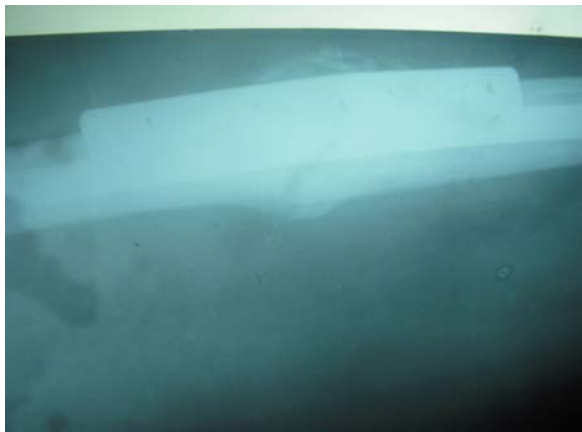
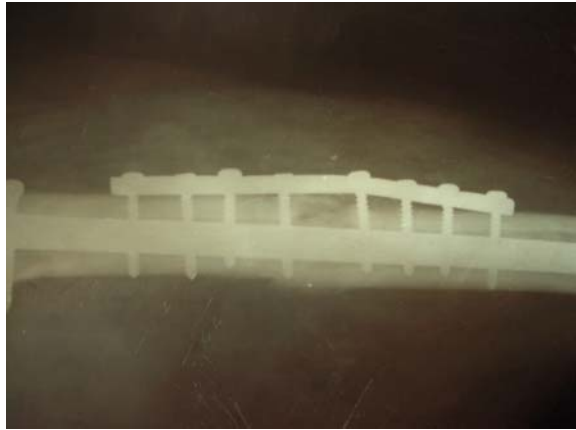
50 years old male sustained injury due to an RTA Underwent three surgeries-primary interlocking nailing and dynamization, bone grafting and exchange nailing.



Immediate post op
At 4 months follow up
Showing good healing response



8 Months Post Op



Immediate Post Op



10 Months post Op



Case 3

45 years male patient sustained injury due to an RTA
Closed interlocking nailing was done for # shaft of femur
10 months post operative x-ray



Case 4

Immediate post op x-ray



3 Months post op



Case 5

Immediate Post op



6 months post op



Discussion

Despite recent developments in fracture treatment, cases of non-unions of femoral shaft fractures following intramedullary nailing are still encountered. Reamed exchange nailing is most appropriate choice for aseptic, noncomminuted nonunions of the femoral diaphysis following prior intramedullary nailing.

In comminuted fractures the intramedullary nails are not canal filling which reduce stability in bending and rotation. The stability is further compromised in the distal third femoral shaft fractures because of the wide medullary canal.

The effectiveness of the exchange nailing in the treatment of nonunions following intramedullary nailing of comminuted fractures has been questioned. Weresh *et al.* 4 reported that only ten of nineteen femoral nonunions following locked intramedullary nailing of comminuted femoral fractures went to osseous union after exchange nailing. Similarly, Banaszkiwicz *et al.* 6 reported that only eleven of nineteen aseptic nonunions following locked intramedullary nailing of high energy, comminuted fractures went on to osseous union after treatment with exchange nailing alone.

Augmentative plate fixation in the presence of existing nail has been used for the management of femoral nonunions following intramedullary nailing. All previous studies have verified rotational instability of the fracture site during operation, which disappeared after plate augmentation. In all our cases there was visible motion at the fracture site which disappeared after plate augmentation.

Conclusion

Our study shows that augmentation plating with bone grafting gives excellent mechanical stability and improves the biology for fracture healing with less complications and less chances for resurgery.

Hence this is an excellent alternative to exchange nailing as a treatment for non union in interlocked femurs.

References

1. Küntscher G, Maatz R. Technik der Marknagelung. Leipzig: Georg Thieme Verlag, 1945.
2. Böhler L. Vorschlag zur Marknagelung nach Küntscher bei frischen Oberschenkelschussbrüchen. Der Chirurg. 1943; 15(1):8-13.
3. Canadian Orthopaedic Trauma Society Non-union following intramedullary nailing of the femur with and without reaming. Results of a multicenter randomized clinical trial. J Bone Joint Surg Am. 2003; 85A(11):2093-2096. [PubMed]
4. Attal R, Blauth M. Unreamed intramedullary nailing.

- Orthopade. 2010; 39(2):182-191. doi: 10.1007/s00132-009-1524-5. [PubMed] [Cross Ref]
5. Brinker MR. Skeletal trauma: basic science management, and reconstruction, 3 edn. Saunders, Philadelphia, 2003.
 6. Yu CW, Wu CC, Chen WJ. Aseptic non-union of a femoral shaft treated using exchange nailing. *Chang Gung Med J.* 2002; 25(9):591-598. [PubMed]
 7. Shroeder JE, Mosheiff R, Khoury A. The outcome of closed, intramedullary exchange nailing with reamed insertion in the treatment of femoral shaft non-unions. *J Orthop Trauma.* 2009; 23(9):653-657. doi: 10.1097/BOT.0b013e3181a2a337. [PubMed] [Cross Ref]
 8. Richardson JB, Gardner TN, Hardy JR. Dynamization of tibial fractures. *J Bone Joint Surg Br.* 1995; 77(3):412-416. [PubMed]
 9. Wu CC, Lee ZL. Low success rate of non-intervention after breakage of interlocking nails. *Int Orthop.* 2005; 29(2):105-108. doi: 10.1007/s00264-004-0628-0. [PMC free article] [PubMed] [Cross Ref]
 10. Pihlajamaki HK, Salminen ST, Bostman OM. The treatment of non-unions following intramedullary nailing of femoral shaft fractures. *J Orthop Trauma.* 2002; 16(6):394-402. doi: 10.1097/00005131-200207000-00005. [PubMed] [Cross Ref]
 11. Wu CC, Shih CH, Chen WJ. Effect of reaming bone grafting on treating femoral shaft aseptic non-union after plating. *Arch Orthop Trauma Surg.* 1999; 119:303-307. doi: 10.1007/s004020050415. [PubMed] [Cross Ref]
 12. Wu CC. Treatment of femoral shaft aseptic non-union associated with plating failure: emphasis on the situation of screw breakage. *J Trauma.* 2001; 51(4):710-713. doi: 10.1097/00005373-200110000-00014. [PubMed] [Cross Ref]
 13. Emara KM, Allam MF. Intramedullary fixation of failed plated femoral diaphyseal fractures: are bone grafts necessary? *J Trauma.* 2008; 65(3):692-697. doi: 10.1097/TA.0b013e31812f6dd9. [PubMed] [Cross Ref]
 14. Megas P, Syggelos SA, Kontakis G. Intramedullary nailing for the treatment of aseptic femoral shaft non-unions after plating failure: effectiveness and timing. *Injury.* 2009; 40(7):732-737. doi: 10.1016/j.injury.2008.11.008. [PubMed] [Cross Ref]
 15. Furlong AJ, Giannoudis PV, DeBoer P. Exchange nailing for femoral shaft aseptic non-union. *Injury.* 1999; 30(4):245-249. doi: 10.1016/S0020-1383(99)00073-X. [PubMed] [Cross Ref]
 16. Wu CC, Chen WJ. Treatment of femoral shaft aseptic non-unions: comparison between closed and open bone-grafting techniques. *J Trauma.* 1997; 43(1):112-116. doi: 10.1097/00005373-199707000-00026. [PubMed] [Cross Ref]
 17. Wu CC, Shih CH, Chen WJ. Treatment of ununited femoral shaft fractures associated with locked nail breakage: comparison between closed and open revision techniques. *J Orthop Trauma.* 1999; 13(7):494-500. doi: 10.1097/00005131-199909000-00006. [PubMed] [Cross Ref]
 18. Weresh MJ, Hakanson R, Stover MD. Failure of exchange reamed intramedullary nails for ununited femoral shaft fractures. *J Orthop Trauma.* 2000; 14(5):335-338. doi: 10.1097/00005131-200006000-00005. [PubMed] [Cross Ref]
 19. Hak DJ, Lee SS, Goulet JA. Success of exchange reamed intramedullary nailing for femoral shaft non-union or delayed union. *J Orthop Trauma.* 2000; 14(3):178-182. doi: 10.1097/00005131-200003000-00005. [PubMed] [Cross Ref]
 20. Wu CC, Chen WJ. Exchange nailing for aseptic non-union of the femoral shaft. *Int Orthop.* 2002; 26(2):80-84. [PMC free article] [PubMed]
 21. Banaszkiwicz PA, Sabboubeh A, McLeod I. Femoral exchange nailing for aseptic non-union: not the end to all problems. *Injury.* 2003; 34(5):349-356. doi: 10.1016/S0020-1383(02)00191-2. [PubMed] [Cross Ref]
 22. Wu CC. Exchange nailing for aseptic non-union of femoral shaft: a retrospective cohort study for effect of reaming size. *J Trauma.* 2007; 63(4):859-865. doi: 10.1097/01.ta.0000233663.24838.76. [PubMed] [Cross Ref]
 23. Wu CC, Lee ZL. Treatment of femoral shaft aseptic non-union associated with broken distal locked screws and shortening. *J Trauma.* 2005; 58(4):837-840. doi: 10.1097/01.TA.0000136307.63608.6D. [PubMed] [Cross Ref]
 24. Finkemeier CG, Chapman MW. Treatment of femoral diaphyseal non-unions. *Clin Orthop Relat Res.* 2002; 398:223-234. doi: 10.1097/00003086-200205000-00031. [PubMed] [Cross Ref]
 25. Weber BG, Čech O. *Pseudarthrosen.* Bern: Hans Huber, 1973.
 26. Nadkarni B, Srivastav S, Mittal V. Use of locking compression plates for long bone non-unions without removing existing intramedullary nail: review of literature and our experience. *J Trauma.* 2008; 65(2):482-486. doi: 10.1097/TA.0b013e31817c9905. [PubMed] [Cross Ref]
 27. Park J, Kim SG, Yoon HK. The treatment of nonisthmal femoral shaft non-unions with im nail exchange versus augmentation plating. *J Orthop Trauma.* 2010; 24(2):89-94. doi: 10.1097/BOT.0b013e3181b8dafd. [PubMed] [Cross Ref]
 28. Ueng SW, Chao EK, Lee SS. Augmentative plate fixation for the management of femoral non-union after intramedullary nailing. *J Trauma.* 1997; 43(4):640-644. doi: 10.1097/00005373-199710000-00013. [PubMed] [Cross Ref]
 29. Choi YS, Kim KS. Plate augmentation leaving the nail in situ and bone grafting for non-union of femoral shaft fractures. *Int Orthop.* 2005; 29(5):287-290. doi: 10.1007/s00264-005-0668-0. [PMC free article] [PubMed] [Cross Ref]
 30. Roetman B, Scholz N, Muhr G. Augmentive plate fixation in femoral non-unions after intramedullary nailing. Strategy after unsuccessful intramedullary nailing of the femur. *Z Orthop Unfall.* 2008; 146(5):586-590. [PubMed]
 31. Chen CM, Su YP, Hung SH. Dynamic compression plate and cancellous bone graft for aseptic non-union after intramedullary nailing of femoral fracture. *Orthopedics.* 2010; 33(6):393. [PubMed]
 32. Marti RK, Kloen P. *Concepts and cases in non-union treatment.* 1. Stuttgart: Georg Thieme Verlag. 2011, 20-150.
 33. Blatter G, Weber BG. Wave plate osteosynthesis as a salvage procedure. *Arch Orthop Trauma Surg.* 1990; 109(6):330-333. doi: 10.1007/BF00636171. [PubMed] [Cross Ref]
 34. Ring D, Jupiter JB, Sanders RA. Complex non-union of

- fractures of the femoral shaft treated by wave-plate osteosynthesis. *J Bone Joint Surg Br.* 1997; 79(2):289-294. doi: 10.1302/0301-620X.79B2.6886. [PubMed] [Cross Ref]
35. Schulz AP, Faschingbauer M, Seide K. Is the wave plate still a salvage procedure for femoral non-union? Results of 75 cases treated with a locked wave plate. *Eur J Trauma Emerg Surg.* 2009; 35-2:127-131. doi: 10.1007/s00068-008-8009-9. [PubMed] [Cross Ref]
 36. Prasarn ML, Ahn J, Achor T. Management of infected femoral non-unions with a single-staged protocol utilizing internal fixation. *Injury.* 2009; 40(11):1220-1225. doi: 10.1016/j.injury.2009.06.009. [PubMed] [Cross Ref]
 37. Cove JA, Lhowe DW, Jupiter JB. The management of femoral diaphyseal non-unions. *J Orthop Trauma.* 1997; 11(7):513-520. doi: 10.1097/00005131-199710000-00009. [PubMed] [Cross Ref]
 38. Oh I, Nahigian SH, Rascher JJ. Closed intramedullary nailing for ununited femoral shaft fractures. *Clin Orthop Relat Res.* 1975; 106:206-215. doi: 10.1097/00003086-197501000-00032. [PubMed] [Cross Ref]
 39. Harper MC. Ununited fractures of the femur stabilized with the fluted rod. *Clin Orthop Relat Res.* 1984; 190:273-278. [PubMed]
 40. Heiple KG, Figgie HE, 3rd, Lacey SH. Femoral shaft non-union treated by a fluted intramedullary rod. *Clin Orthop Relat Res.* 1985; 194:218-225. [PubMed]
 41. Webb LX, Winquist RA, Hansen ST. Intramedullary nailing and reaming for delayed union or non-union of the femoral shaft. A report of 105 consecutive cases. *Clin Orthop Relat Res.* 1986; 212:133-141. [PubMed]
 42. Kempf I, Grosse A, Rigaut P. The treatment of noninfected pseudarthrosis of the femur and tibia with locked intramedullary nailing. *Clin Orthop Relat Res.* 1986; 212:142-154. [PubMed]
 43. Jupiter JB, Bour CJ, May JW, Jr. The reconstruction of defects in the femoral shaft with vascularized transfers of fibular bone. *J Bone Joint Surg Am.* 1987; 69(3):365-374. [PubMed]
 44. Johnson EE. Custom titanium plating for failed non-union or delayed internal fixation of femoral fractures. *Clin Orthop Relat Res.* 1988; 234:195-203. [PubMed]
 45. Barquet A, Silva R, Massafiero J. The AO tubular external fixator in the treatment of open fractures and infected non-unions of the shaft of the femur. *Injury.* 1988; 19(6):415-420. doi: 10.1016/0020-1383(88)90137-4. [PubMed] [Cross Ref]
 46. Wu CC, Shih CH. Treatment of 84 cases of femoral non-union. *Acta Orthop Scand.* 1992; 63(1):57-60. doi: 10.3109/17453679209154851. [PubMed] [Cross Ref]
 47. Shih CHCC, Lee ZL. A simpler surgical technique to treat aseptic non-union-associated femoral length discrepancy. *Arch Orthop Trauma Surg.* 1992; 111(3):160-164. doi: 10.1007/BF00388091. [PubMed] [Cross Ref]
 48. Meng-Hai MH, Liu XY, Ge BF. An implant of a composite of bovine bone morphogenetic protein and plaster of paris for treatment of femoral shaft non-unions. *Int Surg.* 1996; 81(4):390-392. [PubMed]
 49. Weise K, Winter E. Role of intramedullary nailing in pseudarthrosis and malalignment. *Orthopade.* 1996; 25(3):247-258. [PubMed]
 50. Matelic TM, Monroe MT, Mast JW. The use of endosteal substitution in the treatment of recalcitrant non-unions of the femur: report of seven cases. *J Orthop Trauma.* 1996; 10(1):1-6. doi: 10.1097/00005131-199601000-00001. [PubMed] [Cross Ref]
 51. Bungaro P, Pascarella R, Colozza A. Rigid fixation with plate and bone graft in failures of intramedullary osteosynthesis for the treatment of diaphyseal non-union of the femur. *Chir Organi Mov.* 1999; 84(3):263-267. [PubMed]
 52. Bellabarba C, Ricci WM, Bolhofner BR. Results of indirect reduction and plating of femoral shaft non-unions after intramedullary nailing. *J Orthop Trauma.* 2001; 15(4):254-263. doi: 10.1097/00005131-200105000-00004. [PubMed] [Cross Ref]
 53. Rompe JD, Rosendahl T, Schollner C. High-energy extracorporeal shock wave treatment of non-unions. *Clin Orthop Relat Res.* 2001; 387:102-111. doi: 10.1097/00003086-200106000-00014. [PubMed] [Cross Ref]
 54. Abdel-Aa AM, Farouk OA, Elsayed A. The use of a locked plate in the treatment of ununited femoral shaft fractures. *J Trauma.* 2004; 57(4):832-836. doi: 10.1097/01.TA.0000092684.67107.EE. [PubMed] [Cross Ref]
 55. Wu CC, Lee ZL. One-stage lengthening using a locked nailing technique for distal femoral shaft non-unions associated with shortening. *J Orthop Trauma.* 2004; 18(2):75-80. doi: 10.1097/00005131-200402000-00003. [PubMed] [Cross Ref]
 56. Inan M, Karaoglu S, Cilli F. Treatment of femoral non-unions by using cyclic compression and distraction. *Clin Orthop Relat Res.* 2005; 436:222-228. doi: 10.1097/01.blo.0000159153.09508.97. [PubMed] [Cross Ref]
 57. Niedzwiedzki T, Brudnicki J, Niedzwiedzki L. Treatment of femoral shaft union disturbances with intramedullary nailing. Treatment failure. *Ortop Traumatol Rehabil.* 2007; 9(4):377-383. [PubMed]
 58. Oh JK, Bae JH, Oh CW. Treatment of femoral and tibial diaphyseal non-unions using reamed intramedullary nailing without bone graft. *Injury.* 2008; 39(8):952-959. doi: 10.1016/j.injury.2008.02.024. [PubMed] [Cross Ref]
 59. Steinberg EL, Keynan O, Sternheim A. Treatment of diaphyseal non-union of the femur and tibia using an expandable nailing system. *Injury.* 2009; 40(3):309-314. doi: 10.1016/j.injury.2008.07.029. [PubMed] [Cross Ref]
 60. Benazzo F, Mosconi M, Bove F. Treatment of femoral diaphyseal non-unions: our experience. *Injury.* 2010; 41(11):1156-1160. doi: 10.1016/j.injury.2010.08.010. [PubMed] [Cross Ref]
 61. Richter J, Schulze W, Muhr G. Diaphyseal femur pseudarthroses—only a technical problem? *Chirurg.* 2000; 71(9):1098-1106. doi: 10.1007/s001040051185. [PubMed] [Cross Ref]
 62. Moher D, Liberati A, Tetzlaff J, Altman DG. The Prisma Group Preferred reporting items for systematic reviews and meta-analyses: the Prisma statement. *PLoS Med.* 2009; 6(6):e1000097. doi: 10.1371/journal.pmed.1000097. [PMC free article] [PubMed] [Cross Ref]