

Early Functional and Radiological Outcomes Between Plaster Cast and Fiberglass Cast in Stable Thoracolumbar Burst Fracture

Zamzuri Z¹, Ariff Ms¹, Mohd Fairuz Ad¹, Mohd Shukrimi A¹, Nazri My¹

¹Dept. of Orthopaedics, Traumatology and Rehabilitation, Kulliyah (Faculty) of Medicine, IIUM Medical Centre, Kuantan, Malaysia

ABSTRACT

Introduction: Burst fracture results from compression failure of both the anterior and middle columns under substantial axial loads. Conservative treatment was a method of treatment for fractures without neurological deficit. This cross sectional study was designed to evaluate the functional and radiological outcome of patient with thoracolumbar burst fracture treated conservatively. **Methods:** 40 cases were recruited from January 2013 till December 2015. They were followed-up with minimum period of 1 year and evaluated for the functional (Oswestry Disability Index) and radiological outcomes (kyphotic angle deformity and anterior body compression). **Results:** 20 patients were treated with body cast made form plaster of Paris and remaining 20 patients with fiberglass cast. In plaster of Paris group, mean kyphotic angle deformity at last follow up was 16.60 ± 2.95 with a mean improvement 4.45 degree and anterior body compression at last follow up was $30.35\% \pm 10.2$ with mean improvement of 9.30%. In fiberglass group, mean kyphotic angle deformity at last follow up was 15.55 ± 3.38 with a mean improvement 7.25 degree and anterior body compression at last follow up was $25.90\% \pm 7.81$ with mean improvement of 3.45%. The functional outcome showed Oswestry Disability Index (ODI) score in plaster of Paris group was 23.70 (SD = 7.82) and in fiberglass group was 18.50 (SD = 5.94). **Conclusions:** Application of body cast using a fiberglass material give better radiological outcome hence less pain, more functional and higher patient's satisfaction as compared to plaster of Paris.

KEYWORDS: Thoracolumbar burst fracture, conservative treatment, functional outcome, radiological outcome

INTRODUCTION

Burst fracture account for up to 17% of all major spine fractures. It result from compression failure of both the anterior and middle columns under substantial axial loads¹. The thoracolumbar area is the commonest site for injury due to changes of rigid kyphotic thoracic spine to mobile lordotic lumbar spine². Patients may presented with or without neurological deficit where surgical decompression and stabilization was the treatment of choice for patient with incomplete neurological

compromise however a conservative treatment was a method of treatment for fractures without neurological deficit³. The advantage of conservative treatment is the low cost of treatment which is an important issue for patients with spinal fractures in the developing countries⁴. Non operative treatment with moulded brace without any reduction of fracture is a safe method of treatment of thoracolumbar burst fracture with normal neurology⁵. Many different protocol available for conservative treatment which involved initial bed rest with or without postural reduction followed by an application of extension body cast or brace and early mobilization.

In our centre, most of the stable thoracolumbar burst fracture will be treated conservatively with an extension body cast where the material can be a fiberglass or Plaster of Paris. The cost for fiberglass application was higher compare to the later. The objective of the study is to compare the radiological and functional outcome between the plaster cast and fiberglass cast in conservative treatment for stable thoracolumbar burst fracture.

Assoc. Prof. Dr. Zamzuri Zakaria
Department of Orthopaedics, Traumatology & Rehabilitation
Kulliyah of Medicine
International Islamic University Malaysia (IIUM)
Jalan Hospital, 25100 Kuantan, Pahang.
Tel no: +609-5706000
Fax no: +609-5144451
Email address: zamzuri@iium.edu.my

MATERIALS & METHODS

This cross sectional study was performed by reviewing patients and records of patients whom had been admitted for stable thoracolumbar burst fracture in orthopedic ward at Hospital Sultanah Aminah, Johor Bahru and Hospital Tengku Ampuan Afzan, Kuantan from 1st January 2013 until 31st December 2015. Inclusion criteria were; patients 15 years and above with stable thoracolumbar burst fracture treated with body cast, who attended regular follow ups and completed at least one year follow up. Exclusion criteria were patients who sustained unstable thoracolumbar burst fracture and patients who sustained polytrauma injuries.

The Mc Afee classification of thoracolumbar burst fracture was used and considered as stable if the fracture involved anterior and middle column, anterior vertebral height loss of less than 50 percent, intact posterior column and neurology, kyphotic angle of less than 15 degree and canal stenosis of less than 50 percent. Patients were divided into two groups based on the material used for body cast, which was either fiberglass or plaster of Paris. The radiological outcomes included anteroposterior and lateral views of the thoracolumbar spine taken after one year of follow up. Vertebral kyphosis was measured using a Cobb method as an angle between the superior endplate to the inferior endplate of the fractured vertebral body. The anterior body compression (ABC) was measured as the percentage of height loss from the anterior wall compared with the average of the vertebrae above and below it. The functional outcomes were evaluated using an Oswestry Low Back Pain Questionnaire. The questionnaire consists of ten sections describing patient's function in everyday life which includes pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, travelling and changing degree of pain. Each category is followed by six statements describing different potential scenarios in the patient's life relating to the topic in which patient choosing the statement that matches his or her disability. Each question is scored on a scale of 0-5 with the first statement being zero and indicating the least amount of disability and the last statement is scored 5 indicating most severe disability.

The scores for all questions answered are summed, and then multiplied by two to obtain the index (range 0 to 100). The final score will be categorized into minimal disability (score 0 to 19), moderate disability (score 20 to 39), severe disability (score 40 to 59), crippled (60 to 79) and bed bound (score 80 to 100). Statistical analysis was performed using SPSS software (version 15.0E; IBM, Armonk, NY, USA). Mann Whitney U test was used to compare the radiological and functional outcome between the two groups (fiberglass cast and plaster of Paris cast). Statistical significant was taken at $p < 0.05$.

RESULTS

There were a total of 40 patients who received conservative treatment, twenty patients were treated with a body cast made from plaster of Paris (group A) and the remaining 20 patients used cast made from fiberglass (group B). Sixteen male and 4 female in group A, 10 male and 10 female in group B; with ages ranging from 16 to 68 years. The most common mechanism of injury was due to motor vehicle accident (67%). The fracture was at L1 (47%, $n= 19$) and followed by L2 (23%, $n=9$), T12 (20%, $n=8$), L3 (5%, $n= 2$) and T11 (5%, $n=2$).

All patients had bony union within three months after application of body cast. In plaster cast group, the mean kyphotic angle deformity at last follow up was $16.60^{\circ} \pm 2.95$ with a mean improvement of kyphosis angle of 4.45 degree, whereas the mean of anterior body compression at last follow up was $30.35\% \pm 10.2$ with mean improvement of compression of 9.30%. Meanwhile in fiberglass cast group, the mean for kyphotic angle deformity at last follow up was $15.55^{\circ} \pm 3.38$ with a mean improvement of 7.25 degree. Mean anterior body compression in fiberglass cast group at last follow up was $25.90\% \pm 7.81$ with a mean improvement 13.45% (Table I).

In plaster cast group, the mean Oswestry Disability Index (ODI) scored at the last follow up evaluation was 23.70 ($SD=7.82$) with scores being minimal disability in 11 patients, moderate disability in seven patients and severe disability in two patients. In the fiberglass cast group, the mean ODI score was 18.50 ($SD=5.94$) with minimal disability in 11 patients and moderate disability in nine patients.

Mann-Whitney U test indicated that the difference in kyphosis deformity improvement was significantly greater in the fiberglass group at last follow up ($Mdn = -7.50$) than the plaster group ($Mdn = -3.00$), $U = 118.50$, $p = 0.026$. Similarly, significance difference was also observed for the anterior body compression difference in the fiberglass group ($Mdn = -14.50$) compared to the plaster group ($Mdn = -7.00$), $U = 127.50$, $p = 0.049$. No significant difference was indicated by Mann-Whitney test for functional score between the two groups (Table II).

DISCUSSIONS

This study was conducted to compare two different materials which are commonly used in the application of body cast for neurologically intact patients with a burst fracture of the thoracolumbar junction (T10 -L2). The materials of interest were fiberglass and plaster of Paris. The race distribution of the injury in this was dominated by Malay (65%) followed by Chinese (22%), Indian (10%) and others (3%). This pattern of distribution is in parallel with the distribution of race among Malaysian. Men with mean age of 40 years old were more likely to incur this type of injury as they are active income earners who travel on road most of the hours and exposed to

Table I: Radiological parameters at pre cast and last follow up between both groups.

Radiological Parameters	Mean (SD)	Minimum	Maximum	Median	Percentiles 25	Percentiles 75
<i>Plaster Cast Group</i>						
Age	42.45 (15.75)	16	68	48	25	55.75
Pre-cast Local Kyphotic Angle (°)	21.05 (4.67)	10	28	22	18	24.75
Last Follow-up Local Kyphotic Angle (°)	16.60 (2.95)	10	22	16	14.25	19.5
Difference Local Kyphotic Angle (°)	-4.45 (3.46)	-10	0	-3	-7.75	-2
Pre-cast Anterior Body Compression (%)	39.65 (10.36)	20	56	40	30.5	47.75
Last Follow-up Anterior Body Compression (%)	30.35 (10.25)	18	62	29	22	37.5
Difference Anterior Body Compression (%)	-9.30 (7.59)	-25	6	-7	-16	-4
<i>Fiberglass Cast Group</i>						
Age	37.95 (13.42)	16	63	40.5	23.5	46
Pre-cast Local Kyphotic Angle (°)	22.80 (4.67)	15	33	23.5	18.25	25
Last Follow-up Local Kyphotic Angle (°)	15.55 (3.38)	10	22	15	12	18
Difference Local Kyphotic Angle (°)	-7.25 (4.22)	-17	0	-7.5	-10	-3.5
Pre-cast Anterior Body Compression (%)	39.85 (7.80)	28	60	38	34	46.75
Last Follow-up Anterior Body Compression (%)	25.90 (7.81)	14	45	24.5	20	31.5
Difference Anterior Body Compression (%)	-13.45 (5.11)	-21	-4	-14.5	-17.75	-9.25

SD: standard deviation

various work-related injury. Radiographic evidence at one year follow up demonstrated a significance difference between the two groups with respect to fracture kyphosis on admission and at last follow up after one year ($p=0.026$). Both groups showed improvement in the kyphosis with treatment however, more patients in plaster of Paris group identified having no correction of kyphosis deformity at initial injury, after cast application and at last follow up. This may contribute to the overall difference between the two groups.

The degree of anterior body compression at the time of presentation was similar in both groups (39.85% and 39.65%). However, the fiberglass group demonstrated an improvement of anterior body compression and this differences were statistically significant ($p = 0.049$). In this study one patient in plaster of Paris group developed a worsening anterior body compression at last follow up. These

findings may be contributed by the material used in fiberglass which is made from fiber reinforced plastic containing silica or silicate with varying amount of oxides of calcium, magnesium and boron. Furthermore, fiberglass cast are at least twice as strong as those based on plaster of Paris⁶. It is light weight material, less brittle and can be readily molded into various complex shape therefore its application include in aircraft, boats, roofing, water tanks and swimming pool. Its strength and weight are also better than many metals with the stiffness in tension and compression but weak in shearing forces. The patient's compliance and satisfaction also better when using fiberglass type cast as it light weight which suitable for children and elderly. It is also more durable with less breakage rate when used in long duration and not readily damaged when in contact with water. Patients also did not report any incidence of skin irritation, burn or allergy to fiberglass.

Table 2: Difference between age, radiological and functional parameters of both groups of patients

	Group	Median	Percentile 25	Percentile 75	Mean Rank	Mann-Whitney U	p value*
Age	P	48	25	55.75	22.78	154.5	0.218
	F	40.5	23.5	46	18.23		
Pre Cast LKA (°)	P	22	18	24.75	18.43	158.5	0.258
	F	23.5	18.25	25	22.58		
Last Follow-up LKA(°)	P	16	14.25	19.5	22.5	160	0.276
	F	15	12	18	18.5		
Difference LKA(°)	P	-3	-7.75	-2	24.58	118.5	0.026
	F	-7.5	-10	-3.5	16.43		
Pre Cast ABC (%)	P	40	30.5	47.75	20.48	199.5	0.989
	F	38	34	46.75	20.53		
Last Follow-up ABC (%)	P	29	22	37.5	23	150	0.174
	F	24.5	20	31.5	18		
Difference ABC (%)	P	-7	-16	-4	24.13	127.5	0.049
	F	-14.5	-17.75	-9.25	16.88		
Oswestry disability score	P	22	18	27.5	23.95	131	0.06
	F	18	14.5	22	17.05		

* Analysis performed using Mann-Whitney U test
P: plaster of paris, F: fiberglass, LKA: local kyphotic angle, ABC: anterior body compression

In contrast, the plaster of Paris has been long used in orthopaedic and its first documented medical use dates back to 1852 by an army surgeon. The universal acceptance of plaster of Paris as a casting material is mainly due to low cost and easy moulding however the disadvantages include long setting times, messy application and low strength⁷. The strength depends upon the thickness of plaster and the shape of cast which follows the contours of the affected limb. However excess of plaster will also increase weight and heat product. Plaster of Paris slows to dry and gain full strength when in complete dry state which may take roughly 36 to 48 hours and seriously weakened if it becomes wet again. There were patients in this study group whose wearing plaster of Paris body cast experienced a breakage of body cast especially at the edges adjacent to bony prominence and as it also easily contact with water, hence required reapplication. Low compliance were observed with early removal as patients complained of itchiness, bulky weight and smelly from underneath cast from sweat.

In this study, no significant differences between the two treatment groups with respect to pain, personal care, lifting, walking, sitting, standing, sleeping, social life, travelling and changing degree of pain either at the time of presentation or at the final follow-up examination. This may contribute to the union of fracture after period of time which may improve pain.

In another aspect, few complications were noted with application both type of cast. These included

revision of cast due to loosening or broken cast, loss of reduction and correction, skin irritation and allergy and odour from sweating underneath cast. In another study of immobilization of fracture of arm and leg, fiberglass was preferred from plaster of Paris as it had shown lower breakdown rate, light weight, reduced odor from sweating under the cast, and overall fewer restriction and comfort⁸. In larger perspective, controversies regarding the treatment of choice in patients with thoracolumbar burst fracture still exist. According to one study reported excellent and satisfying results after treatment of burst fracture or compression fracture involving anterior and middle column by closed reduction and casting⁹. Another recent study reported a stable burst who was treated nonoperatively reported better function and less pain compared with those who were treated operatively¹⁰. In one of the prospective, randomized study found that operative treatment of patients with a burst fracture and normal neurologic findings would provide no advantages over nonoperative treatment¹¹. As limitation of this study, one should consider its retrospective nature and small sample size. Several reports have suggested that the accuracy and reproducibility of plain radiographic measurement of kyphotic angle and anterior body compression may be suboptimal. Additionally, no long term clinical and radiological assessment was performed for these patients as the outcome would be different in medium and long term follow up. We also did not assess the patients' socioeconomic status or level of education which may be confounding variables associated with this injuries. Finally, nearly half of our patients could not be located, or were unwilling

to participate in the study, which potentially resulting in biased study population. This study serves as a foundation upon which to build future investigations, including prospective randomised controlled trial which can give more understanding on this matter.

CONCLUSION

In conclusion, the application of body cast using a fiberglass material give better radiological outcome hence less pain, more functional and higher patient's satisfaction as compared to plaster of Paris.

REFERENCES

1. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine* 1983; 8: 817-831.
2. Gertzbein SD. Scoliosis Research Society. Multicenter spine fracture study. *Spine* 1992; 17 (5): 528-540.
3. Mumford J, Weinstein JN, Spratt KF, Goel VK. Thoracolumbar burst fracture. The clinical efficacy and outcome of non-operative management. *Spine* 1993; 18: 955-970.
4. White AA, Panjabi MM. Clinical biomechanic of the spine. Lippincort: Philadelphia, 1978.
5. Rajasekaran S. Thoracolumbar burst fractures without neurological deficit: the role for conservative treatment. *European Spine Journal* 2010; 19(1): 40-47.
6. Mihalko MM, Beaudoin AJ, Krause WR. Mechanical properties and material characteristics of orthopaedic casting material. *Journal of Orthopaedic Trauma* 1998; 3: 57-63.
7. Berman AT, Parks GP. A comparison of the mechanical properties of fiberglass cast materials and their clinical significance. *Journal of Orthopaedic Trauma* 1990; 4: 5-92.
8. Kowalski KL. Evaluation of fibre glass versus plaster of Paris for immobilization of fracture of arm and leg. *Military Medicine* 2002; 167: 657-61.
9. Weninger P, Schultz A. Conservative management of thoracolumbar compression and burst fracture. Functional and radiological outcome in 136 cases treated by close reduction and casting. *Archives of Orthopaedic and Trauma Surgery* 2009; 129(2): 207-219.
10. Kirkham BW, Buttermann G, Rishabh P, Christopher CH. Operative compared nonoperative treatment of a thoracolumbar burst fracture without neurological deficit. *Journal Bone and Joint Surgery (America)* 2015; 97: 3-9.
11. Wood K, Buttermann G, Mehbod A, Garvey T, Jhanjee R, Sechriest V. Operative compared

with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit. *Journal Bone and Joint Surgery (America)* 2003; 85-A: 773-781.

